Bulletin No. 251

Series { A, Economic Geology, 44
B, Descriptive Geology, 55

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

THE GOLD PLACERS OF THE FORTYMILE, BIRCH CREEK, AND FAIRBANKS REGIONS, ALASKA

BY

LOUIS M. PRINDLE

WASHINGTON
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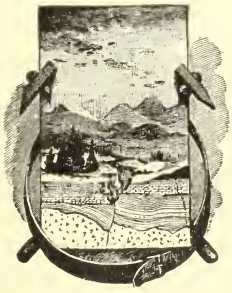

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LETTER OF TRANSMITTAL.

Department of the Interior,
United States Geological Survey,
Washington, D. C., June 28, 1904.

Sir: I have the honor to submit herewith the manuscript and illustrations of a report entitled "The Gold Placers of the Fortymile, Birch Creek, and Fairbanks Regions, Alaska," and to recommend its publication as a bulletin.

This report contains the economic results of a reconnaissance of these gold fields of the Yukon basin which was carried out by Mr. Louis M. Prindle last season (1903). It has been prepared essentially for the placer miner and prospector, for which reason the descriptions of the auriferous gravels are presented in considerable detail, while only the salient features of the geology are treated. This course was determined upon because, although there was an immediate demand on the part of the mining public for information in regard to the gold placers, the geology is so complex that it will require several more field seasons to solve even the general problems of structure and succession.

Although the Fortymile and Birch Creek districts are among the oldest of the gold-placer producers of Alaska, Mr. Prindle's investigations show that they are by no means exhausted, and that, with the introduction of improved methods of mining, they will continue to yield good returns. It is too soon to predict the future of the newly discovered Fairbanks placers, but they show every evidence of handsome profits. The facts presented by Mr. Prindle indicate that the conditions of occurrence of the gold are such that for profitable exploitation it must be mined by improved methods, and should invite the attention of capitalists. The fact that the placers are within a few miles of water transportation on the Tanana will permit the introduction of machinery at much less cost than at some of the older camps.

The value of this publication is much increased because it becomes the medium of making public two reconnaissance maps of the

region based on surveys by Mr. T. G. Gerdine in 1903. One map, on a scale of 1:250,000, extends from Fairbanks to Circle, and the other, on a scale of 1:625,000, embraces the entire Yukon-Tanana district.

The maps and the text of this report must be regarded as preliminary, for at this writing both geologic and topographic surveys are in progress in the same field.

Very respectfully,

ALFRED H. BROOKS,
Geologist in Charge Division of Alaskan Mineral Resources.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

OUTLINE MAP OF ALASKA.

THE GOLD PLACERS OF FORTYMILE, BIRCH CREEK, AND FAIRBANKS REGIONS, ALASKA.

By L. M. Prindle.

INTRODUCTION.

GEOGRAPHIC RELATIONS.

The Yukon-Tanana interstream area, which includes from 35,000 to 40,000 square miles, is naturally delimited by the Yukon and Tanana rivers, which for some distance flow northwesterly in nearly parallel courses about 100 miles apart. At the Arctic Circle, however, the Yukon makes its great bend to the southwest, and, 200 miles farther on, near the one hundred and fifty-second meridian, in the central portion of Alaska, is joined by the Tanana (Pl. I). The area is thus irregularly shaped, its longer diameter extending northwest and southeast. On the east it is delimited by the international boundary—the one hundred and forty-first meridian—along which it extends to the south somewhat beyond the sixty-third parallel; on the north it just crosses the Arctic Circle (Pl. XVI, in pocket).

ECONOMIC DEVELOPMENT.

Some of the earliest prospecting in the interior was done in this area, and portions of it are comparatively well known. The discovery of placer gold on Fortymile in 1886, and the later discoveries in 1893 in the Birch Creek and Rampart regions, led to a rapid development of the creeks tributary to the Yukon. During the summer of 1902 placer gold was found in quantities of economic importance about 200 miles above the mouth of the Tanana and a few miles north of the river. This led to an influx of people and the formation of a center of population on the Tanana side of the area.

There are at the present time in the Yukon-Tanana country four widely separated regions which are producing placer gold—the Fortymile region, the Birch Creek region, the Rampart region, and the Fairbanks region. The Yukon and the Tanana are the main routes of travel, and from these rivers the gold-producing creeks are

reached either by overland trails or by tributaries which are navigable for small boats.

Fortymile region (Pl. VII).—Eagle, the principal town of the Fortymile region, is pleasantly situated on the west side of the Yukon, about 100 miles below Dawson. There are trails to the placer camps in the vicinity of Fortymile Creek, 60 miles to the south, to the important localities on American Creek, only about 12 miles to the south, and to those scattered along the Seventymile, about 50 miles to the west. Eagle, so far as its location will allow, is a source of supply for this region; it has a population of about 300, and was incorporated in 1891. An army post is located there, and the town is the terminus of the Government trail and telegraph line from Valdes to the Yukon. There is also telegraphic communication with the upper Yukon, the whole region being thus brought into close touch with the rest of the world.

There are two main trails to the Fortymile country. One is by way of Thirteenmile Camp, Liberty Fork, and Dome Creek to the junction of Fortymile and Steele creeks, about 40 miles south from Eagle. The settlement at the mouth of Steele Creek is shown in Pl. II, A. Thence the trail follows the divide to the southwest, crosses South Fork at Franklin, and passes from the Fortymile region to the Kechumstuk Hills and the Tanana. This trail traverses most of the areas of economic importance, and all creeks where mining is in progress can be reached from it by side trails. It is generally followed by the mail carriers on the Valdes-Eagle route. Roadhouses are located at Steele Creek and on all the important gold-producing creeks. The other trail, known as the Government route, leaves the first at the Thirteenmile Camp, follows the long divide to the southwest between the headwaters of Champion and O'Brien creeks, and crosses North Fork at the telegraph office, about 8 miles above the "Kink."

In dry weather these trails afford good traveling for pack trains, but transportation of supplies is so expensive that most of the miners in the Fortymile area get their supplies elsewhere than at Eagle. In the absence of good roads the trade necessarily goes up the river, generally to Dawson; in this case duties must be paid at the boundary, and these add greatly to the burdens of the miner. Navigation on the Fortymile is rather difficult, as the current is frequently swift and rapids are numerous, but small boats carry freight as far as Chicken Creek on Mosquito Fork. Transportation rates to the Fortymile area by pack train during the summer are as high as 25 cents a pound, but in winter, when freighting is comparatively easy, the average is about 5 cents a pound. Most of the men buy their supplies at Dawson in the fall and have them freighted to the creeks during the winter. During the summer of 1903 prices of supplies on the creeks

A. STEELE CREEK, WITH FORTYMILE CREEK IN THE FOREGROUND.

B. GLACIER MOUNTAIN.

were found to be as high as 30 cents per pound for sugar, $8.50 for a 50-pound sack of flour, and 50 cents a pound for bacon.

The important localities on American Creek can be easily visited in a day's trip from Eagle by a trail which climbs the long spur west of American Creek, from which a comprehensive view of the whole area can be obtained, and then descends abruptly into the deep valley of the creek. In wet weather the trail is a rather hard one to travel. These localities can also be reached by following the Steele Creek trail about 10 miles to a point where a branch trail leads down a steep descent to Star Gulch.

The localities on the Seventymile where work is in progress are widely separated and are generally reached by a trail which crosses Mission Creek at its junction with Excelsior Creek, follows the ridge north of Excelsior, crosses Bryant about 4 miles from the mouth, climbs to the ridge on the west, and then drops down into the valley of the Seventymile and follows the stream to the falls; from the falls to Barney Creek it keeps on the north side, and in places is better along the base of the ridge; about half a mile above Barney Creek it leaves the river for the ridge on the north side. This is the starting point of the route overland from the Seventymile to the Birch Creek region, about 120 miles to the northwest from Eagle. The ridge to the south of the Seventymile is preferred by some of the miners in traveling from the upper Seventymile to Eagle. This is a high, dry trail that leads round the north end of Glacier Mountain, down the long spur between Excelsior and Mission creeks, and thence to Eagle.

Birch Creek region.—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, which are situated about 50 miles to the south, across the Yukon Flats, just within the edge of the plateau country. The trail between Circle and the gulches is direct and good during dry weather, but in long-continued rain it 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 the winter.

Rampart region.—Rampart, which is about 170 miles below Circle, is the supply point for the men working in the neighboring gulches. There are trails up Little Minook Creek over the divide to the headwaters of Troublesome Creek and the Hutlina, and up the Minook to the Glenn Creek country, 25 miles south of Rampart.

Fairbanks region.—The new towns of Fairbanks and Chena are situated about 200 miles up the Tanana Valley. Chena is on the main

river and Fairbanks is about 9 miles above, on a slough, while the gulches where work is being done are about 12 miles to the north. Fairbanks, which is about 200 miles due west of Eagle and 150 miles southwest of Circle, is accessible by trails from both places. That from Circle is the shorter and better. Stores are located at both places, and both are supply points for the camps. Only the smaller river boats, like the *Koyukuk* (a most useful type of boat, 120 feet long by 24 feet wide, with an average draft of 22 inches), are used on the Chena Slough. Chena, however, is accessible by the larger river boats. There are trails from both settlements to the creeks, but that from Chena is somewhat longer, and, following lower ground, is not so good a one to travel during the summer season. Where the trails pass through the timber they have been well cleared; along the creek bottoms they are often soft. Pack trains make regular trips and carry supplies at about the same rates as in the other regions. Various business interests are represented in the two towns, and three sawmills were in operation at Fairbanks in 1903, with a daily capacity of about 50,000 feet. The Government telegraph line along the Tanana has brought the region into close communication with the outside world.

The population of the two places, with that of the creeks, was about 800 in 1903, and over 4,000 in 1904.

CLIMATE AND VEGETATION.

Although the winters are intensely cold, the summers are much warmer than is generally supposed, and the great number of hours during which the sun is above the horizon compensates for the shortness of the summer; the weather is often hot; frosts are generally uncommon, and the conditions are favorable for the development of an abundant vegetation.

The most common trees are the spruce, aspen, and birch, while alder and willow grow thickly along the stream courses, and a scattering growth of tamarack is found in the valleys of the Yukon and Tanana rivers. Spruce grows abundantly in the valleys of the larger streams and attains considerable size; throughout the area it is found along the steep slopes of the deep gulches as high as the climatic conditions will permit, and even covers with a light growth the lower ridges in the vicinity of the main drainage lines. The higher slopes and ridges are often covered with dwarf birch and alder, which finally give place to the moss-covered surface of the divides. The aspen is found abundantly along the stream bottoms, and birch is common near the large rivers.

Feed for stock is found in the headwater valleys of the streams throughout most of the region and is generally abundant along the larger streams. At Eagle, and also near Central House, in the Birch

Creek region, hay is put up for use during the winter months, and in portions of the Tanana Valley grass grows luxuriantly. One of the interesting sights of the trip was that of a bunch of cattle near the Tanana resting lazily in the warm sunshine of a September day surrounded by an abundance of good grass.

WORK OF THE SURVEY.

PREVIOUS WORK.

The Fortymile, Birch Creek, and Rampart regions were visited in 1896 by a survey party consisting of Spurr, Goodrich, and Schrader, the trip resulting in detailed descriptions of the gold-producing areas, an account of the developments that had been made up to that time, and sketch maps of the areas traversed.[a]

In 1898 Mr. Alfred H. Brooks,[b] of the Survey, studied the geography and geology along the Tanana side of the area and noted the lithologic resemblances to the gold-bearing rocks of the Fortymile and Birch Creek regions, described by Spurr. The valley of the Tanana was mapped, and in the same year another party, led by Mr. E. C. Barnard, made a map of the Fortymile region on a scale of about 4 miles to the inch (Pl. VII).

The trip of the Peters and Brooks party[c] of the Survey, in 1899, gave an opportunity for comparing the geology of this area with that of the country south of the Tanana, and to note the economic developments that had been made in the Fortymile region since the visit of the Spurr party.

In 1902 Mr. Collier studied the geology along the Yukon with special reference to the occurrence of coal, and investigated the gold placer diggings on Glenn Creek in the Rampart region.[d] During the same season the Brooks party from the Mount McKinley region crossed the Tanana at Tortella and studied a section of the area from this river to Rampart.[e]

WORK OF 1903.

Exploitation has been steadily carried forward since Spurr's investigations, and the camps have continued to develop in spite of the

[a] Spurr, J. E., Geology of the Yukon gold districts, Alaska: Eighteenth Ann. Rept. U. S. Geol Survey, pt. 3, 1898, pp. 87–392.

[b] A reconnaissance in the Tanana and White river basins, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, 1900, pt. 7, pp. 425–494.

[c] Brooks, Alfred H., A reconnaissance from Pyramid Harbor to Eagle City, Alaska, including a description of the copper deposits on the Copper and Tanana rivers: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 2, 1900, pp. 331–391.

[d] Collier, Arthur J., The Glenn Creek gold mining district, Alaska: Bull. U. S. Geol. Survey No. 213, 1903, pp. 49–56; The coal resources of the Yukon, Alaska: Bul. U. S. Geol. Survey No. 218, 1903.

[e] Brooks, Alfred H., An exploration in the Mount McKinley region, Alaska: Prof. Paper U. S. Geol. Survey No. — (in preparation).

great discoveries at Dawson and Nome. Miners who have tried their luck at these more promising localities have often returned to make a living at the old camps, where many of the pioneers are now to be found. In consequence of these developments and of the demands on the part of the public for information in regard to these districts, two Geological Survey parties were sent to this field in the season of 1903, one under charge of Mr. T. G. Gerdine, to make a topographic survey between Eagle and the Tanana and from Tanana to Circle; and the other, under charge of the writer, to study, so far as possible within the limits of a single field season, the occurrence of gold in the placers of the districts which have been mentioned, and to extend the studies of the geologic problems. The following report includes only the results of immediate economic bearing, the publication of the geology being deferred until further studies have been made.

Topographic party.—The combined topographic and geologic parties, in charge of Mr. T. G. Gerdine, topographer, traveled by way of Dawson to Eagle, arriving there June 16. Mr. Gerdine, with Mr. R. B. Oliver (assistant), 6 men, and 14 horses, began the topographic work about 30 miles west of Eagle and carried a belt of reconnaissance mapping to the southwest into the Goodpaster Valley, and thence across the Salcha nearly to Fairbanks. Here, unfortunately, the surveys were interrupted by a dense pall of smoke from forest fires, but they were begun again at Fairbanks, on the Tanana, and carried northeast through the new gold district as well as through the older Birch Creek diggings, and thence to Circle, on the Yukon, which was reached about the middle of September. Within the limits of one season Messrs. Gerdine and Oliver completed the reconnaissance mapping of over 6,000 square miles, and much of the value of this report rests in the fact that through it these cartographic results are presented to the public. The map of the Fairbanks-Birch Creek regions, on a scale of about 4 miles to the inch (1:250000), includes the region between the Tanana and Circle (Pl. XIII). A second map (Pl. XVI) has been prepared, on a scale of 10 miles to the inch (1:625000), of the entire region, which embraces not only Mr. Gerdine's surveys, but all those that were previously made in the entire Yukon-Tanana region.

Geologic party.—The writer's party, which included a packer, a cook, and 7 horses, began work at Eagle on June 16 and continued it until the close of the season at Fairbanks on September 12, during which time about 400 miles were traveled. Eighty-eight days were available for work, fifty-five of which were bright and clear. The latter part of June and July were spent in the placer camps of the Fortymile area, those near Eagle, and those on the Seventymile; the month of August in traveling from Eagle to Birch Creek and in studying the placers of the Birch Creek region; and the time that

emained in making a trip across country to the Tanana and in the Fairbanks placer region, where only four days were available for work.

The work was concentrated on the gold-producing creeks and localities where prospecting was in progress, with the aim of learning as much as possible in regard to the origin and distribution of the gold, the methods by which it is obtained, and the undeveloped possibilities of the older as well as the newer camps.

The journey naturally falls into four divisions—that from Eagle to the Fortymile country and return, that embraced by side trips in the vicinity of Eagle and to the Seventymile, that from Eagle to Birch Creek, and that from the Birch Creek region to the Tanana.

In the Fortymile region the writer visited Wade Creek, Walker Fork, Franklin Creek, Chicken Creek, North Fork of Fortymile, and several outlying localities where some work is being done; in the vicinity of Eagle, American Creek and Discovery Fork and the localities on the Seventymile; in the Birch Creek region, Deadwood, Mammoth, Mastodon, Miller, and Eagle creeks; in the Fairbanks region, Pedro, Cleary, and Fairbanks creeks.[a]

From Eagle (see map, Pl. VII) the party traveled south along the Steele Creek trail, crossed the Fortymile at Steele Creek and the South Fork at Franklin Creek, encircled the headwaters of Buckskin Creek to the telegraph line, and traveled thence to the "Kink," on North Fork of Fortymile, outside the area shown on the map. (Pl. VII.) From this point a good trail was followed along the divide in a northeasterly direction to Eagle. In crossing the country from Eagle to Birch Creek a northeasterly course was taken. The ridge to the north of the Seventymile at Flume Creek was found to offer good traveling, and farther to the west the northern slopes of a group of sharp peaks were traversed till a descent was made to Fiat Creek. Charley Creek was crossed without difficulty at a point perhaps 30 miles above the mouth, where it flows in a meandering course in a narrow canyon. A divide was then followed for three days without crossing a single stream to the forks of South Fork of Birch Creek, keeping the northern tributary of this fork, with its deep canyons, on the north. Birch Creek was crossed at a point about 6 miles above where it emerges from the hills into the great flat country south from Circle, and the divide was followed round toward Deadwood Creek till a trail was found crossing the flat from the Hot Springs to Central House. The distance from Eagle to Central House in a straight line is about 120 miles. The course followed by the Survey party was found to be comparatively direct;

[a] The writer, assisted by Mr. F. L. Hess, revisited the Fairbanks district in 1904, and has been possible to embody in this report a description of the present developments this portion of the Yukon-Tanana region.

the only points where difficulties may be encountered are at Charley River and Birch Creek, which at times of high water may become sources of delay, though at low water they present no difficulties. Charley River was easily crossed, but high water caused a delay of two days at Birch Creek.

From the Birch Creek region there is a direct and easy trail to the Tanana, by which Fairbanks, 150 miles to the southwest from Circle, was reached the night of September 11, just in time to take the steamer down the river next morning.

Conditions of travel.—Traveling through the Yukon-Tanana country with pack trains is comparatively easy. The trail keeps mostly to the divides, and these, except in rainy weather, generally afford good firm footing and can often be followed for two or three days without crossing the main drainage lines. The summer of 1903 was very dry in the Fortymile region, and the hot days of June and July, hazy with the smoke of many forest fires, hardened the trail and lowered the streams till the conditions were unusually favorable for travel.

When traveling on the high divides, which are covered only with moss or a sparse growth of dwarf birch and occasional clumps of alder, it is easy at camping time to drop down to the green valley of some small stream where the horses find the freshest grass and where the straggling spruces from the thickly covered slopes furnish abundant firewood. In these upper valleys caribou are frequently to be found in great abundance during the fall and winter months. Hundreds of them were encountered between the Seventymile and Birch Creek. They betrayed only curiosity at the presence of the pack train and were apparently migrating slowly toward the east.

The larger streams can generally be forded at low water, and at the points where the main trails cross them ferry boats are available for the transportation of passengers and outfits, while horses cross either by wading or swimming. At Fairbanks a wire-cable ferry has been constructed capable of carrying several horses with their packs.[a] A wire cable was also in use at Twelvemile, on Birch Creek. In case of sudden rain a stream like Birch Creek may rise several feet in a few hours, and the crossing, which was so easy while the water was low and clear, becomes an impossibility till the flood has subsided. Fortunately, with clear weather the water falls rapidly and the crossing can be made in a day or so with little difficulty. This sudden change in character illustrates the delicate adjustment between the streams and the weather conditions, which results from the fact that, in consequence of the frozen character of most of the ground in the drainage areas, the rainfall finds its way rapidly to the streams.

[a] A bridge has replaced the wire-cable ferry.

Road houses have been established at points along the main trails n the vicinity of the mining regions. Good board and bunks are to e had, and the cultivation of garden spots within the last few years as resulted in the addition of a wholesome variety of fresh vege- ables to the ordinary Alaskan diet. Caribou, too, killed in the fall nd winter months, are often kept in cold storage throughout the ummer in ice houses or in old shafts, where at a depth of 20 to 30 eet the ground is always frozen. Grayling are abundant in the lear streams and are easily caught.

The members of the party during the journey often experienced he helpfulness and hospitality so characteristic of the prospector, nd have occasion to look back with pleasure upon the days spent mong men who have labored hard in a quiet way to satisfy the raving for individual independence and have gained through hard- hip something that is worth while even if their hopes are yet un- ealized. In the hazy atmosphere of an after-dinner smoke in some eatly kept cabin bits of Alaskan exploration come to the surface vhich tell most forcibly the story of the days of 1898; or perhaps a lue column of smoke, faintly rising from the spruces of some lonely ulch, guides one to the temporary camp of a pioneer who has been n Alaska since the first discovery of gold. Over a cup of coffee, pre- ared in an old baking-powder can, one is made to understand the mportant part these men have played in the development of this por- ion of our possessions and their reasons for having learned to call t home.

GEOGRAPHIC DESCRIPTION.

TOPOGRAPHY.

The Yukon-Tanana area is only a portion of the great interior lateau which extends from the northern base of the Pacific Moun- ain system to the Rocky Mountains, far north of Yukon River and east nd west throughout Alaska. The average altitude is about 3,000 feet bove sea level, and the undulating surface presents a comparatively ven sky line, broken by occasional, short, rugged, sharp-peaked idges, which rise to a height of about 6,000 feet, and by lower, solated prominences, locally known as "domes." (See map, Pl. XVI, n pocket.) The apparent continuity of the general surface is inter- upted by many steep-walled valleys which have been incised to a epth of 1,000 to 3,000 feet and have made the area one of broad ndulating divides and long flat-topped spurs, all of nearly uniform levation. Toward the Yukon the plateau region breaks off abruptly o the river or to the surface of the large area known as the Yukon flats, and the outer edge of it has frequently become a fringe of sharp idges separating the many smaller streams in the vicinity of the

river. On the southern side the ridges often persist to the Tanana, or become gradually lower toward its valley or those of its tributaries. The valleys, too, are more open than those on the Yukon side.

DRAINAGE.

There is no well-defined divide between the two rivers, and the drainage is carried away by their interlocking tributaries, which often pursue most irregular courses. The most important tributaries of the Yukon within this area are the Fortymile, Mission, Seventymile, Charley, Birch, Preacher, Beaver, Hess, and Minook; those of the Tanana are the Volkmar, Goodpaster, Salcha, Chena, Tolovana, and Baker.

FORTYMILE REGION.

General character.—The greater portion of the Fortymile region, about 2,100 square miles, is included in the Fortymile quadrangle, which was mapped by Mr. E. C. Barnard in 1898, and shown on Pl. VII of this report.

In this region the mountains are of two types—ridge and dome. Glacier Mountain, 15 miles west from Eagle, which is one of the most prominent examples of the ridge type, is partly shown in Pl. II, *B*. It is a gray, sharp-peaked ridge, with a northeast-southwest trend, an altitude of about 6,000 feet, and a length of about 10 miles. It forms a strong contrast to the surrounding country. From its flanks can be seen several domes which attain heights up to 5,000 or more feet. Fortymile Dome, about 15 miles south of the Yukon, along the boundary, is one of the most conspicuous examples. Between these types of prominences extends the undulating plateau-like areas interrupted by the valleys of many streams.

The Yukon River at Eagle is about 810 feet above sea level, and its tributaries have consequently a fall of something like 2,000 feet from their sources in the plateau country to the level of the main river. As the Yukon has been cutting for itself a narrow valley in the Yukon Plateau, so the many tributaries have been deepening their channels until the prevalent type is that of the canyon. The most important streams are the Fortymile, Mission, and Seventymile.

Fortymile system.—Fortymile Creek, which drains about two-thirds of the area, is formed by the union of North and South forks at a point about 45 miles southwest from Eagle and 25 miles west of the boundary and flows in a meandering easterly direction to the Yukon through a narrow valley (Pl. III, *A*), the bottom of which, where the forks join, is about 1,000 feet above sea level. From the higher elevations a few miles back long spurs descend toward the stream with gradual slopes, which at an elevation of about 500 feet above

the stream and in places as far as a mile back from it are conspicuously benched. The bench can be traced all along this portion of the river and is the floor of an older valley formed by the stream and occupied by it at a period before the present canyon was commenced. This feature is well shown on the map of the Fortymile quadrangle (Pl. VII).

The Fortymile, which varies in width from 250 to 300 feet or more, carries a considerable volume of water, and often flows in long reaches of quiet water, separated by riffles caused by outcrops of bed rock across the stream. Navigation is rather difficult, but freight is carried in small boats as far as Chicken Creek on South Fork. At low water the stream is easily forded by pack animals.

North Fork, which drains a large area to the west and has numerous tributaries from the north toward Glacier Mountain, has sunk itself in a canyon like that of Fortymile, and flows in an easterly direction to the main river. South Fork, on the other hand, flows in a general northerly direction in a canyon which becomes more open toward the south and bends abruptly to the west about 15 miles above the forks; 5 miles beyond, it divides into Denison and Mosquito forks, which drain a large area to the south and west. Because of its placers, Chicken Creek is an important tributary of the latter. Walker Fork heads on the Canadian side, flows in an irregular westerly direction, and joins South Fork about 12 miles south of the main forks; it forms the southern boundary of an area containing several creeks of economic importance. Fortymile, between the forks and the boundary, receives from the south several small tributaries, of which Canyon Creek, about 5 miles west of the boundary, is the most important. A larger number of creeks are tributary from the north, but most of them are small. O'Brien Creek, however, gathers the drainage from an area extending 25 miles to the north, where its most distant sources are opposite those of American Creek.

Mission Creek system.—The Mission Creek system drains the area between Glacier Mountain and Eagle. The headwaters of its many tributaries are cutting into the plateau surface far more vigorously than are those of the Fortymile system, which flow in less accentuated valleys on the southern side of the divide with the decreased power due to greater distance from the major stream. For the greater portion of their courses Mission Creek and its tributaries flow in a northeasterly direction. At the point where Excelsior Creek joins it the main stream turns nearly at right angles to its former direction, and flows southeast for a distance of about 8 miles to the Yukon. The valley through this part of its course is unsymmetrical, being bounded on the north by a steep ridge and on the south by a slope 3 or 4 miles in width, which rises gradually toward the higher level. The stream belongs to a smaller class than the Fortymile and is

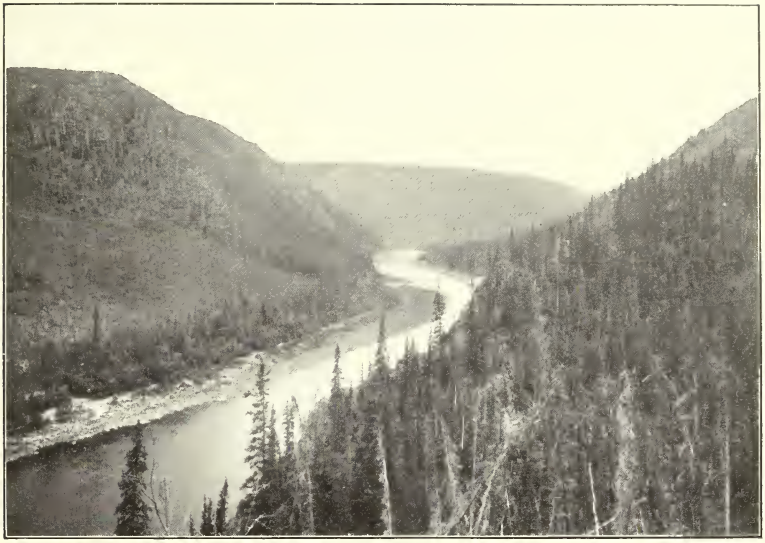
shallow and swift, with an average width of perhaps 30 feet. American Creek is its most important tributary.

Seventymile system.—The Seventymile, which is nearly the size of Fortymile, has a length of about 75 miles, and flows in a general easterly course, through a beautiful valley, to the Yukon, about 25 miles below Eagle. Its upper valley is of the canyon type, but at Barney Creek, about 30 miles west of Eagle, it becomes broader, and is bounded on the north by a high, steep ridge, and on the south by massive spurs that descend rather abruptly from the plateau region to the foot of a flat which is about one-half mile in width and from 10 to 20 feet above the level of the present stream. In the canyon portion the spurs from the hills to the south are even more clearly benched than are those on the Fortymile. The surface of the most prominent bench 500 feet above the stream, is shown in the accompanying photograph (Pl. III, *B*). Farther south the hills rise to a height of about 2,500 feet or more above the river, and exhibit beautifully preserved rock-cut benches to their summits, which are flat topped, several acres in extent, and often correspond in level to the truncated tops of neighboring hills. The benches, except where obscured by gulches, can be traced around the hills: they are especially prominent on the spurs and occur at corresponding levels. The vertical distance between the step-like benches varies from a few feet to about 50 feet, the rise from one to the other often showing an outcrop of the bed rock. The rocks comprising this area are highly contorted metamorphic schists and granular intrusives. Whatever the bed rock or its attitude, the same forms have been developed and are most striking features of the landscape. Similar forms were observed in other localities on the northern side of the Yukon-Tanana country, but nowhere exhibited such development as in the valley of the Seventymile.

The tributaries from the north are short and enter the river through deep, narrow canyons. Some of those from the south attain a length of from 12 to 15 miles. Bryant, Mogul, Granite, and Flume are the most important. These head in beautiful open valleys, which become narrower as the main river is approached, until, in the lower portions the streams flow through narrow canyons cut by them in the broad flat bench, which, at the Seventymile, is about 500 feet above the stream.

The river can be easily forded on foot at low water, and with the exception of a short portage at the falls, is generally navigable for small boats nearly to Barney Creek.

The same type of country prevails from the Seventymile to the Birch Creek region. Ridges like Glacier Mountain, however, are more prominently developed. One extending from the Seventymile about opposite the mouth of Flume Creek for about 15 miles in a westerly direction is the most conspicuous example. The altitude i



A CANYON OF FORTYMILE, 500 FEET BELOW THE LEVEL OF THE OLD VALLEY.

B. SURFACE OF BENCH, 500 FEET ABOVE LEVEL OF SEVENTYMILE.

bout 6,000 feet, the same as that of Glacier Mountain; it has several harp, precipitous peaks, and the northern slopes are deeply furowed by minor streams. The country to the north is one of open alleys and broad interstream areas, where the minor lines of drainge have been gathered into a few main streams which flow in a ortherly direction toward the Yukon.

The most important streams between the Seventymile and Birch reek are Flat Creek and Charley River. The former, which is about 4 miles west from the mouth of Flume Creek, on the Seventymile, ows in a canyon within an older valley like that of the Seventymile, ut is a much smaller stream. Charley River, which is 8 miles farther est, is of the Birch Creek type. It meanders in a narrow canyon bout 500 feet deep, the course of which is northeasterly toward the ukon. The river, which rises far in the interior, has a width in this wer portion of its course of 200 to 300 feet, can be easily forded on ot at low water, and is said to be navigable for small boats for a istance of 100 miles above its mouth.

BIRCH CREEK REGION.

General character.—This region, situated about 50 miles south of he Yukon at Circle, is shown on the reconnaissance map of the Birch reek and Fairbanks districts (Pl. XIII). The general characteris-cs of prominent ridges, less prominent isolated domes, and an undu-ating plateau surface deeply incised by many streams are the same s in the Fortymile region. Here, however, the ridges descend to he surface of an extensive flat about 800 feet above sea level and 0 miles in width, which extends from their base to the Yukon. his ill-drained area is flecked with lakes and crossed by the mean-ering drainage from the plateau. A prominent ridge, similar to hat of Glacier Mountain, can be seen from the plateau level about 0 miles to the west. The most prominent domes are Mastodon and Porcupine, 4,400 feet and about 4,900 feet, respectively, situated bout 8 miles apart, near the area of economic interest.

Birch Creek system.—The creeks of importance all belong to the rainage system of Birch Creek, a stream comparable with Forty-ile Creek, which receives many active tributaries ramifying far ithin the plateau, and, after flowing parallel with the Yukon in a ng meandering northwesterly course, finally joins that stream below he great bend at the Arctic Circle (map, Pl. XVI). It is formed y North and South forks (which have southeast and northwest ourses, respectively, to the point of union, just within the edge of he plateau) and flows northward through a narrow canyon into he Yukon flat. North Fork, which is the more powerful stream, rains a large area to the west and south, the headwaters inter-

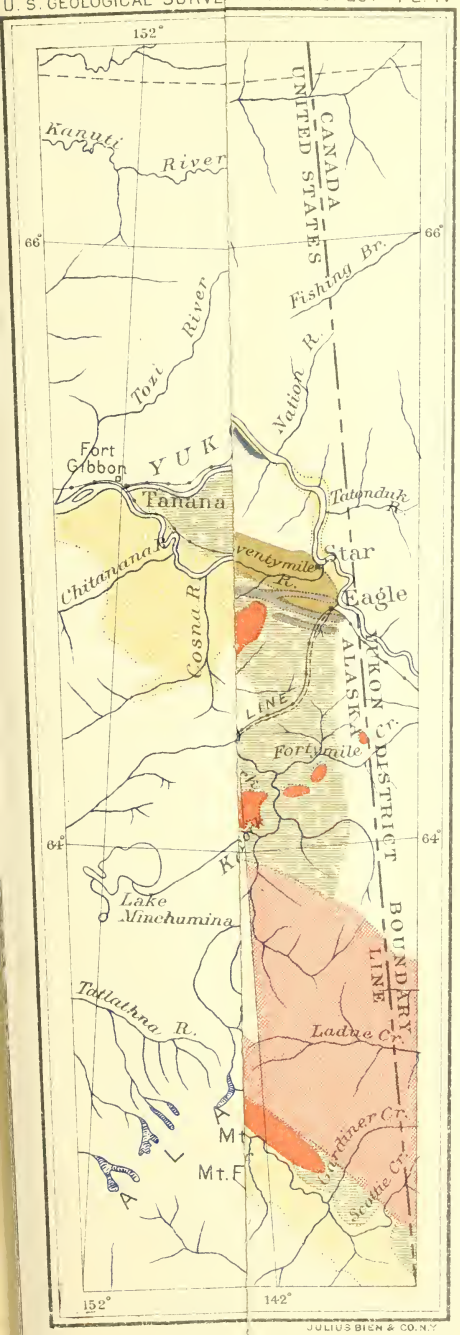
locking with those of streams tributary to the Tanana. South Fork, 6 miles to the southeast of the main forks, divides into two strong tributaries, and these rapidly split up into numerous smaller streams which are deeply sunk within the region and interlock with the system of the Charley River to the east and southeast. The valleys of the two main forks are bounded to the north by a steep slope rising 1,000 feet or more above them. A well-defined bench about 100 feet above the present streams bounds the narrow valleys to the south, and extends, with a gradually rising slope, to the foot of the spurs which lead to the higher ridges. About 5 miles north of the hills Birch Creek is joined by Crooked Creek, which flows in an easterly direction through a broad, flat valley and receives the waters of several short, northward-flowing streams of economic importance, which drain the edge of the plateau. The wide flat of Crooked Creek merges into that of Birch.

The valleys of Mission Creek, Seventymile, and of the forks of Birch Creek are similar in that they have an unsymmetrical section—steep slopes on the north and an open, more or less benched country to the south.

FAIRBANKS REGION.

General character.—This region occupies a position on the south border of the plateau country corresponding to that of the Birch Creek region on the north, and is also shown on the reconnaissance map of the two districts (Pl. XIII). The area in which there is present interest lies between Little Chena and Chatanika rivers, and is drained by their tributaries. The general character of the region is the same as that of Birch Creek, except that the plateau region descends more gradually to the valley of the Tanana and has somewhat lower average altitude. Domes which have received local names rise above the general level to a height of 2,600 to 3,000 feet above sea level. The valleys are more open than those to the north and the divides separating them are lower.

Chatanika and Chena rivers.—The Chatanika has its source far back in the plateau, and flows in a southwesterly direction to the Tanana. Twenty miles to the east is the Little Chena, which flows in a course parallel to the Chatanika and joins the Chena in the flats a few miles south of the plateau. The divide separating the Chatanika and the Little Chena extends in a southwesterly direction parallel to their courses and has been much dissected by minor tributaries, which flow to the northwest and the southeast, respectively, toward these streams. The occurrence of gold on these small streams has made the area one of economic importance. The distance



LEGEND

SEDIMENTARY ROCKS

QUATERNARY

Silts, sands, and gravels

EOCENE

Kenai series
Conglomerate, sandstone, and shale, and some coal seams

LOWER CRETACEOUS

Black slates and thin-bedded limestones

CARBONIFEROUS

White limestone, heavy conglomerate, and shale

DEVONIAN

Rampart series
Volcanic material, limestones, and slates

METAMORPHOSED SEDIMENTS

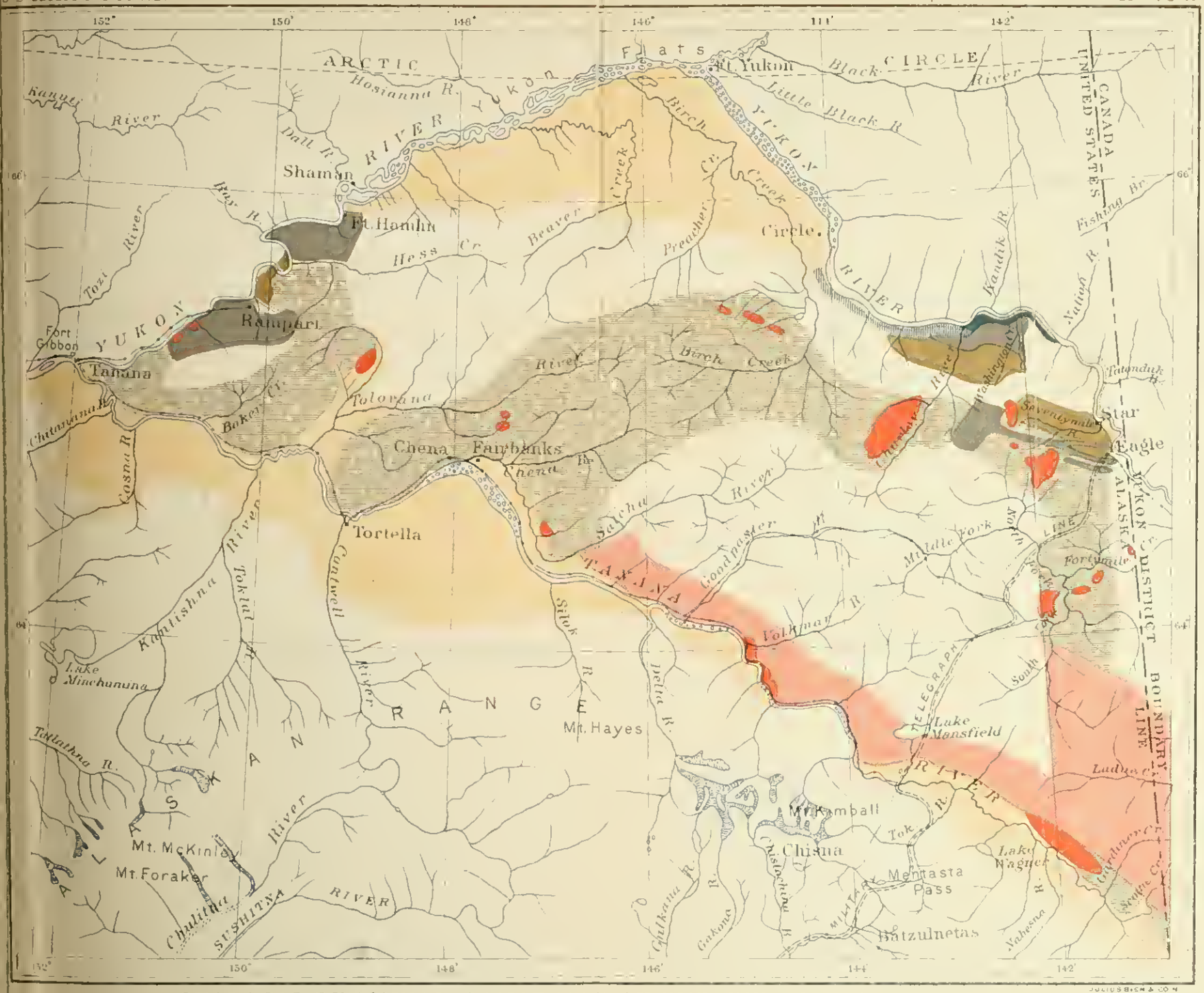
Made up chiefly of mica-schists and other schists, quartzites, and crystalline limestones, including Birch Creek schists and Fortymile series, probably the source of placer gold

IGNEOUS ROCKS

ARCHEAN?

Pelly gneisses
Gneisses and mica-schists

Intrusive rocks ranging from granite to diorite



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Gneisses and mica-schists

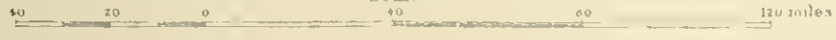
Intrusive rocks ranging from granite to diorite

GEOLOGIC RECONNAISSANCE MAP OF THE YUKON-TANANA REGION

By Louis M Prindle, Arthur J Collier and Alfred H Brooks

1904

Scale



JULIUS BIEN & CO N

from the plateau country across the flats to Tanana River is about 8 miles. The Chena Slough, however, from the main river, meanders along the northern limit of the flat and receives the streams soon after they leave the hills. The altitude of the slough at Fairbanks is approximately 450 feet.

GEOLOGIC SKETCH.

INTRODUCTION.

The shape and surface of the area have been briefly described, and the material or bed rock of which this block of country is composed next demands consideration. The attainment of detailed knowledge of a region of complex geology like that under discussion is the work of many years, but the results from the various reconnaissance surveys have thrown much light on the broader geologic problems, and these are epitomized in the table of stratigraphic succession to follow, as well as on the map (Pl. IV).

Both in the field and in the laboratory the writer's chief energies have been directed toward a study of the economic problems, to which the purely geologic investigations have been made entirely subordinate. In view of this and because more detailed studies of the stratigraphy are to be undertaken, only a few general conclusions in regard to the geology will be here presented. The stratigraphic succession of the general province will be presented in tabular form, but in the text only those formations and rocks which the writer has personally studied will be considered, and these chiefly from the standpoint of economic importance, the constant aim being to present such matter as will enable the miner to understand better the relation of the deposits in which he is interested to the bed rock in which they occur, or from which they have been derived.

The rocks include representatives of the igneous and sedimentary classes—those clearly formed by solidification from a molten condition and those which have been deposited through the agency of water—and the metamorphic rocks—a class most important in this region—which result from the alteration of either of the others.

Granite, which occurs abundantly in this area, illustrates the first class. The minerals of which it is composed have developed in place as the final result of the slow cooling to which the rock material has been subjected. With rapid cooling there would have been little opportunity for the development of minerals, and the molten mass would have consolidated as a product somewhat resembling the slag from a glass furnace. Coarse-grained, fine-grained, and glassy rocks, entirely different in appearance, may thus result from the same material simply through a difference in the conditions of solidification;

but whatever the conditions the resultant products have the earmarks of igneous origin.

Shale, sandstone, and conglomerate, which are very common in the Seventymile Valley, are composed, on the other hand, of mud, rounded grains, and pebbles, respectively, arranged in rather well-defined layers that give the coarser varieties a banded appearance. All lines of evidence lead to the conclusion that such characters are due to the reworking and sorting of material derived from older rocks and its subsequent deposition by water. Except that they are consolidated and folded, these rocks differ in no essential respect from similar deposits now in process of formation. Limestones also are known to have been deposited under water and often contain recognizable remains of organisms. The unaltered igneous and sedimentary rocks thus show their mode of origin by their characteristics.

The most widely distributed rocks within this area are the schists and gneisses, rocks which have been so changed by complex processes of metamorphism that their origin is often in doubt. The sedimentary and igneous rocks, in passing through the metamorphic mill, have had new minerals developed and new structures imposed upon them until their primary characteristics are obscured or replaced by those of a secondary nature. Further, these two classes, which are in places most intimately mingled, react on each other, and, beside the mutual results of such close relation, have often undergone together the processes of metamorphism. The formation of quartz veins is generally an accompaniment of these changes, while, locally, the quartz veins or the rocks themselves have been mineralized and become sources of some of the gold deposits, the discovery of which has made the region of importance and rendered the distribution of the metamorphic rocks a problem of economic interest.

STRATIGRAPHIC SUCCESSION.

An important purpose of all geologic work in any given province is to determine the sequence of the strata which outcrop in the area. In a region where the rocks have been much deformed the succession can be definitely established only after the most painstaking and detailed studies, which in the Yukon-Tanana region have not yet been begun. The results of the various surveys have, however, determined the succession of the larger subdivisions of a geologic time scale, which is presented in the following table. This scale, which is practically identical with that prepared by Mr. Collier[a] with the cooperation of Mr. Brooks, will, in connection with the map (Pl. IV), elucidate the general geologic features.

[a] Collier, Arthur J., The coal resources of the Yukon: Bull. U. S. Geol. Survey No. 218, 1903, p. 15.

Provisional tabular statement of Yukon stratigraphy.

Age.	Formation name.	Contact relations.	Lithologic character.
Quaternary	Alluvium		Flood-plain deposits.
	Yukon silts	Unconformity	Fresh-water silts, sands, and gravels.
Post-Eocene:			
Tertiary		(?)	Sands, clays, and gravels.
Eocene	Kenai formation.	(?)	Fresh-water sandstones, shales, and conglomerates.
Upper Cretaceous.		Conformity?	Fresh-water and marine sandstones, shales, arkoses, and conglomerates.
Lower Cretaceous.		(?)	Fresh-water calcareous sandstones.
Do		Conformity	Marine, black, slaty shales, and thin-bedded limestones.
Permian		Unconformity	Marine, massive, white limestones, heavy conglomerates, and gray shales.
Mississippian		do	Marine, black slates, and thin-bedded limestones.
Devonian	Rampart formation.	(?)	Volcanic material, interbedded with limestone, slate, etc.
Pre-Devonian	Fortymile formation.	Unconformity	Schists and crystalline limestones.
Do	Birch Creek schists.	Conformity	Quartzites and schists.
Archean?	Pelly gneiss	Unconformity	Gneissoid and schistose granites.

The region visited by the writer is largely occupied by the metamorphic sediments called in the table the Birch Creek schists and the Fortymile formation, by the Devonian rocks (Rampart formation), by igneous intrusions, by Tertiary sandstones and conglomerates (Kenai), and by the Quaternary deposits. These formations will therefore be described, but the Carboniferous and Mesozoic horizons, which have not been studied by the writer, will receive no further consideration.

GEOLOGIC MAP.

Though much of the Yukon-Tanana country has not been surveyed in detail, yet the general facts of rock distribution indicated on the accompanying map (Pl. IV) are probably correct. The writer is only responsible for the geology of the central part of the area, that along the Yukon being based on Collier's work, while the southeastern and southwestern parts are based on the Brooks surveys.

It is of interest to note the general facts of distribution. A broad belt of gneisses and schists, termed the Pelly gneisses, stretches north-

westward from the Canadian boundary probably to the Salcha Valley. These gneisses, provisionally assigned to the Archean, are flanked both north and south by the metamorphic sediments, which include the Birch Creek schists and Fortymile formation. These later occupy a broad zone, which is probably continuous from the Fortymile basin to the valley of Beaver Creek, interrupted only by smaller areas occupied by intrusives, or Devonian or Tertiary formations. The Devonian (Rampart formation) finds an irregular distribution in small patches in the eastern portion of the country; west of the Beaver Valley it attains an extensive development. Some Mississippian, Permian, and Cretaceous rocks outcrop along the Yukon between Eagle and Circle, and Carboniferous rocks have been found west of the Beaver Valley, but rocks of these ages have not been recognized elsewhere in the district, though it is quite possible that detailed surveys may discover them.

If this map has any significance to the placer miner, it lies in the distribution of the metamorphic sediments which nearly everywhere seem to be the source of the placer gold. It is possible that the igneous rocks of the Rampart formation may also be gold bearing, but in the placer districts studied by the writer the source of the gold seemed in most instances to lie in the metamorphic sediments. This fact leads to the conclusion that the most promising fields for prospecting will be the areas occupied by these metamorphic rocks. Furthermore, the prospector should pay special attention to localities in which igneous intrusives are plentiful, for the auriferous veins seem to be largely, if not entirely, confined to such associations. The economic importance of the Tertiary lies in its being the coal-bearing horizon of the district.

SEDIMENTARY AND METAMORPHIC FORMATIONS.

There are many unsolved problems regarding the subdivisions and stratigraphic succession of the rocks occurring in different regions of the Yukon-Tanana country. Gneisses, quartzite-schists, and schists of various kinds with interbedded crystalline limestones, have been considered as the oldest rocks and their relations have been studied by a number of observers. Gneisses and schists, possibly forming a basal complex, are most extensively developed in the southeastern portion of the country toward the Tanana, the quartzite-schists in the Birch Creek and Fairbanks regions, and schists with interbedded limestones in the valley of the Fortymile. In both the Birch Creek and Fortymile regions, however, the latter types occur in close relation, associated with local areas of gneiss. The problem of separation is further complicated by the close folding which the schists have undergone. These old rocks will be considered here in

the order in which they have been mentioned, without laying too much stress on their separation, sequence, or age.

A formation composed of limestone, quartzite, shale, and chert beds, with closely associated tuffs, serpentine, and diabase, occurs above the older rocks, is much less metamorphosed, and is generally characterized by its green igneous content. This is the Rampart formation of Spurr.

The massive conglomerate and shales of the Kenai form the youngest consolidated sediments observed.

The Quaternary unconsolidated deposits include the bench gravels and stream deposits.

The igneous rocks are both intrusive and extrusive. There are granular representatives which vary in composition from acidic granite to gabbro, and occur, so far as known, as intrusive masses in all the formations but the Kenai. Extrusives are associated with the rocks of the Rampart formation, and some limited areas of fresh olivine-basalt that were encountered probably represent flows of comparatively recent origin. Dikes and sills are numerous and vary greatly in composition.

PELLY GNEISS.

Large areas of gneissoid rocks, provisionally assigned to the Archean, have been described, the most extensive one in the Yukon-Tanana country being found along the north side of the Tanana west from the boundary. This, as described by Brooks,[a] consists of rocks which vary in character from comparatively massive granite to mica-schists, and may include some sediments. The rocks generally exhibit a gneissoid structure due to dynamic metamorphism. Areas of similar rock in the vicinity of the Fortymile were studied by Spurr[b] and referred by him to the basal granite. Local areas of gneiss were observed in 1903, but the relations were not worked out in sufficient detail to justify definite conclusions as to their origin. It is believed, however, that they represent metamorphosed granitic intrusives, like those described by McConnell.[c]

BIRCH CREEK SCHISTS.

The quartzite-schists have been described and named by Spurr[d] the Birch Creek formation. These rocks are most extensively developed

[a] Brooks, Alfred H., A reconnaissance in the White and Tanana river basins, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 460–470; A reconnaissance from Pyramid Harbor to Eagle City, Alaska: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 2, 1900, pp. 356–358.

[b] Spurr, J. E., Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 134–137.

[c] McConnell, R. G., Note on the so-called basal granite of the Yukon Valley: Am. Geologist, vol. 30, 1902, pp. 55–62.

[d] Spurr, J. E., Geology of the Yukon gold district, Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 140–145.

in the Birch Creek region and southward to the Tanana. The rock varies from a massive quartzite to quartz-mica-schist; a quartzite-schist is most common. At the one extreme is a pure, light-colored, massive quartzite, composed almost entirely of fine, rounded or interlocking quartz grains, with occasional grains of bluish quartz which attain a diameter of a millimeter or more. In other localities the rock breaks more easily along planes which show glistening flakes of mica on their surfaces. The quartz grains are still round, and the development of mica is practically the only change which has taken place; then the grains become elongated, the proportion of mica, both muscovite and biotite, increases, and finally, in some localities, the rock has become a quartz-mica-schist. Graphitic phases are common, and metamorphic minerals, especially garnet, are frequently developed during this process.

The rocks have not only undergone changes in composition, but have been folded upon themselves so closely that the structure is apparently simple. Examination, however, discloses minor folds with limbs so slightly divergent as to appear like separate beds of strata in nearly parallel positions; furthermore, the folds are often horizontal, and the area resembles one of slightly folded rocks. Most instructive examples of these closely appressed folds were observed along the trail from Circle to Fairbanks, the structure being apparently a characteristic one. Determinations of the thickness of these rocks become, therefore, very uncertain. The strike of the axial planes of the folds, where observable, is about east and west, and their dips have a maximum of about 45°; the most important system of joints strikes northwest.

In the section from the Birch Creek to the Fairbanks region, a distance of nearly 150 miles, the rocks show a great uniformity in composition. A small outcrop of closely folded calcareous beds was observed at the mouth of Mastodon Creek, in the Birch Creek region, and a small quantity of limestone is interbedded with the quartzite-schist about 16 miles northeast of Fairbanks Creek. The strike at this locality is N. 80° E., and the dip of the structure 30° to the south. Occasional feldspathic schists, which are possibly altered igneous rocks, were observed interbedded with the others. Intrusives occur in the Birch Creek region and in the Fairbanks region, but none were observed in the intervening area. The rocks contain numerous small quartz seams, and locally have been more or less mineralized. Pyrite is often seen in the schists, and pieces of schist have been found containing gold-bearing quartz. The gold in the placers of the Birch Creek and Fairbanks regions has been derived from these rocks.

The contact of these rocks with the Fortymile formation was not observed, but from the dominant lines of structure it would seem that

A. SCHISTS ON SOUTH FORK OF BIRCH CREEK.

B. CONTORTED SCHIST ON RIDGE NORTH OF MOSQUITO FORK.

they underlie the latter. The Fortymile rocks occur 6 miles east of the forks of Birch Creek, where they have a northwesterly strike and a northeasterly dip. Farther west the strike swerves round toward the north, and this would carry them outside of and dipping away from the rocks of the Birch Creek formation. The same formation occurs in the eastern portion of the Fortymile region, where their occurrence has been described by Spurr in the report to which reference has already been made.

FORTYMILE FORMATION.

The formation described and named by Spurr[a] the Fortymile series is most extensively developed in the Fortymile region. A fine exposure of the rocks composing this formation, however, is shown in the ridge referred to above between the forks of South Fork of Birch, about 6 miles east of the main forks of Birch Creek, where a long, irregular spur about 8 miles in length descends gradually toward the northwest between the deep, narrow valleys of the two forks. The roughest part of this spur is formed by outcrops of massive crystalline gray limestone, and the schists also contain occasional thin beds of limestone. In contrast to the quartzite-schists, these rocks vary greatly in character.

The most common rock is quartz-mica-schist, containing much garnet, staurolite, and biotite. Hornblende-schists occur, sometimes closely associated with limestone, and there are some thin beds of quartzite-schist. The strike, as already mentioned, is northwest, and the dip 20° to 45° to the northeast. The spur terminates abruptly in a prominent point 1,500 feet in altitude above the forks and 1½ miles to the east of them. Just below the forks the stream has cut a narrow canyon in garnet and quartzite schists, which may be transitional to the Birch Creek formation. The thin-bedded character of the schists, their northeasterly dip, and the spur of garnet-staurolite-schist to the southeast are shown in Pl. V, *A*. They are here cut by small granitic dikes. The continuation along the strike of the Birch Creek rocks would carry them across the valley of Crooked Creek toward the Crazy Mountains. In the other direction they extend to the southeast, and to the south of the northern tributary of South Fork of Birch form a prominent ridge, which attains a height of about 4,000 feet, and is furrowed on its southern slopes by the deep canyons of minor tributaries. The strike is uniformly to the northwest and the dip to the northeast.

The Fortymile schists attain a strong development in the Fortymile region and have been described in detail by Spurr. They include mica, garnet, hornblende, quartzite, and graphite schists.

[a] Op. cit., pp. 145–155.

Crystalline limestone occurs in beds from a few inches to 50 feet or more in thickness. The rocks are closely folded and have a variable strike and dip, with a general structure nearly east and west. Contorted strata of hornblende-schist are shown in Pl. V, *B*. These rocks, like those of the Birch Creek region, contain many quartz veins. Locally the rocks and the veins have been mineralized and become the source of gold.

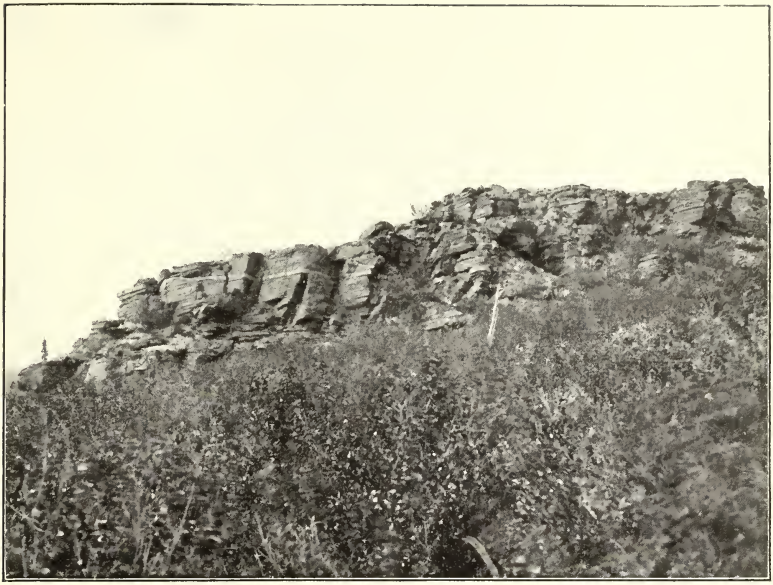
In the Fortymile region they have been intruded most complexly by igneous rocks. Some of these have undergone metamorphism along with the schists and have become an intimate part of them, while others are fresh and vary in size from large intrusive masses down to thin sheets and narrow dikes. The accompanying photograph (Pl. VI, *A*) shows a typical outcrop of hornblende-schist with a granitic sheet 6 inches in thickness parallel to the schistosity. In prospecting the rocks of the Fortymile formation the marble beds have often been taken for veins, and much labor has been lost. They are often in a nearly vertical position on account of the close folding which the rocks have undergone, but an examination will show that they form an integral portion of the country rock, and can be traced sometimes for an indefinite distance.

These schists are prominently developed on all of the gold-producing creeks of the Fortymile area, with the exception of Chicken Creek. They occur to the southwest of the Fortymile quadrangle around the head of the Buckskin, along Confederate Creek, and on North Fork of Fortymile Creek. They were observed also far to the west, along Charley River.

In the northern portion of the Fortymile quadrangle the areal boundaries are not clearly determinated. Hornblende-schists and schistose limestones occur at the falls on the Seventymile, and are provisionally correlated with the Fortymile rocks. Quartzite-schists, similar to schists of the Fortymile, dip away to the east and west from the northern termination of the intrusive mass of Glacier Mountain. It seems best at present to draw the boundary between the quartzite-schists, which are often graphitic, and the limestone, which at several localities occurs to the north of them and is included provisionally in the Rampart formation. This limits the northern extension of these rocks to a line running northwesterly from the headwaters of American Creek. The boundary between this and the succeeding formation is probably very irregular.

The Birch Creek and Fortymile formations and all the other metamorphic schists were included by Brooks[a] under the name of Kotlo series, and in the geologic map (Pl. IV) no attempt has been made to differentiate the various members. The age of these rocks

[a] Brooks, Alfred H., A reconnaissance from Pyramid Harbor to Eagle City, Alaska: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 2, 1900, pp. 357–358.



A. SCHISTS WITH THIN GRANITIC SILL ON TRAIL FROM WADE CREEK TO WALKER FORK.

B. VIEW UP WADE CREEK.

is undetermined, though they are known to be older than the Devonian and therefore will fall in the lower Paleozoic or pre-Cambrian.

RAMPART FORMATION.

This formation also was described by Spurr[a] in the report to which reference has already been made. It includes limestones, quartzites, black slaty shales, cherts, green shales with interbedded tuffs, and a mass of igneous material, mostly serpentine, diabase, and fine-grained fragmental volcanics, which have imparted a characteristic green color to the formation. A problem arises in drawing the boundary between these rocks and those of greater age. In discussing the Fortymile formation the line was drawn between a quartzite-schist and a rather massive limestone. Several sections were observed where, in passing from schists believed to belong to the Fortymile formation toward the rocks that are characteristically Rampart, a limestone occurs closely associated with the green igneous rocks. Such a limestone outcrops just below the forks of Bryant Creek, where it forms a steep slope about 200 feet in height, contains some fine-grained chert-like, siliceous beds, and is in close contact with the green igneous rock. The ridge to the north of Excelsior Creek and along the north side of Mission Creek has at its base a low sharp ridge of quartzite-schist with quartz veins, which may possibly belong to the Fortymile formation. This is separated by a timbered hollow from the main ridge, which is composed of gray limestone about 150 feet in thickness, capped by a very fine-grained, green, vesicular, diabasic rock. This limestone, which forms prominent outcrops all along the steep slope toward Eagle, has frequently associated with it black shaly slates and is everywhere capped by the igneous rock.

In the Fortymile region south of Eagle, between the graphitic quartz-schist and the green schists north of Thirteenmile camp, there is a limestone which occasionally yields fossils. Only crinoid stems were found, and these are of little stratigraphic value, but it is believed that this limestone, like those above mentioned, is more closely related to the green rocks than to those of the Fortymile formation. A dark shaly limestone and dark shales occur also between the greenstone area south of King Solomon Creek and the metamorphic schists to the north of this creek. It is deemed best, in view of the little evidence at present available, to include all the rocks above described in the Rampart formation. The members of this formation have been metamorphosed far less than those of the Fortymile. They are well developed on American Creek and on the ridge to the west, forming a belt several miles wide, with a northwest-southeast trend. This belt crosses Bryant Creek just below the forks and covers a consider-

[a] Op. cit., pp. 155–169.

able area to the south of the Seventymile; it also crosses Granite Creek and the lower part of Flume Creek, and farther west lies to the north of the Seventymile. The serpentines, with their diabasic dikes and a medium-grained massive gabbro, become prominent in the high ridge which extends from the Seventymile toward Charley River.

Another narrower belt, which also seems to have a northwesterly trend, occurs to the south of King Solomon Creek. The rocks are found again to the southeast of the Fortymile quadrangle and in the far southwest between Chicken Creek and South Fork. The dark shales at this locality, which carry gold in calcite seams, are also referred provisionally to this formation. These rocks seem to overlie unconformably the Fortymile rocks. Their age is probably Devonian.

KENAI FORMATION.

Far younger than the rocks above described are those of the Kenai formation of Eocene age. They are best displayed in the lower valley of the Seventymile, where the river is bounded on either side by high ridges of massive conglomerate, with interbedded leaf-bearing shales. These occur on the lower part of Bryant Creek in an almost continuous section nearly a mile wide. The creek flows northeast. About 4 miles above the mouth occur thin-bedded gray and black shales, grits, and a small amount of conglomerate. In the shales are numerous heavy, yellow, ferruginous nodules, often containing plant remains, which are also abundant in the thin-bedded grits. The strike is about N. 70° E., and the dip 15° to the north. About 700 feet downstream are precipitous slopes of conglomerate with an east-west strike across the stream and a nearly vertical dip. Great slabs of this compact rock have fallen from the slopes and lie weathering at their bases. These beds, with possibly some shales, occur over a width of about 3,000 feet and are succeeded by 60 feet of dark and gray paper shales and grit, with the same strike and dip and in close contact with conglomerate on both sides. The shales contain many plant remains, and the sandy beds of the conglomerate next to them exhibit irregular impressions a foot or more long and up to 4 inches wide. These show generally well-defined linear markings, and there seems little doubt that they represent some form of vegetable life. The shales are succeeded by 350 feet of conglomerate, and this by more fine sediments 50 feet thick, composed of gray, micaceous, somewhat loosely consolidated, leaf-bearing shales and grits and fine-grained compact shales, where the leaves are beautifully preserved. These shale beds, like the others, are in contact on both sides with conglomerate; that on the downstream side outcrops with possibly some interbedded shales for nearly a quarter of a mile to a point where a wooded slope descends gradually toward

the Seventymile. Precipitous slopes were seen nearly 2 miles to the north across Seventymile. These were not visited, but in the continuation of these slopes a few miles to the west the same formation was found. The maximum size of pebbles observed in the conglomerate was 5 inches; the average was from 1 to 3 inches. The material is mostly black, gray, and green chert, quartzite, and vein quartz. The rock grades into a sandstone containing black chert pebbles in a sandstone cement resembling mortar. All the way to Barney Creek the ridge on the north side of the river is made up of this formation, either nearly vertical or dipping steeply toward the valley. The cement contains much ferruginous matter, and the rock breaks down easily into its constituent materials, which form loose heaps of gravel and sand. The strong, abrupt spurs on the south of Seventymile are also of this material as far as the falls. The steepness of the dip is well shown in the nearly vertical position of the leaves so abundant in the shale.

On the west side of Mission Creek, about 2 miles above Excelsior Creek, there is a bluff 150 feet high of similar conglomerate, composed mostly of chert and vein quartz. Some pebbles of quartzite-schist were seen. Brownish sandstone is associated with it and ferruginous nodules, both containing the same species of plant life that were found on Bryant Creek. The dip is 50° to the northwest.

A similar conglomerate occurs on Wolf Creek, about 1½ miles above its mouth, forming a bluff 125 feet high on the west side of the creek. The occurrence is very similar to that on Mission Creek; the conglomerate varies to a brownish sandstone, and its pebbles are mostly black and red chert and vein quartz with occasional pieces of granite and diorite. Some of the rock weathers easily and some is compact, like that of Seventymile. About 4 miles above the mouth of Wolf Creek, in the valley of a small tributary from the west, occur conglomerate, brown sandy beds, and clay. There is some associated coal, loose pieces of which, a foot or more in diameter, were seen at the head of the creek; a few shallow prospect holes had been sunk to determine its amount. The coal contains grains of soft, brittle amber. Nodules similar to those on the Seventymile were found which contained ill-preserved plant remains correlatable probably with those of the Seventymile. The low ridge directly south of Eagle is also composed of conglomerate, which continues for 4 miles southwest from Eagle, on the trail to American Creek, up to an altitude of about 2,000 feet. This is probably an extension of that on Wolf and Mission creeks. As in other localities, the conglomerate breaks down easily into constituents, and the gravels thus formed may readily be mistaken for more recent deposits. Conglomerate occurs again about half way between the mouth of Excelsior Creek and Gla-

cier Mountain. This may be an independent belt or an extension from the main mass.

In the Chicken Creek area patches of sandstone occur, with associated shale and coal and possibly some loosely consolidated conglomerate. As on Seventymile and Wolf creeks, there are ferruginous nodules which contain fragments of dicotyledonous leaves. The sandstone and shales also contain plant remains, badly preserved, but indicating the relationship of these beds with the Kenai, to which they are provisionally referred.

Until more detailed studies are made it has seemed best to correlate with the Eocene or Arctic Miocene the rocks of all the localities visited, where conglomerate beds occur associated with sandstone, shale, and coal. Plant remains are always present, and where determinable have been found to belong to this horizon. On Napoleon Creek there are conglomerates, sandstone, and coal-bearing beds similar to those on the Chicken, which, with those on the Chicken, have been referred by Spurr and Schrader [a] to the Mission Creek formation. The problem of the relations of the younger rocks to the underlying metamorphics and to each other requires detailed work for its solution.

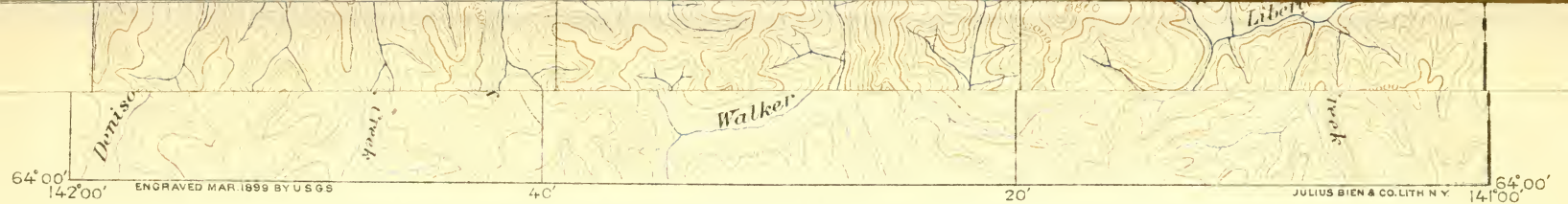
A deposit on the west side of Mission Creek, about a quarter of a mile above the mouth of the Excelsior, unlike any seen elsewhere by the writer, was described by Schrader [b] in Spurr's report. The bluff, here 90 feet high, is composed mostly of very slightly consolidated, angular, granitic material. Fragments of coarsely porphyritic light-colored granite 2 feet in diameter occur. There is much fine material of the same nature and a few water-worn pebbles, but apparently no chert pebbles. Some thin-layered beds of gray sandstone and clay beds with carbonaceous matter occur. The outcrop has a thickness of about 30 feet and is tilted with a dip of 50° to the south; the strike is N. 35° W. It is capped unconformably with 20 feet of coarse stream gravels. The locality is about 1½ miles below the bluff on Mission Creek, where the Kenai conglomerate with characteristic fossils was found; the nearest outcrop on the north is quartzite-schist at the foot of the hill, a quarter of a mile distant. It is referred provisionally to the Kenai.

QUATERNARY DEPOSITS.

Bench gravels.—Bench gravels are common and attain their greatest development near the larger streams. They have been observed in many valleys of the Fortymile region and at various heights. The land

[a] Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 175–176.

[b] Op. cit., p. 339.



MAP OF FORTYMILE QUADRANGLE

Triangulation and topography
by E.C. Barnard
Surveyed in 1898

Scale $\frac{1}{250\,000}$

2 1 0 2 4 6 8 10 miles

2 1 0 2 4 6 8 10 kilometers

Contour interval 200 feet
1904

Datum is mean sea level based on elevation of Transit House at Camp Davidson on Yukon River, estimated by U.S. Coast and Geodetic Survey as 575 feet

MAP OF FORTYMILE QUADRANGLE

Triangulation and topography by E. C. Barnard
Surveyed in 1898

Datum is mean sea level based on elevation of Fremont House at Camp Davidson on Yukon, determined by U.S. Coast and Geodetic Survey as 575 feet

Scale 1/250,000

10 miles

10 kilometers

Contour interval 200 feet

1904

has undergone many changes in level, which have been recorded on the valley sides by benches and deposits of gravel, which indicate the former water levels just as mud and driftwood register the level of high water in a stream. The simplest case is perhaps that of Seventymile Creek, where the stream is at present sunk, with nearly vertical banks, to a depth of about 20 feet within an older valley a half mile or more in width. The floor of the older valley, which is comparatively flat, is formed of the upturned beds of the conglomerate and shale. Before the stream commenced to cut its present shallow canyon it had deposited gravels widely over the surface of the valley floor, where they have been left. The tributaries necessarily had a similar development. The clean-cut rock bench near the mouth of Flume Creek, 20 feet in height, capped by several feet of gravel, is the best example that was observed. The conditions here at a level of only 20 feet above the present stream were repeated at various levels. The greatest height at which stream gravels occur on the Seventymile has not been determined. The most prominent bench is 500 feet above the water, but no gravels were observed at this level (Pl. III, *B*). On Mission Creek, about a mile below the mouth of Excelsior, there is a bench 15 feet high, capped by about 7 feet of gravel, and a short distance above the mouth of Excelsior, on Mission Creek, a bluff 70 feet high, capped by 20 feet of stream gravels.

The Fortymile and its tributaries are prominently benched. The most extensive of these benches, like that on the Seventymile, is 500 to 600 feet above the stream. Gravels were observed near Bonanza Bar 200 feet above the stream, and gold in paying quantities was reported in the high gravels nearly opposite Steele Creek. On Chicken Creek bench gravels are found 275 feet above the creek, and the discovery of good values in them is leading to an investigation of similar deposits in many places.

Stream gravels.—The gravels of the present streams have been derived, so far as has been observed, from the material within their immediate drainage areas, either that of the bed rock or of older gravels within their borders. Bars were worked extensively in the early days on the Fortymile, and at the present time a small amount of this kind of work is being done.

IGNEOUS ROCKS.

Igneous rocks occur in great variety in the Yukon-Tanana country. Those of the Fortymile and Birch Creek regions have been described in detail by Spurr,[a] and only a brief reference to the most important kinds and occurrences will here be undertaken.

The intrusives are granite, diorite, and gabbro, with many inter-

[a] Op. cit., pp. 225–250.

mediate types and altered derivatives. The extrusives, so far as known, are diabases and basalts.[a]

GRANITE.

The granites vary greatly in composition and may be roughly divided into three varieties—alaskite, biotite-granite, and hornblende-granite. The alaskite is composed almost entirely of quartz and feldspar; it occurs generally as small unaltered dikes and sills in the schists. The relation of this rock to quartz veins has been described in detail by Spurr in the chapter to which reference has already been made. 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 was traversed for about 10 miles. The rock forms a bare ridge which attains an altitude of about 4,000 feet. It is an evenly granular, medium-grained biotite-granite, with pegmatitic areas and a local development of a gneissoid structure. A similar rock occurs commonly in the Fortymile region, and a fine porphyritic phase of it occurs in the Birch Creek region, where it is found on the gold-producing creeks. Some of the gneisses have probably been formed by metamorphism from granitic rocks which were perhaps older than the schists, and others, similar in character, from later intrusions which have been metamorphosed along with the rocks in which they are contained. There are some areas of hornblende-granite.

DIORITE.

Diorite occurs in limited quantity, and many rocks intermediate in composition between it and granite are found. These rocks resemble hornblende-granite, but contain much plagioclase and are more closely related to quartz-diorite. A rather fine-grained porphyritic variety of a rock, which is closely related to quartz-diorite and may be called a granodiorite-porphyry, occurs on Chicken Creek and is composed of corroded quartz phenocrysts, abundant plagioclase, orthoclase, much hornblende and biotite, considerable titanite, and apatite.

A large mass of a medium-grained fresh rock, varying in composition from granodiorite to quartz-diorite, forms the sharp gray ridge of Glacier Mountain, 20 miles west from Eagle, and covers a considerable area to the westward. Some of this rock contains abundant quartz, plagioclase, biotite, and hornblende. Other varieties contain considerable orthoclase. There is a fine, sharp, isolated peak, about 6,000 feet in height, on the westernmost fork of Charley River, composed of this same beautiful rock. This locality is bounded on the north by the large area of biotite-granite already described and on the west by schists. Like the granites, this rock also has its gneissoid

[a] During 1904 many detached areas of extrusives were observed southwest of the Fortymile quadrangle.

facies, and some dikes of it show clearly the characteristic effects of dynamic metamorphism.

GABBRO.

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 the minerals. The distribution of this rock has not been determined. There is much serpentine and many dikes of diabase in the same area.

DIABASE AND BASALT.

Isolated diabasic dikes are common throughout the Fortymile and Birch Creek regions, but the most important occurrences are in the Rampart formation, which is made more prominent by the presence of these rocks than by the less conspicuous sedimentaries. The rocks, which probably comprised originally a complex of basaltic flows, dikes, and tuffs, are now greatly altered and contain a large proportion of serpentine. A fresh olivine basalt occurs sparingly. It is best developed on Chicken Creek, where it probably occurs as a flow. A small dike was observed on Confederate Creek, and on North Fork of Fortymile, a short distance above the "Kink," two dikes occur.

SUMMARY.

The region is a complex one, composed mostly of metamorphic rocks. The oldest rocks are believed to be the granites and gneisses of the southeastern portion, the contacts of which with later rocks are obscured by dynamic metamorphism and by the presence of similar rocks of intrusive origin. These are succeeded by a closely folded metamorphic complex, locally separable into the Birch Creek and Fortymile formations. The Rampart (Devonian) rocks, which unconformably overlie the others, contain a large proportion of volcanic material, and, like them, have been closely folded. Foldings, intrusions, the formation of quartz veins, and mineralization have probably taken place at several periods. The material of the Kenai was deposited on these older rocks, afterwards folded with all that had gone before, and still later worn with them by erosion to an undulating, more or less level, surface. Recent elevations and depressions have been many and have left their traces on the terraced slopes of many valleys and in accumulations of deposits, like those of

the Yukon silts, which have not been touched upon in this description. There was a time, too, when volcanic dust from some distant source to the southward was deposited in a thin layer over large areas of the Fortymile region, where it occurs just beneath the surface as a deposit similar in appearance to quicklime.

FOSSILS.

The following report was prepared by Doctor Knowlton on the material collected from the various localities visited by the party:

Fossil plants obtained by L. M. Prindle from various localities during the season of 1903.

[By F. H. Knowlton.]

3AP 224. Irene Gulch, Chicken Creek: Fragments of stems, indeterminable.

3AP 224½. McDowell claim, Chicken Creek: Equisetum sp.

3AP 237. Mouth of creek, 1 mile west of Chicken: Black carbonaceous shale with minute plant fragments, indeterminable.

3AP 251. Chicken Creek: Fragments of dicotyledons, possibly Corylus MacQuarrii, but uncertain.

3AP 330. Wolf Creek: Taxodium dubium? Heer; Populus sp.

3AP 336. Branch of Wolf Creek: Populus, cf. P. Richardsoni Heer; dicotyledonous fragments.

3AP 337. Branch of Wolf Creek: Only fragments of stems and bark.

3AP 348. Bryant Creek: Sequoia Langsdorfii (Brgt.) Heer; Taxodium dubium? Heer; Populus arctica? Heer; Populus Richardsoni? Heer; Corylus MacQuarrii (Forbes) Heer; Quercus platania Heer; Betula prisca? Ett.

3AP 349. Bryant Creek: Sequoia Langsdorfii (Brgt.) Heer; Corylus MacQuarrii (Forbes) Heer; Populus arctica Heer; Populus Richardsoni? Heer; Juglans nigella? Heer.

3AP 350. Bryant Creek: Sequoia Langsdorfii (Brgt.) Heer; Equisetum sp.; Populus latior Heer; Populus Hookeri Heer; Fagus Deucalionis Unger; Quercus furcinervis (Ross M.) Unger; Juglans sp.?

3AP 355. Mogul Creek: Sequoia brevifolia? Heer; Corylus MacQuarrii (Forbes) Heer; Populus sp.?

3AP 432. Mission Creek, 2 miles above junction with Excelsior: Corylus MacQuarrii (Forbes) Heer; Betula prisca Ett.; Fagus Deucalionis Unger.

Listing the species from all the localities, we have the following:

Full list of species collected.

Sequoia Langsdorfii.
Sequoia brevifolia.
Taxodium dubium.
Populus arctica.
Populus latior.
Populus Richardsoni.
Populus Hookeri.
Corylus MacQuarrii.
Quercus furcinervis.
Quercus platania.
Fagus Deucalionis.
Betula prisca.
Juglans nigella.

Taking well into account the fact that not all of the above species are determined with absolute certainty, it is nevertheless perfectly clear that all are of the same age, and I do not hesitate to say that this is Arctic Miocene.[a] Not a trace of the Cretaceous element appears.

[a] This flora was first described as the Arctic Miocene. Subsequent investigations have shown that it is of Eocene age, but the old name is still retained.—L. M. Prindle.

A. WASHING THE OVERBURDEN FROM THE GOLD-BEARING GRAVELS, WADE CREEK.

B. STEAM SCRAPER WITH BUCKET CONVEYOR AT MOUTH OF POKER CREEK.

GOLD PLACERS.

FORTYMILE REGION.

FORTYMILE AREA.

Since the discovery of gold on Fortymile Creek, in 1886, prospectors have devoted much attention to its basin. The most important creeks at present are Wade, Walker Fork, Chicken, and Franklin, while some work is being done on the Fortymile itself, Napoleon Creek, the tributaries of Canyon Creek, and on North Fork of Fortymile. Prospecting is in progress in many places and still results occasionally in discoveries of economic importance.

Wade Creek.—The basin of Wade Creek, which is reached by trail from the mouth of Steele Creek, lies about 10 miles south of the Fortymile, and embraces about 50 square miles (map, Pl. VII). The creek, which is about 12 miles long, heads in Steele Dome, 3,750 feet high, and flows in a nearly straight southwesterly direction, entering Walker Fork a few miles above its mouth. There is a fall of about 600 feet from the upper limit of placer mining to the mouth—a distance of about 8 miles. The valley is sunk to a depth of about 1,500 feet within the plateau, and is narrow and V-shaped in its upper portion; lower down it gradually widens, finally merging into the valley of Walker Fork, where the stream follows a meandering course over the surface of a broad flat. The spurs from the northwest descend somewhat more gradually toward the stream than those from the opposite side, and the cross section of the valley is thus somewhat unsymmetrical. The general characteristics are shown in Pl. VI, *B*. The tributaries are short and flow in narrow V-shaped valleys. In dry seasons the demand for water far exceeds the supply, and much of the mining is brought to a standstill.

There is considerable timber on the northwest slopes of the valley, and a light growth of spruce on the southeast. The valley floor is generally covered with willows, but in the wider portion, toward Walker Fork, is well timbered with spruce and aspen. Dawson is the main source of supply, and most of the freighting is done during the winter.

The bed rock in which the valley of Wade Creek has been incised includes several varieties of schist and some ferruginous, thin-bedded limestone, which is apparently interbedded with the schist. Mica-schist and hornblende-schist are the most common rocks. Their attitude is variable, but the general strike is northeast, about parallel with the creek, and the dip of the schistosity varies from nearly horizontal to 50° or more to the southeast, while a prominent system of joints strikes N. 30° W. The schists are often contorted and the structure is probably complex. A small dike of basalt, with a strike

of N. 60° E., was observed about a mile above Robinson Creek. Quartz veins are common in the schist and seem more abundant toward the head of the creek. Both bed rock and quartz veins contain in places considerable pyrite.

The gravels vary from 1 foot to 3 or more feet in thickness and are composed of the rocks that are found outcropping in the valley and along its slopes, no foreign material being observed. The proportion of vein quartz is small. The fragments are more or less angular, owing to the schistose and jointed structure of the bed rock, are little worn, and are generally less than a foot in diameter. They are found across the entire width of the valley and on the low bench-like termination of the spurs, perhaps 10 to 20 feet above the valley floor. The gravels are covered with a layer of muck up to 20 feet in thickness.

It is said that gold was discovered on this creek by Jack Wade about 1895. Rim prospects were found in the fall of 1898. The gold is rarely found more than 1½ feet above the bed rock in the gravels. Most of it is on bed rock and extends into it in crevices and along joint planes to a depth, in places, of 4 feet. It occurs rather irregularly, and the creek has the reputation of being spotted. Good pay was first struck on the rim at the terminations of the spurs on either side, and these became the favorite localities for work. The pay there is more accessible and found frequently in greater quantities than on the valley floor.

As much of the gold occurs as nuggets, which are irregularly distributed, it is difficult to form an idea of the average value of the ground. It is said to average about $100 to the box length of 12 by 12 feet, but some ground has yielded, by the winter's work, from 50 cents to $3 per cubic yard, including everything from surface to bed rock.

Much of the gold is picked up during the work, and many nuggets have been found. One was found during the winter of 1900 worth $216; and in January, 1903, one was picked up which measured 4⅛ by 1¾ by 1¼ inches and was worth $558. A week later another was found worth $437.85 in gold, valued at $17 to the ounce. The nuggets are well smoothed, of a bright yellow color, contain very little quartz, and are often convex on one side and more or less flat and irregular on the other. Some of the prospectors had observed that the nuggets found by them were generally rougher on the side lying next to bed rock. The larger nuggets have been found in the part of the valley which is about midway between the source and the mouth. The gold occurs generally as small flat pieces, and a large portion of that from the head of the creek is rusty. The little gold found in prospecting the side gulches differs in character from that in the main creek in that it is very rough and somewhat rusty. Very little fine gold is found, and the proportion of black

sand is small. Barite is abundant, and its rounded pebbles are a characteristic associate of the gold. Black, shiny, rounded grains of hematite are also found.

The fact that no foreign wash was observed makes it probable that the gold has been derived directly from the drainage area of the creek itself. Many quartz seams and stringers occur in the schists, some of them of considerable thickness, but the quartz is not sufficient in quantity to make the proportion in the gravels a very large one. Pieces of gold with quartz attached are common. Both the schists and the quartz contain pyrite. One quartz vein occurring in the upper portion of the creek was found by assay for the Survey by E. E. Burlingame & Co., Denver, Colo., to carry 0.06 of an ounce of gold to the ton. It would seem from the information available that the gold has probably been derived from quartz veins and stringers in the schists and possibly also from mineralized areas in the schists themselves.

The mining developments are scattered along about 5 miles of the creek, commencing at a point about 4 miles above the mouth and extending toward the source. Claims are generally one-fourth of a mile lengthwise of the creek. There are two Discovery claims, and claims have been staked from each in both directions. The gold is mined by drifting, by hydraulic methods, and by open cuts.

Where the ground is deep and frozen some method of thawing is necessary. The most primitive way is by the wood fire. Hot water and hot rocks are sometimes used, either alone or in combination, but the most effective method is that of the steam thawer. The apparatus consists generally of a small boiler for the generation of steam, pipes for its transmission, and points. The latter are pipes, 4 feet or more in length, for driving into the frozen ground. They are connected near the one end with the steam pipe and provided at the pointed end with one or more small apertures, through which the steam rushes with greatly increased penetrative force, like water from the nozzle of an ordinary hose. They are placed against the frozen ground and driven in as fast as the ground becomes thawed. The quantity of steam can be easily regulated, and successful results on sinking and drifting depend largely on experience and good judgment in the use of the steam. Too much steam is liable to thaw the walls or roof of a drift to an undesirable extent and cause "sloughing," or falling in of the walls, with the consequent necessity of handling much more dirt than is necessary.

The drifting method is employed on Wade Creek mostly during the winter, the dump being washed out in the spring. On several of the claims the hydraulic method was in use in a small way. Pl. VIII, *A*, shows a claim being stripped of muck by this method. Ditches have been built up to about a mile in length, and when used

in connection with canvas hose give sufficient head to strip the muck from the surface of the gravel, so that it can be reached and shoveled directly into the sluice boxes. The open-cut method is being introduced. For this the grade of the creek necessitates a bed-rock drain 700 feet or more in length. The muck, perhaps 7 feet thick, is stripped by ground sluicing and the gravel shoveled in.

As much of the best ground has been worked out, development is being carried laterally to the benches, which may furnish considerable gold. The difficulty, however, is to get sufficient water, the season of 1903 being a particularly bad one in this respect. The output for the year 1902–3 was generally supposed to be about $50,000, and the expense of working probably absorbed from 40 to 50 per cent of this amount. About 50 men were at work on the creek, and wages were $5 and board.

Walker Fork and neighboring localities.—The area of economic interest on Walker Fork is in the far southeast corner of the Fortymile quadrangle (Pl. VII) and extends from the boundary nearly to Cherry Creek, a distance of about 4 miles. It is reached from Wade Creek by a good trail of about 14 miles along the ridge, and also from points on the Canadian side, whence the supplies are generally obtained.

The headwaters of Walker Fork are small streams having their sources in the divide about a mile within Canadian territory. Poker and Davis creeks, which are the most important of these small streams, have narrow V-shaped valleys. Poker Creek flows directly west, about 1 mile of its short valley being on the American side. Davis Creek flows southwest in a similar valley and joins Walker Fork about one-fourth of a mile below Poker; it heads just beyond the boundary, about 1½ miles of its valley being on the American side. Both were described by Goodrich in Spurr's report.[a]

The course of Walker Fork below Davis is westerly, with a fall of about 100 feet to the mile. The valley is bounded on the north by a dome 3,380 feet high and to the south by a spur which descends gradually from an altitude of over 4,000 feet and terminates just south of the creek in a benched surface 400 feet high. The valley is about 2,000 feet above sea level and is unsymmetrical in cross section. Across the valley to the north the rise to the plateau level of about 3,000 feet is gradual and there is a bench corresponding to the one on the south. The slopes are covered with a light growth of small spruce, and the valley floor in places has produced timber of sufficient size for mining purposes.

The bed rock, similar to that of Wade Creek, includes quartzite-schists, graphitic schists, and garnet-hornblende-schists. Strikes

[a] Spurr, J. E., Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, pp. 326–331.

were observed varying from 50° to 80° to the northeast, and the rocks have been closely folded. Quartz seams are common.

The material on bed rock varies from 4 to 12 feet in thickness and includes muck, sand, gravel, and sometimes clay. In places there is no muck on the gravels, and rarely no gravels are found under the muck. The average thickness of the gravels is about 6 feet, generally exceeds 4 feet, and the maximum is 10 feet. A small amount of clay is sometimes found between the gravels and bed rock. Occasionally rounded quartz bowlders a foot or more in diameter are found, but the greatest proportion is composed of angular schist fragments of small size.

The thickness of the gravels increases gradually downstream, and from year to year it has been found profitable to work those of greater depth. Unlike Wade Creek, the gold is found not only on the bed rock, but in the gravels above bed rock through a distance oftentimes of 2 feet or more. In the bed rock it is found to a depth of 1½ feet. The pay streak has been worked in places over a width of 50 feet, but on the outer limits it contains small values. Ground has been worked, ranging in values to over $2 per cubic yard, and is said to run from $50 to $100 to the box length. The gold is found in pieces worth as high as $20, but the general run consists of small, flat pieces. Toward the head of the creek it is frequently black. Its origin is supposed to be in the small quartz stringers in the schist, which have sometimes been found to carry gold.

As the drainage area is small a dry season quickly affects the water supply, thus making the output of the creek, especially that of the upper portion, largely dependent on climatic conditions. The richest gravels on these creeks have apparently been worked out, but there is some ground left which could probably be made to pay if water were available. On Walker Fork several outfits have been doing fairly well during the past few years on ground that was not worked in the early days, and the present annual production is probably about $20,000 to $25,000.

Most mining has been carried on by the open-cut method. For this it has been found necessary, on account of the low grade of the stream, to construct bed-rock drains 400 to 1,000 feet in length. A horse scraper was in use on one claim to clear away the tailings, and on another a steam engine was in operation, running a scraper and a bucket conveyor to elevate the dirt to the sluice boxes, handling effectively 400 to 500 scrapers of dirt a day (Pl. VIII, *B*).

In July, 1903, about 40 men were working on Walker Fork and its tributaries, and wages were $4 a day with board.

The country south from Walker Fork on the headwaters of Cherry Creek is being prospected. The bed rock and gravels of this area are similar in character to those found on Walker Fork. At the

junction of Owl and Crow creeks a little work had been done and some pay found, but the developments are not sufficient to give any indication as to the values of the ground.

Tributaries of Canyon Creek.—Some mining is being done north of Walker Fork over the divide on tributaries of Canyon Creek. Squaw Gulch is the most important tributary, and is easily reached by following the spur between Baby and Woods creeks. It heads in the divide opposite Wade Creek, and its tributaries have their source within a mile of those of the latter. In the lower 4 miles of its course it flows in a northeasterly direction and joins Canyon Creek about 6 miles above its mouth. It is a small stream with a fall of perhaps 150 feet to the mile. Its valley is narrow and V-shaped, and is sunk 1,500 feet below the level of the spurs on either side. The bed rock is marble, schist, and quartzite, which strike N. 45° W. and dip 30° to the northeast, and are cut occasionally by small granitic dikes.

The gravels are of the same types as the bed rock, and the proportion of bowlders is large, especially toward the mouth of the creek. The depth of gravel varies from 3 to 10 feet, the average being about 8 feet. Gold is found in about 1½ feet of gravel over widths up to 50 feet. It occurs as small flat pieces, often containing a considerable admixture of thin, flaky gold; but coarse pieces are common and specimens work $43 have been found. The best values thus far have averaged about $2 to the cubic yard, and the creek has produced a few thousand dollars. Considerable ditching has been done and dams have been built, but only a few men were on the creek in July. The flow, like that of other streams having small drainage areas, is closely dependent on climatic conditions and is immediately affected by drought.

Franklin Creek.—This creek and the conditions obtaining in 1897 were described by Goodrich in Spurr's report,[a] already referred to. Its mouth is at the end of the ridge trail from Steele Creek to South Fork of Fortymile, and is also on the Eagle-Valdes mail route. A small collection of cabins, picturesquely located on the small flat at the mouth, is known as Franklin and includes a post-office and road house.

Gold was discovered on this creek in 1886, and the early days are said to have been full of interest. One man's grub list in 1890 for two months consisted of 1 sack of flour and 5 pounds each of beans, rice, dried apples, and tea; the daily pancake was cut in three pieces, one for each meal. The gold was easy to mine and more easily spent on the little flat at the mouth of the creek, which was then crowded with miners, and passed quickly through many hands.

[a] Spurr, J. E., Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 332–335.

The creek, which is a short one, about 8 miles in length, flows in an easterly direction and joins South Fork about 10 miles south of the junction. The valley of the upper portion is comparatively open, that of the lower portion is narrow and V-shaped, with precipitous slopes; the stream bottom has a width of only about 50 feet. The bed rock includes micaceous, garnetiferous, and hornblendic schists, and crystalline limestone, which strike nearly east and west and have a southerly dip; they show much crumpling locally, and have been closely folded. The schists were found to be cut in places by acidic granitic dikes.

The gravels are composed of more or less angular fragments of schist, crystalline limestone, granite, dark heavy rounded pieces of basalt, and heavy brown and green masses composed of garnet, epidote, and quartz often with considerable pyrite. The depth to bed rock varies from 2 to 30 feet, with an average of 8 to 10 feet. Pay is found mostly near bed rock and across the entire width of the creek bottom, and there is said to have been considerable ground which contained as high as $5 to the cubic yard. The ground worked recently has varied from about $30 to $150 to the square box length of 12 by 12 feet, which means a maximum value of about $3 per cubic yard. There has been much variation in the size of the gold. Two of the largest nuggets found in the creek were worth $239 and $500. The general run of gold at present rarely includes nuggets worth above $30.

The depth to bed rock on the bar at the mouth of the Franklin is about 3 feet; the gold there is found mostly on bed rock and to a depth of 2 feet within it. The average value is about $1 to the square foot of bed rock. There is no evidence that the gold on Franklin Creek has had other than a local origin. Pieces are often found with quartz attached, and an assay for the Survey, by E. E. Burlingame & Co., of a quartz fragment containing considerable pyrite yielded 0.16 of an ounce of gold and 0.16 of an ounce of silver to the ton. The average annual production at present is about $8,000.

Some winter drifting has been done on Franklin Creek, and in 1903–4 the bar at the mouth was worked with a steam-thawing apparatus, but most of the ground is better adapted for summer work. There are generally about twenty days of good water for sluicing and sixty days for shoveling in; this may continue to about September 20. The creek affords another illustration of the dependence of a small drainage area on abundant rain for satisfactory results. On July 4, 1903, there was only a small stream of water trickling through the gravel and standing here and there in disconnected pools; little work had been done since the middle of June. In one summer operations were entirely suspended from July 4 to August 15, while in 1902 conditions were favorable for work throughout the entire season.

Chicken Creek.—As one climbs the ridge south of Franklin a view is obtained far to the south with the peak of Fairplay in the background and the Kechumstuk Hills off to the west. (See map, Pl. VII.) In the foreground is the open valley of Chicken Creek, limited on the north by a rugged mass 3,400 feet in height, which occupies the right angle where South Fork bends to the west, and on the west by a broad flat spur between Chicken Creek and Mosquito Fork, which rises gradually to a level of about 2,000 feet, forming a striking feature in the landscape. In the middle distance Mosquito Fork crosses the region in an easterly direction and Denison Fork is seen coming in from the south. The valleys of all three streams are benched. The drainage area of Chicken Creek includes about 20 square miles of a fan-shaped area, which is only about 5 miles in length in a north-and-south direction. The tributaries converge from their sources in the divide between it and Franklin, thus giving an amphitheatral form to the upper valley. Below the last tributary the creek has a length of only about 1½ miles. It is a small one, flows in a southerly direction, and in the lower portion of its course has a fall of less than 80 feet to the mile. Of the tributaries, which flow in narrow valleys, the Stonehouse and Myers Fork are the most important. The valley of the main stream has a flat on the west which rises gradually until, at a distance of several hundred feet from the stream, it meets the foot of the broad, low spur west of Chicken Creek. This flat, as seen from the ridge between Chicken and Franklin creeks in July, 1900, was flecked with tents and cabins and presented an appearance of much activity. Toward the south it merges into the broad, grass-covered meadows of Mosquito Fork, where moose are said to have been abundant in the early days. The ridge to the east of the Chicken shows a rather well-defined benching in the vicinity of Mosquito Fork. About a mile east of the Chicken and 275 feet above it there heads a small stream known as the Lost Chicken, which flows southeasterly to Mosquito Fork.

The distance from Franklin to Chicken Creek is about 5 miles. There is a trail which ascends the divide from a point on South Fork just below the mouth of Franklin Creek, and another by way of Franklin and Tin Kettle creeks.

Supplies are brought by freight boats up Fortymile Creek, South Fork, and Mosquito Fork to the mouth of Chicken Creek. There is, however, but little freighting done in summer.

There is an interesting variety of rocks in the valley of Chicken Creek. The igneous rocks may be roughly divided into members of the granite-diorite families, dark hornblende rocks (partly of tuffaceous origin, cut by dikes of the former group), and fresh olivine-basalt. The other rocks include dark shales, much jointed and broken

and containing quartz and calcite seams, and a formation consisting of sandstone, sandy shales, and coal beds.

The ridge between Franklin and Chicken Creeks is composed of granular and porphyritic representatives of types ranging from hornblende-granite to quartz-diorite, those related to the latter type being the more common. These rocks also form the canyon wall of Mosquito Fork about 2 miles west of the Chicken, and occur again on the ridge between Chicken and Lost Chicken creeks. The greenstone and related rocks, largely of tuffaceous origin, form the high ridge east of the Chicken and are cut by dikes of the preceding types. Olivine-basalt occurs on Myers Fork, on the lower portion of Stonehouse Creek, and on the east side of the Chicken about a mile below the Stonehouse. It apparently extends over the entire area westward from this latter point to the dioritic rocks on Mosquito Fork. Dark jointed shales with quartz and calcite seams overlie the porphyry east of Stonehouse Creek and are of interest because gold has been found in them. Sandstone, sandy shale, and coal beds occur at several localities on Chicken Creek, and coal is sometimes the bed rock on which the gold is found. The sandstone, the ferruginous nodules which it contains, and the sandy shales all contain badly preserved plant remains, and the formation is correlated provisionally with similar occurrences near Eagle which belong to the Kenai formation.

The stream gravels, so far as known, lie on a bed rock of basalt, sandstone, or coal. They include representatives of the different kinds of bed rock occurring in the neighboring hills. There is a large proportion of greenstone and much olivine basalt; granular and porphyritic varieties of the granodiorite type are abundant, and there is some quartz, slate, sandstone, coal, and ferruginous nodules often containing fragments of dicotyledonous leaves. Pieces of marble and schist indicate the occurrence of a formation like that of Franklin Creek somewhere within the valley. The depth to bed rock in the main valley varies generally from 6 to 45 feet. A layer of muck 22 feet thick covers the gravels, often forming more than half the entire deposit on bed rock. The gravels vary from 6 to 20 feet in thickness and are found mostly on the west side of the stream to a distance of nearly 1,000 feet from it. They vary in size up to a foot or more in diameter, and in the lower portion contain considerable clay, which often acts as a gold robber by balling up in the sluice boxes.

The pay is found mostly on bed rock, but sometimes extends into it and often above it, where it is found through 5 feet or more of the gravel. Most of the work has been done on the west side at a considerable distance from the creek. Pay has been found to nearly the extreme western limit of the gravel and over a width of 80 feet. The

values vary from $50 to $175 to the box length, and a considerable portion of the ground probably averages about $1 to the square foot. The gold is different from that of the other creeks. It is usually rather fine, much of it is granular, and the color is generally dark. Some of the gold is rather rough and is frequently found with quartz attached. No large nuggets have been found.

The bench between Chicken and Lost Chicken creeks is about 275 feet above the valley. Ground was located at the head of the Lost Chicken in 1901. Several holes were sunk along the creek and on the bench, and in the last one pay was found at a depth of 33 feet. One hole sunk in the west side of the bench near the top is interesting in that sandstone with plant-bearing shales was found at a depth of 90 feet, overlain by loosely cemented gravels surmounted by 15 feet of muck. In the fall of 1902 some drifting was done on a portion of the ground, which averaged about $1 to the square foot. Near at hand two shafts were sunk to bed rock, one 53 feet and the other 45 feet in depth, and a dump obtained, which was estimated to contain from $35,000 to $40,000. This is shown in the accompanying photograph, taken after $25,000 had already been washed from it (Pl. IX, *B*). The bed rock is of the same dioritic type as that already referred to on Mosquito Fork. The 45-foot hole was sunk to bed rock through 23 feet of muck and 22 feet of gravel and the upper portion of the decomposed bed rock was taken out along with the gravels. These are the same in kind as the recent stream gravels, but are somewhat finer and show more wear. The discovery of gold on this bench has led to much activity in prospecting the benches throughout the region, and considerable work was under way west of Chicken Creek on the high benches of Mosquito Fork.

Chicken Creek has a further interest in that two localities have been found bearing on the origin of the gold. One of these is about $2\frac{1}{2}$ miles west of Chicken Creek on Mosquito Fork. At this point on the north of Mosquito Fork there is a steep canyon wall composed of a medium-grained greenish rock having about the composition of a quartz-diorite. On the side of this canyon wall, about 200 feet above the stream, occurs a mineralized zone, which has a thickness of about 6 feet and a strike of about N. 25° W., in which weathering has produced brilliant red and yellow colors. The rock within this zone is mostly decomposed to a kaolin-like mass, containing abundant fragments of quartz seams. This material pans fine flour gold. Assays of two specimens for the Survey by E. E. Burlingame & Co., Denver, gave for the one, in ounces per ton, gold 0.58 and silver 0.10; for the other, gold 0.36, silver 0.10; or an average of the two of about $9.70 in gold per ton. No drifting has been done and the specimens were taken directly from the surface. The extent of the deposit was still unknown, and as such values would not pay for working under

A. SHAFT AND HORSE HOIST ON CHICKEN CREEK.

B. DUMP OF PAY DIRT ON LOST CHICKEN.

present conditions the occurrence is of interest chiefly in pointing to one possible source of the placer gold occurring on Chicken Creek. This rock is the bed rock on the bench between the Chicken and the Lost Chicken. A porphyry of about the same composition but very different in appearance outcrops abundantly on the south side of the divide between Chicken and Franklin creeks.

On the broad spur east of Stonehouse Creek, about 1 mile north of the junction of the Stonehouse and the Chicken and about 500 feet vertically above it, gold has been found in place in dark shales lying on the nearly flat surface of the fine-grained, dark-colored porphyry to which reference has just been made. At this locality a 10-foot hole has been sunk and a crosscut of less depth run to a distance of 35 feet on the west side. In the bottom of the hole there is exposed about 2 feet of the porphyritic rock, containing abundant corroded quartz phenocrysts up to 3 mm. in diameter, and some larger ones of plagioclase feldspar in a fine-grained, dark-gray groundmass containing some pyrite. This hard, tough rock is considerably jointed and much discolored by iron rust along the joint planes. On top of it is a 10-inch layer of soft black material of the consistency of clay, succeeded by 5 to 6 feet of blackish shales, much jointed and having a general dip of 25° to the southwest, thus conforming with the surface of the porphyry and that of the black layer. These shales contain many calcite and some quartz seams; but these are rarely more than 2 inches in thickness and do not extend into the black layer below them. The quartz seams were found to contain considerable pyrite, and the thinner calcite seams contain interesting specimens of gold, which occurs in thin plates along planes in the calcite. The shales are covered with 2 to 3 feet of soil.

Twelve hundred feet southwest of this locality a similar porphyritic rock occurs, but here the rock is more coarsely crystalline and more like a dark-colored granite in appearance. It was covered with a thin deposit of gravel resembling the bench gravels found at other localities within the valley of Chicken Creek. The igneous rock probably forms the main mass of this broad spur and is overlain locally by the shales. The distribution of the shales and other possible occurrences of gold with them have not been determined. Shales somewhat similar in character are cut by the ditch on the east just above Stonehouse Creek, where they are covered by about 5 feet of muck.

The locality above described has produced many beautiful specimens of gold associated with calcite, and is of present interest chiefly in pointing out another possible source of the placer gold. No work has been done to show whether the shales have been uniformly mineralized over considerable areas. If such were the case and con-

ditions were favorable, they could be stripped from the underlyin rock. The water supply in this area is a very limited one.

On the main creek methods are in use adapted to the depth an character of the ground, most of the work being done by the stea thawer. Shafts are sunk to bed rock and drifting continued hori zontally to the limits of the pay streak, while the dirt is hoiste to the surface in buckets, sometimes by hand windlass, but generall by horsepower or steam hoist. A tripod is erected over the shaf and the rope or cable from the bucket passed over a pulley at th top of the tripod and thence by other pulleys to the source of powe (Pl. IX, A). Horsepower is cheaper, and with it about 60 cubi yards can be hoisted a day from a depth of 20 to 30 feet. One outfit by the use of a 12-horsepower boiler steam thawing apparatus an hoist, raised about 80 cubic yards in a day of ten hours from tw shafts 45 and 53 feet in depth.

It has been found cheaper to drift in the summer season, for th cost of winter work is about 60 per cent of the output and of summe work only about 40 per cent. The thawed dirt can be dumped im mediately into the sluice boxes and washed. There are several mile of ditching to bring water from the various tributaries, but in a dry season the supply is insufficient. In the first week of July, 1903, there had been already three weeks of dry weather and much of the work was at a standstill.

At a few localities on Chicken Creek, Myers Fork, Stonehouse Creek, and Irene Gulch, claims are worked by open cuts. Work can commence May 1 and continue to September 20.

Three claims were being worked on the upper portion of Myers Fork, where the bed rock is olivine-basalt and the gravels vary from 8 to 20 feet in thickness. About 2½ feet of gravels are washed, but most of the gold occurs on bed rock. It is coarser than that on the Chicken and runs from $80 to $100 to the box length.

On the Stonehouse, where a few men were working, the depth to bed rock is about 14 feet, and pay is found through 3 to 4 feet of gravel. On the rim to the east of the Stonehouse the depth varies up to a maximum of about 12 feet. The gold found here is rough and dark colored and may have been derived from the shales cut by the ditch just above this locality that are similar to those in which gold has been found in place one-fourth mile farther east. Irene Gulch enters the Stonehouse from the east. It is very short, hardly more than a sag in the slopes of the main valley, but is interesting in that it also heads in the shale area. The bed rock in the lower portion is sandstone containing nodules with plant remains. Water is brought by a ditch 2,800 feet in length from the upper valley of the

A. ARTIFICIAL CUT-OFF IN SCHIST ON NORTH FORK OF FORTYMILE.

B. BED OF THE NORTH FORK DRAINED BY ARTIFICIAL CUT-OFF.

Stonehouse. Little could be done last season on account of the low water.

The production from Chicken Creek and the benches during the season of 1903 was about $100,000. In July about 80 men were working; earlier in the season there had been perhaps twice that number.

North Fork of Fortymile.—North Fork meanders in a narrow rock-cut canyon about 600 feet below the floor of the old valley. The upstream part and the downstream part of a meander are frequently brought close together and are sometimes separated by only a narrow ridge of rock. In a river like the Mississippi cut-offs are often formed at high water in such portions of the stream, but in a stream like North Fork, deeply sunk within hard rock, a cut-off can be formed by natural processes only when the stream wears away the narrow rock barrier. About 20 miles up North Fork from the junction the two parts of a meander were separated from each other by a sharp ridge of rock over 100 feet high and only 100 feet wide at the base, while the distance around by stream was $2\frac{3}{4}$ miles. This locality, which is known as the "Kink," lies a few miles west of the area shown on the map (Pl. VII). It was a comparatively easy matter to blast away the rock barrier, and thus form an artificial cut-off which drained the "Kink," with the exception of a few standing pools of water. The original width of the cut-off was only about 15 feet, and at first only a small quantity of water flowed through it, but after a few hours the main body rushed through and soon worked out a channel over 40 feet wide. The low gradient in the $2\frac{3}{4}$ miles around is now concentrated in a fall of about 17 feet in two portions, an upper one of about 15 feet and a lower one of about 2 feet. There is a deep hole below the falls where grayling swim in great numbers, unable to travel upstream by the customary route or to jump the falls. It is said, however, that the rock is rapidly wearing away, and that even now an occasional fish can make his way to the upper river. A view downstream through the cut-off and another showing the drained bed of the river are shown in Pl. X, *A* and *B*.

The bed rock at the cut-off is quartz-biotite-garnet-schist, with a northwest strike and a northeast dip of 45°. Half a mile to the west occur large outcrops of thin-bedded and massive crystalline limestones with a similar strike and dip. These outcrop on the east side of the hill to the west of North Fork, and the schists occur again on Hutchinson Creek at the saw mill. The same formation of schists and limestones, which is found for several miles to the north and south of North Fork, is a continuation of the formation occurring on the lower Fortymile at Bonanza Bar, Franklin Creek, Wade Creek, and other gold-producing areas. About half a mile above the Kink the schists are cut by a dike of olivine-basalt about 100 feet thick, and

500 feet farther up by another dike of the same rock. The stream gravels are derived largely from the metamorphic formation, but include also a considerable proportion of granodiorite and some basalt. It is proposed to work the gravels in the drained portion of the river bed, which is about 200 feet wide, by a steam dredge during the season of 1904. The gravels along the side of the channel are 7 feet thick and are covered with about 8 feet of sand and muck, while those of the lower benches vary in thickness from 10 to 20 feet. Considerable work has been done here, but it is not known whether the average values of the gravels have been found sufficient to justify their exploitation.[a]

Other localities.—There has been some prospecting in upper Hutchinson Valley. Two men working on Confederate Creek, just above the mouth of Humbug Pup, report about 6 feet of gravel on a bed rock of schist. Some prospecting was in progress on Montana Creek, at the mouth of which good results are said to have been obtained in 1902. So far as seen the bed rock throughout the valley belongs to the schist-limestone formation, cut occasionally by granitic and basaltic dikes.

Napoleon Creek was not visited, but is said to carry good values. It has been extensively exploited in the past, though little except representation work was done during 1903.

A few men were found working on the bars of Fortymile between Steele Creek and Bonanza Bar. The rocks along this portion of the river are closely folded hornblende, mica, garnetiferous and quartzite schists, interbedded with bluish crystalline limestone, with a uniform strike about east and west.

Nugget Gulch, a small tributary of Fortymile, has its source in a dome 3,320 feet in height, about 4 miles north of the river. It flows in a southerly direction through a narrow V-shaped valley, and enters Fortymile about 2 miles below Steele Creek. This creek is said to have produced considerable gold in the early days, but in June, 1903, no one was found working on it. The schist-limestone formation outcrops frequently in the bed of the creek and on the sides of the canyon, with a northerly upstream dip. The quartzite-schists often show crumpling and even brecciation of the different layers. A large mass of basic igneous rock related to gabbro occurs at the head of the creek. The gravels include varieties of schist, limestone, vein quartz, and pieces of the dark-green igneous rock. The creek has been worked for a mile above the mouth, over a width of about 30 feet.

Gravels occur on the benches in the vicinity of the Fortymile, and as the gulch diggings become worked out attention is being directed

[a] No work was done here during the season of 1904 and the locality at present is chiefly of physiographic interest.

to these possible sources of gold. The stream which formerly occupied the old valley of the Fortymile had its meanders and deposited its gravels in about the same way as the stream is now doing at a level from 500 to 600 feet lower. As in the present valley only a few localities are found where pay occurs in quantities of economic importance, so in this older, larger valley there were also some localities more favorable than others for the deposition of gold. In prospecting these gravels, then, the form of the old valley, the probable position of the stream within it, its relations to the bed rock, and the lateral spurs and the probable location of the old bars should be carefully studied. The old conditions should be restored so far as possible in the mind of the prospector, and those localities selected for prospecting which seem to have presented in the older time the best conditions for the concentration of the gold.

Miller Creek is a small branch of Dome Creek about 2½ miles in length, which has its source in the divide between Dome and McKinley, and flows in a southerly direction through a comparatively open valley, bounded on either side by the broad spurs which slope gradually from the divide to Dome Creek. Gold was discovered here in 1893 by men who packed in their supplies from Nugget Gulch. The bed rock belongs to the schist formation and most of the gravel is schist. Pieces are found up to a foot or more in diameter, and a few well-rounded bowlders of quartz of somewhat larger size occur. There are about 8 feet of gravel covered by a variable thickness of muck and moss. The pay, which occurs near the bed rock, in about 10 inches of dirt, over a width of about 20 feet, is said to be mostly coarse and rough, but to include also some smooth pieces. No gold has been found in the other tributaries of the Dome or in the Dome itself, except just below the mouth of Miller Creek, where good pay was found. The locality is interesting in showing an isolated occurrence of gold in a region where there are large areas of similar bed rock.

EAGLE AREA.

American Creek.—At present the most important gold-producing area in the vicinity of Eagle is that of American Creek and its tributary, Discovery Fork. American Creek heads in the divide, about 16 miles southwest of Eagle, flows in an irregular northeasterly course, and enters Mission Creek about a mile above its mouth. From the divide at the source to the mouth there is a fall of more than 3,000 feet. Discovery Fork is formed by the union of several small tributaries, flows in a northerly direction, and joins American Creek within the headwater area. The main stream and tributaries flow, with a swift current, in narrow V-shaped valleys, deep within the inclosing ridges, as shown in Pl. XII, *A*.

Graphitic schists, containing abundant quartz seams, form a portion of the bed rock about the headwaters, and crystalline limestone outcrops on the divide at the head of Discovery Fork. Schists similar to those above described occur again on American Creek about a mile above its junction with Discovery Fork. Below this point to Discovery Fork and on the latter stream, the bed rock is mostly serpentine, frequently cut by basic dikes.

Though American Creek has been worked for several years and considerable coarse gold found upon it, no preparations were made to work the gravels on a large scale until 1903, when a hydraulic plant was installed at a point about 1 mile above Discovery Fork, where there is an ill-defined bench on the west side. The gravels at this locality are about 5 feet thick, composed of schist and igneous rocks. There are 3 feet of loose gravel called "chicken feed," and 2 feet of similar material with a large proportion of clay. Gold is found throughout this lower deposit, but the best pay is next to bed rock, some being also found in the bed rock itself to a depth of 2 feet. Barite is a common associate of the gold.

The slope is a rather steep one, from the edge of which to the water of the creek there is a fall of about 15 feet. A flume, 7,200 feet in length, with a capacity of 1,200 inches, has been built from the upper portion of American Creek, giving a head of 150 feet and furnishing water intended to supply two hydraulic elevators. The capacity of the plant was expected to be about 1,000 cubic yards of dirt in a day of twenty-four hours, and the expense of working about 10 per cent. At the time of the writer's visit the water was turned on the ground for the first time. The plant is a very complete one for work and, if the water supply can be depended upon, should accomplish good results. It is shown in Pl. XI.[a]

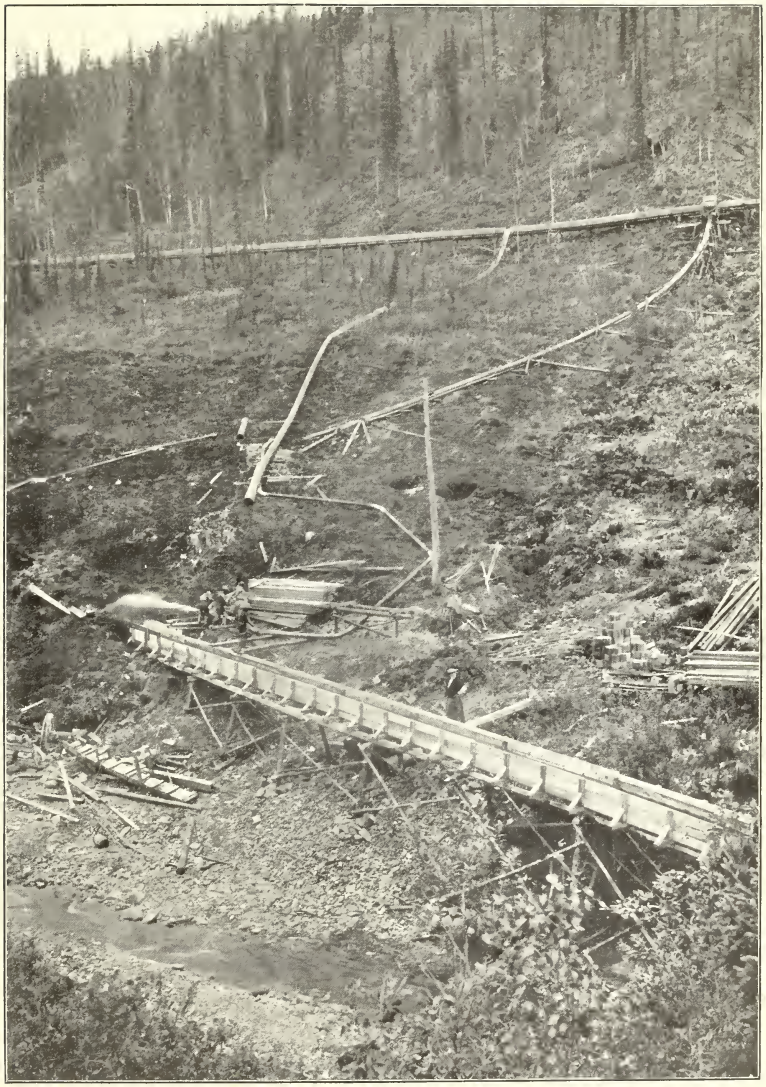
Discovery Fork.—On Discovery Fork there are from 4 to 10 feet of gravels lying on the serpentine bed rock, covered with as much as 12 feet of muck. The pay is mostly on bed rock and is rather coarse. Values are found over a width of from 8 to nearly 30 feet. The creek has produced perhaps $20,000. During the season of 1903 two outfits were working on it.[b]

SEVENTYMILE AREA.

Broken Neck Creek.—This creek is about 20 miles northwest of Eagle. It is short, entering the Seventymile from the north just above Mogul Creek, which enters from the south. Its valley is bounded by precipitous walls several hundred feet high, and where

[a] The water supply was found insufficient for the demands of the plant, and during 1904 modifications of the method were being tried to make a more effective use of the available water.

[b] During 1904 excellent results were secured by the use of an automatic dump gate.



HYDRAULIC PLANT ON AMERICAN CREEK.

the stream leaves it to cross the flat to the Seventymile is only 120 feet wide. The bed rock is conglomerate, interbedded with shale containing many fossil leaves of Arctic Miocene (Eocene) age. The strike is N. 60° W., and the dip 75° upstream to the north. The gravels are composed of the pebbles found in the conglomerate, fragments of the conglomerate itself, pieces of shale and sandstone, occasional bowlders of quartzite a foot or more in diameter and unlike the pebbles found in the conglomerate, and bowlders of conglomerate, which are finer grained than that outcropping along the creek, are very compact, and contain a larger proportion of chert pebbles. The creek has been worked to a width of 100 feet at the mouth for about one-half mile upstream. The pay streak is said to have been about 6 feet wide, and the total production about $10,000.

The falls.—The falls are about 20 miles northwest of Eagle, on the Seventymile. Below them the valley of the Seventymile is bounded by conglomerate on both sides; above them for a few miles the river flows close to the contact of the old metamorphic schist formation and the conglomerate; at them the river is cutting the schists and has become separated from the conglomerate by a hill of schist and impure limestone 400 feet high. The falls are only about 9 feet in height. Just below them the stream flows through schist walls 20 to 40 feet apart and 20 feet high. The strike of the schistosity is about N. 75° E.; the dip 25° to the northwest. Folding has been very close, as is shown by the closely appressed minor plications, and the rocks have been much jointed. On the south side of the stream, just above the falls, there is a deposit of gravel on the schist 3 to 9 feet thick, covered with a few feet of muck. At the point where work was in progress the bank is about 10 feet high; a section from top to bottom showed 2 feet of moss and muck, 4 feet of fine gravel and sand, 1 foot of muck and sand, and 3 to 4 feet of gravel. The gravels include conglomerate, schist, vein quartz, limestone, and considerable clay. Pay is said to be found all through the lower gravels.

Three men were working at this locality. A ditch 1¼ miles long brings water from Washington Creek to a point on the opposite side of the Seventymile, across which it is carried in a canvas hose, 8¾ inches in diameter, on a bridge 220 feet long and 30 feet high, to another ditch 400 feet in length, whence it is used (Pl. XII, *B*). During the night the water is run on the muck, sluicing it away, and thus preparing the ground for shoveling in.

Sonickson Creek.—This creek heads in the high ridge about 6 miles south of Seventymile and enters the river about 2 miles west of the fall. In this part of its course it runs close to the southern boundary of the valley, leaving on the north a finely preserved flat a half mile in width and 20 feet above the stream. Sonickson is a small creek, flowing in a canyon whose slopes exhibit well-defined benching in the

vicinity of the Seventymile. The bed rock at its mouth is a calcareous and graphitic schist, with a strike N. 80° W. and a vertical dip. Some work has been done near the mouth. The average depth to bed rock is about 8 feet, and the mantle of sand and gravel is about 2 feet thick. The gravels contain bowlders of schist, conglomerate, greenstone, and granite. The gold occurs in thin pieces, which sometimes have quartz attached. At the time of examination little work had been done for five weeks on account of low water.

Barney Creek.—Barney is a small creek entering Seventymile from the north, about 5 miles west of Sonickson Creek and 30 miles northwest from Eagle. It is formed by two tributaries, one from the north and the other from the east, and flows south about a half mile through a very narrow canyon to the Seventymile. The bed rock includes closely folded conglomerate and plant-bearing shales, as on the Broken Neck. The strike is N. 65° W. and the dip varies from 55° south to vertical.

The gravels in the creek are 1½ to 3 feet thick, composed of pebbles from the conglomerate, pieces of the conglomerate, and bowlders of vitreous quartzite up to 3 feet in diameter. The gold occurs in thin plates up to one-fourth inch in diameter.

At a level about 50 feet above the mouth of the creek, on the west side of the stream, and also between the forks about one-half mile upstream, is a deposit about 6 feet thick on the upturned edges of the conglomerate. This deposit consists of 3 feet of gravel and 3 feet of sand and muck. The gravels contain large quartzite bowlders, and on the point between the creeks have been found to carry gold.

The fact that similar bench gravels occur on both Broken Neck and Barney creeks indicates a considerable distribution of these gravels, and the fact that gold has been found in them at Barney Creek points to them as a possible source of the placer gold. The quartzite is entirely massive, vitreous, with no evidence of shearing or schistosity. The nearest locality where similar rock was found in place is on the ridge east of Glacier Mountain and north of Seward Creek. Farther west the ridge south of the Seventymile contains many metamorphosed quartzose sediments and granular intrusives. No evidence could be obtained as to whether gold had ever been found in the conglomerates themselves. The creek was first prospected in 1895, and is said to have been a good producer in 1896.

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

A VIEW UP AMERICAN CREEK.

B BRIDGE FOR CONVEYING WATER IN A CANVAS HOSE ACROSS SEVENTYMILE.

claims. Two men were working on the creek, but could do little on account of the low water.

Flume Creek.—This 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 becomes very narrow and is 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 in width. 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 schist, but include a considerable proportion of large quartzite bowlders, greenstone, vein quartz, crystalline limestone, black chert conglomerate, and a rock which resembles granite, but is more closely related to a quartz-diorite. The rock is said to occur abundantly 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.

Benches.—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. Prospecting requires much time and systematic work before the values of the gravel can be determined.

In conclusion, it may be said that there are a few of the tributaries of Seventymile that have produced good pay and are still producing a small quantity of gold, and that there are extensive deposits of gravel along the main stream, some of which are known to contain gold, but none of which have had their distribution and values accurately determined. Up to the present time apparently no results have been obtained through the investigation of these gravels sufficient to justify their working on an extensive scale.

About 25 men were working on the Seventymile during the season of 1903.

SUMMARY.

The gold-producing localities of the Fortymile region are divided geographically into three rather widely separated areas, the Fortymile area, the Eagle area, and the Seventymile area.

Through most of the Fortymile area the bed rock belongs to the formation known as the Fortymile formation. It is composed of various schists with interbedded crystalline limestone. All have been closely folded, highly metamorphosed, and intruded by many kinds of igneous rocks. Some of these were intruded so early in the history of the region as to have also undergone metamorphism; others are comparatively fresh. Small quartz veins are numerous, and locally the rocks have become mineralized and are a source of gold. The occurrence on Chicken Creek is different. The bed rock is mostly olivine-basalt and a formation of sandstone, coal, and shale which probably belongs to the Kenai. The walls of the valley are olivine-basalt, granular and porphyritic igneous rocks of types ranging from hornblende-granite to quartz-diorite, and greenstones of the Rampart formation. As the rocks differ from those of the other localities, so, too, there is a difference in the character of the gold, which is generally granular, of a dark color, and suggests a different origin. At two localities gold has been found in place. One of these is outside the valley of Chicken Creek, but in a dioritic rock which is found abundantly within the valley; another is in a shale of undetermined age which may possibly belong to the Rampart formation. The placer gold on Chicken Creek may have been derived mostly, if not entirely, from these two sources.

In the Eagle area the occurrence has not been traced to a source. The bed rock of American Creek near the headwaters is schist and greenstone. In the lower part of its course the creek flows mostly through greenstones and serpentine.

In the Seventymile area also the origin is indefinite. The creeks from the north flow through conglomerate of the Kenai formation. No case is known where gold has been found in place in the conglomerate, but it has been found in a wash containing heavy quartzite bowlders which occurs locally, overlying the conglomerate. No such bowlders were found in the conglomerate, and the wash may possibly have been derived from rather distant sources.

The most interesting recent developments in the Fortymile region are the discovery of gold in place on the Chicken, the working of the high-bench gravels between the Chicken and the Lost Chicken, the draining of North Fork by an artificial cut-off at the Kink preparatory to working the ground on an extensive scale, and the installation of a hydraulic plant on American Creek. The best results so far have

been obtained between Chicken and Lost Chicken creeks. About 300 men were working in the region during 1903, and the production was about $175,000.

BIRCH CREEK REGION.

GENERAL STATEMENT.

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

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 (Pl. XIII). 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 southward and flow northeasterly 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 are Deadwood, Mammoth, Mastodon, Independence, and Miller; on the south side they are the Eagle and its tributary, Mastodon Fork. These creeks were all visited by a survey party in 1896, and descriptions of them by Spurr, Goodrich, and Schrader are to be found in the report of the expedition.[a]

CREEKS.

Deadwood Creek.—This creek, which is about 20 miles long, heads at an altitude of about 3,000 feet, and has a fall of over 2,000 feet from source to mouth. It is divided into two portions, an upper one about 12 miles long, where the stream flows through a rather narrow valley bounded by gradually sloping spurs about 1,200 feet above it, and a lower one about 8 miles long, where the individuality of the valley is abruptly lost in that of Crooked Creek. The fall in the valley portion is about 150 feet to the mile. The stream flat, which attains a width of several hundred feet, 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 shows a more or less well-defined bench, which rises gradually from a level about 20 feet above the stream toward a ridge which separates Deadwood and Boulder creeks. Switch Creek, which is the most important tributary, is about 3 miles in length, flows in a narrow V-shaped valley and joins the main creek about 3 miles above its emergence from the hills.

[a] Spurr, J. E., Geology of the Yukon gold district, Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 342–355.

The bed rock in most of the valley varies from a rather massive, blocky quartzite to a 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 on Ketchum Creek, only a few miles east of Deadwood Creek, where weathering has produced very striking pinnacled forms from this rock in the valley of the creek itself. On Deadwood Creek it is not so conspicuous, but forms the bed rock over a considerable portion of the creek. Dark-colored, more basic rocks occasionally occur.

The gravels are composed of the varieties of rock outcropping in the drainage area and consist mostly of subangular fragments of comparatively small size, 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, as far as known from work already done, from 6 to 20 feet. The gravels in the creek vary in thickness up to about 8 feet, and there is generally but a small amount of top dirt to be removed. The values are sometimes found through the whole thickness of gravel, but are generally close to bed rock and are found also in the bed rock to a depth of 2 or more feet. When the bed rock is massive and 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. Some ground has averaged much more, values ranging from $100 to more than $200 having been obtained in 1903. Not much work has been done thus far on the bench to the west side of the valley, and 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. At one locality 20 feet of gravel lie on a rather massive quartzite bed rock at a level of 20 feet above that of the adjacent creek. Little gold is found in the gravel; it is mostly on bed rock and along the joint planes to a depth of 4 feet within it. From something over half a box length of ground, 16 by 12 feet, $128 had been washed, which would give an average for the amount of dirt moved of something more than $1 to the cubic yard. Two nuggets had been found worth $8 and $10, respectively. This locality is important in pointing out the possibility of the extension of the pay over portions of the bench. The creek gold is generally flattened and at the entrance of the valley is rather flaky. The coarsest piece found thus far on the creek was worth $122. That found on the bench is rougher and more

RECONNAISSANCE MAP OF FAIRBANKS AND BIRCH CREEK DISTRICTS ALASKA

Scale 1:250000

0 5 10 15 Miles

0 5 10 15 20 Kilometers

Contour interval 200 feet

Datum is mean sea level.

Probable drainage not surveyed.

1904

Alfred H. Brooks, Geologist in Charge.

Topography by T. G. Gerdine and H. B. Gilmore.

Triangulation by T. G. Gerdine.

Surveyed in 1903

lumpy in character. The present annual production is probably under $50,000; the total production has been about $1,500,000.

Ground is now worked from the headwaters throughout the narrow part of the valley, a distance of about 12 miles, but it was not until 1900 that the lower part was found to be productive. The open-cut system has been employed on most of the ground. It has been found advantageous to work the cuts generally to a width of 16 feet. The depth is such that dirt can be shoveled directly into the sluice boxes. Little drifting has been done thus far on the creek, but it was purposed during the winter of 1904 to work ground on the bench by this method. About 35 men were on the creek at the end of August, 1903. The bench trail from Central House across the flat, about 4 miles, 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, which unites with Porcupine to form Crooked Creek, is itself formed by Mastodon and Independence creeks, which unite about 4 miles to the southwest. Miller Creek joins it from the west about 2 miles above its union with Porcupine Creek. About a mile below this last junction it flows through a flat 200 to 300 feet wide, gradually widening as the Porcupine is neared. On the east side spurs descend abruptly from an altitude 1,200 feet above the creek. On the west the valley is bounded by the termination of a narrow spur between Mastodon and Miller creeks, and that of a broad, low spur between Mammoth and Porcupine creeks.

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. One of the interesting developments has been the introduction of machinery. A steam shovel, shown in Pl. XIV, *A*, was shipped in over the snow from Circle during the winter of 1903 and gotten into position to work the ground during the following summer. This shovel is capable of handling 500 cubic yards of dirt in ten hours, and has a working width of 26 feet. Twelve hundred feet of track have been provided for it, and there is a face of gravel of about 10 feet upon which to work. The shovel holds about three-fourths of a cubic yard, and the dirt is dumped from it into a car of 1½ cubic yards capacity, which is drawn by cable up a steep grade, a vertical distance of 22 feet, to the boxes. The flume, which has a capacity of 5 sluice heads, brings water from a point 1,700 feet upstream. It is said 3 sluice heads are sufficient for all the gravel the shovel can furnish. The system requires 1½ cords of wood a day and the attention of about 15 men on a shift. A bed-rock drain 400 feet long carries away the water from

the cut. Work can be commenced here about June 15 and continued to about September 20.

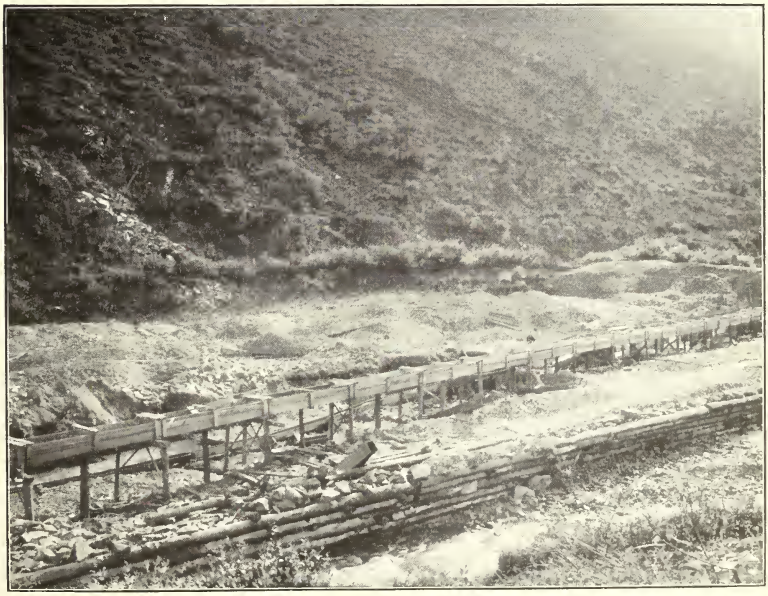
Mastodon Creek.—The headwaters of Mastodon Creek are gathered from an amphitheatral area on the northern slopes of Mastodon Dome, 4,400 feet high, situated about 7 miles southwest from the point where the creek enters Mammoth. The creek flows through a picturesque valley limited by even-topped spurs, which slope gradually in a direction parallel to the creek at an altitude of about one-fourth mile above it. The valley is unsymmetrical in section, the stream in its lower portion approaching the steep ridge on the east, and being bounded 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 attains a width of several hundred feet.

Quartzite-schist and 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 to the south. Near the mouth of the Mastodon some thin-bedded, impure, closely folded limestone was observed. 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 which has undergone metamorphism along with the other rocks. Small granitic dikes also occur.

The gravels are similar in character to those on the Deadwood. They include subangular fragments of the bed rock, with fine material of the same nature and some sand and clay. A large part of it is but little worn, and the arrangement is generally more or less irregular. 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 on top of the gravels, which attains a thickness of about 4 feet. Seven feet is the maximum of stripping that is required. 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 thus far 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. Estimates of the annual production have been made varying from $75,000 to over $100,000. The gold brings $17 an ounce in trade.

Work, the results of which are said to be satisfactory, is being done on the rim to the west of Mastodon. The gold is somewhat coarser than the creek gold. Portions of the creek have been worked thoroughly and systematically by the open-cut method. At one locality 11 parallel cuts, each 18 feet wide, have been run. (See Pl. XIV, *B*.) It is said to require about twelve days' work of one man to shovel a box length 18 by 12 feet, with an average depth to bed rock of about 8

A. STEAM SHOVEL OPERATING ON MAMMOTH CREEK.



B. BED OF MASTODON CREEK WORKED BY OPEN CUTS.

eet. This makes over 5 cubic yards a day to the man. A strip 2 uts wide is sometimes worked in conjunction with 2 sets of sluice oxes, and in most cases it is possible to shovel directly into them.

Machinery has been introduced on a few claims. A steam trolley as in use on one claim, by means of which the dirt was raised in a ucket, conveyed along the cable, and dumped automatically into the luice boxes, which were elevated about 18 feet above the ground. By the use of this arrangement it was said a man's capacity was ncreased to 12 cubic yards of dirt a day.

On another claim, where there was a depth to bed rock of 8 to 16 eet, a plant was being installed to work by the hydraulic method. There was an 80-foot head of water to be conveyed through the 12-inch ipe to a $2\frac{1}{2}$-inch giant. Everything was to be washed through the oxes, and the tailings raised by steam power to be carried away by ater. A combined ditch and flume two-thirds of a mile in length ad been constructed, and machinery, consisting of a 20-horsepower ouble-drum and a 10-horsepower single-drum hoist, had been put in lace to elevate the tailings. At another locality the depth to bed ock was about 15 feet, and it was necessary to strip 6 to 7 feet. Machinery was on the ground, consisting of a 20-horsepower boiler, oist, pumps, trolleys, and scrapers. Part of it was in use and plans ere under way for more extensive work.

The season of 1903 was the first in which machinery was used to ny extent, and it is yet too early to compare its results with those chieved by other methods. Where machinery had been installed the ork was largely experimental, as many of the men were unfamiliar ith it, and much time was spent in learning how to get the best esults. As there is no wood in the upper part of the creek, fuel had o be brought from Mammoth Creek, and problems in regard to the wnership of timber were already causing difficulty.

There is some winter work done by drifting in the upper portion f the valley, where it is said $20,000 to $25,000 were produced by his method during the winter of 1902–3.

Independence Creek.—This creek also has its source on the northern lopes of Mastodon Dome and flows in a northerly direction, to unite nally with Mastodon Creek. It was not visited, but as far as could e learned the conditions were similar to those on the Mastodon. Seven men were said to be working on it during the season of 1903.

Miller Creek.—Miller Creek is similar in all essential features to Mastodon Creek. It is less than 2 miles farther west, flows northeastrly in a course nearly parallel to that of the Mastodon, and joins the Mammoth about 2 miles above the Porcupine. The stream heads in picturesque amphitheater of hills. In the upper part of its course here is a bench on the northwest side, and it keeps rather close to the

steep slope which borders the valley on the southeast. In the lower valley these conditions are reversed.

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 and there is from 4 to 8 feet to strip. Occasionally there is clay, which has been found to be as much as 3 feet in thickness between the gravels and bed rock. This, 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 found 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, where the average depth to bed rock is about 12 feet, with 6 to 8 feet to strip. It is said that two men can work about 20 box lengths of 12 by 16 feet in a season. Near the head of the creek a month's work may be lost during the summer by low water. The annual production is perhaps $3,000 to $5,000. About 10 men were working on the creek during the season of 1903.

Eagle Creek and tributaries.—All the above creeks are tributary to Crooked Creek. Over the divide from 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. Mastodon Fork heads in an amphitheatral area on the northwest slope of Mastodon Dome, and flows northwesterly through a narrow V-shaped valley for a distance of about 3 miles to Miller Fork. The bed rock and gravels are similar to those on the other side of the divide. As on Miller Creek, clay is often found next to the bed rock of quartzite-schist. The depth to bed rock varies from 8 to 10 feet or more. 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 occur irregularly on the creek. Some ground has been very good and has yielded from $2 to $4 per cubic yard. The gold is often coarse. A flat nugget was found during the season of 1903 the dimensions of which were 2 by 1¼ inches and the weight 2½ ounces. Some quartz was attached, and the nugget had the appearance of having been derived from a seam in the bed rock. Work has been done on about 1½ miles of the creek, the claims having been worked by open cuts. The creek is said to have produced from $15,000 to $18,000 during the season of 1903.

Eagle Creek has a length of about 4 miles. The valley widens rapidly below the junction of the forks until the valley floor becomes one-fourth mile or more in width, bounded by spurs, which recede gradually as the mouth is approached and terminate in broad low 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 varied from 14 to 18 feet; about 6 feet is ground sluiced, and pay is found in about 6 feet. Values have been found ranging from $125 to about $400 per box length of 12 by 18 feet. Some of the gold is coarse, one piece worth $74 having been found. Work was being done at only a few places on the creek; on one claim a drain was being put in preparatory to winter drifting; at another locality the ground was worked by open cuts, but the depth to bed rock made it necessary to shovel the dirt first to a staging and then to the sluice boxes. The grade of the gold of Eagle Creek and Mastodon Fork is the best found in the Birch Creek region. About 20 men were working on these creeks in September, 1903.

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. It seems probable that here is at least one source of the gold. 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. In a broad way, then, the occurrence of gold shows localization. Whether the rocks have been uniformly mineralized over a considerable portion 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 found on the creeks of the Birch Creek region has been derived from large areas of bed rock more or less uniformly mineralized; that there are probably no zones or pockets especially rich in the metal; and that the distributed products from the areas

have been concentrated by stream action modified by localized annual glaciation, or "annual glaciers," as they have been called by Spurr.[a]

About 200 men were working on the creeks, the annual production being about the same as that of the Fortymile region—$175,000.

FAIRBANKS REGION.

GENERAL STATEMENT.

In the rush of 1898 many started for the Yukon from Valdes. Some, after a hard trip, succeeded in reaching the Fortymile region; others, on arriving at the Tanana, chose the line of least resistance and drifted down the river. The economic results were scanty, but some knowledge was gained of general conditions in the Tanana Valley. In the same year a party from the Geological Survey, under Peters and Brooks, descended the Tanana from the headwaters, mapped the area along the river, and studied the geology. An opportunity was thus given to compare the rocks of this region with those of the gold-producing creeks of the Fortymile and Birch Creek regions, studied by Spurr in 1898. The formations were found to be similar to those of the better-known regions, and it is interesting, in the light of recent developments in the Tanana Valley, to read again the following extract from the summary of Brooks's report regarding the possibilities of the region:

> In this description of the gold resources an attempt has been made to state the bare facts, clearly shorn of all speculations and wild rumors. We have seen that traces of gold have been found throughout the region examined by our party, and that the conditions for its occurrence are in many respects favorable; also that the little prospecting which has been done up to the present time has been too hurried and too superficial to be regarded as a fair test of the region. Our best information leads us to believe that the same horizons which carry the gold in the Fortymile and Birch Creek districts are represented in the White and Tanana river basins. I believe, therefore, in spite of the adverse results which have been obtained so far, which are purely negative, that the White and Tanana river basins still offer a favorable field for the intelligent prospector. I am inclined to think that the upper basins of these rivers are occupied chiefly by the younger non-gold-bearing rocks. I should advise prospectors to carefully investigate the small tributary streams of the lower White and of the Tanana from Mirror Creek to the mouth. The headwaters of the streams lying to the north of the Tanana ought to offer favorable returns, situated, as they are, opposite the headwaters of Fortymile and Birch creeks, streams which are more or less gold bearing.[b]

Occasionally men from the Fortymile and Birch Creek regions made short trips over the hills to the south in the early days and did some prospecting in the valley of the Tanana, but trips through this country were necessarily of a hurried nature on account of the dis-

[a] Spurr, J. E., Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, p. 346.

[b] Brooks, Alfred H. A reconnaissance in the Tanana and White river basins, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, p. 488.

tance from sources of supply, and very little thorough work could be done.

A trading post was established in 1901 at the point where Fairbanks is now located, and finally, in July, 1902, gold in quantities of economic importance was found. Felix Pedro, who was prospecting some of the small streams about a dozen miles north of the Tanana and 200 miles above the mouth, found good prospects on the creek which is now called Pedro. Gold was soon found on neighboring creeks and the region became known as the Fairbanks mining district, the name being given in honor of Senator C. W. Fairbanks, now vice-president elect of the United States. The towns of Fairbanks and Chena quickly sprung up on Chena Slough and Tanana River, respectively, and trails were made connecting these places with the creeks. Exaggerated reports naturally found their way to the other camps. People came by way of the river over the direct trail from Circle, 150 miles to the northeast, and by way of the Goodpaster from Eagle, 200 miles in a direct line to the east. The road houses in the Birch Creek region were often scenes of great activity during the winter evenings when men and dogs were gathered from all along the trail. Conditions, however, did not come up to anticipations, and an unfavorable impression of the camp spread up and down the Yukon.

In spite of the unfavorable conditions due to high prices of all kinds of supplies and the lack of ready money for the development of their claims, the men on the creeks kept digging, and by the fall of 1903 the production amounted to $30,000 or $35,000 and the population of the region had become about 800.

The creeks of economic importance referred to under the name of the Fairbanks mining district during 1903 were the Pedro and its tributary, Twin Creek; Gold Stream, the continuation of the Pedro below the Gilmore; Cleary Creek and its tributaries, Wolf and Chatham creeks; and Fairbanks Creek. These all head within a few miles of each other in the divide between Chatanika and Little Chena rivers and flow in divergent courses. (See map, Pl. XIII.)

The Fairbanks district has developed so rapidly that the work of 1903 was supplemented by that of two parties from the Geological Survey during the field season of 1904. C. W. Purington, assisted by Sidney Paige, in the course of detailed studies of the placer camps throughout Alaska and the northwestern British possessions, visited the Fairbanks placers during the later part of July. The writer, assisted by Frank L. Hess, with a packer, cook, and 7 horses, left Eagle June 17 for the Tanana country, traversed the region drained by the Goodpaster, Salcha, and Chena rivers, and reached the Fairbanks district about the same time as the other party.

Many changes were found to have taken place since September, 1903. The town of Fairbanks had become a thriving supply point, the facilities for transportation to the creeks were being rapidly improved, and the production of gold had amounted to at least $350,000. From the opening of navigation on the Yukon, when the party left Dawson on one of the early boats, nearly to the close of navigation in September, all steamers downward bound from Dawson had been crowded with passengers and freight, and during the present winter, 1904–5, there are from 4,000 to 5,000 people in this portion of the Tanana Valley, about one-tenth of whom are employed on the creeks. Naturally, a larger number of people gathered there than the conditions at the time would justify, and along with the workers came an undesirable element to lead a parasitic life upon the miners. It is believed, however, that the Fairbanks district is strong enough in its natural resources to develop healthily in spite of this influx, and the season of 1905 promises to be one of much activity.

The scarcity of supplies and consequent high prices retarded development during the winter of 1903–4, which was a rather hard one for many of the miners. Provisions at Fairbanks and Chena were sold on a cash basis, and a necessary part of the winter's work was the rocking out of sufficient gold from the dumps to pay the grocery bill, which, with flour as high as $30 a hundred, and other things in proportion, was a very important item. Provisions were also obtained as far away as Circle and Rampart and freighted across country. Men were able to buy from one another, and with mutual helpfulness and hard work the time was passed till the boats came again in the spring. Among a few was a spirit of bitterness that things had been as they were, but the general feeling was one of independent cheerfulness. Their resourcefulness was voiced by one of the miners, who said there were too many men handy with the Winchester to go hungry while there were caribou among the hills.

The town of Fairbanks is located along the south side of Chena Slough, upon an extensive flat which affords abundant opportunity for growth. In 1903 a loose collection of log cabins was strung irregularly along the slough and a cable ferry connected the town with the pack trail to the creeks. In 1904 this locality presented a scene of much animation. Warehouses, stores, saloons, and restaurants, either in operation or in various stages of completion, lined the street along the water front, while along the slough, beyond the business portions of the town and over the flat in the background, were scattered the comfortable and tasteful cabins of the inhabitants. Frequent steamers were bringing passengers and freight from the outside, and freight teams and pack trains were loading supplies for transportation to the creeks. The constant hum of the sawmills in town, heard far along the slopes to the north proclaimed the steady

growth of the settlement which has sprung to importance on the once quiet flats of the Tanana.

Fairbanks is at present the most important supply point in the interior of Alaska. Transportation from the outside during the last season has been largely by way of Dawson. The largest boats plying on the Yukon transship their passengers and freight at Tanana to boats better adapted to the conditions on the Tanana River.

All of the boats at times of low water are liable to experience difficulty in the slough between Chena and Fairbanks, and some men made good wages during the early part of the past season in poling supplies from Chena to Fairbanks. Supplies are brought also by way of St. Michael, but the fact that boats can reach Fairbanks much earlier in the spring from the upper river has made this route popular at that time of the year, when supplies of all kinds are in greatest demand. Cattle were successfully brought to Fairbanks by being shipped to Dawson, carried thence by scow down the river to Circle, and driven over the trail, a distance of about 150 miles, from Circle to Fairbanks.

The first-class passenger rate from Seattle to Fairbanks during the season of 1904, either by way of St. Michael or Dawson, was $150. The freight rate varies greatly, according to the kind of material; that for ordinary supplies by way of St. Michael was $100 a ton.

A bridge has been constructed across the slough and a wagon road has replaced the pack trail. The wagon road leaves the flat about 2 miles from town, winds with easy grades among the beautiful birches of the lower slopes, and then follows the wooded ridge to a point about 12 miles from town, opposite the mouth of Gilmore Creek, where it descends rather abruptly to the creek. The road from the town to the slope of the Gilmore Valley has required but little work in its construction, and freight wagons drawn by from two to six horses and carrying up to 3,000 pounds of freight find but little difficulty in traversing this portion of it. From here on the conditions are different. There is much soft ground along the creeks, and considerable work and expense are involved in making roads suitable for the transportation of heavy freight wagons. The fact that good roads are possible under similar conditions has been proved again and again on the Canadian side of the boundary, but in the Yukon-Tanana region such roads are not yet in existence. The miner on a claim which is producing only a fair living has no time and little money to spend in combination with other miners in working on roads. It is imperative for him to get as much gold out of the ground as possible during the short season at his command, and the work accomplished on the roads is generally of the intermittent, temporary character which the demands of the moment necessitate. Work was being done, however, on the worst places along the

creeks, and by another season the conditions in this respect will probably be improved.

Mining operations which men hesitated to undertake during the winter of 1903–4, on account of lack of supplies, were frequently postponed during the last season to the winter of 1904–5 on account of the bad roads and consequent high freight rates. The rates, however, were reduced somewhat until during the later part of the season the summer rates varied from 10 to 20 cents a pound from Fairbanks to the different creeks. The winter rates are about one-quarter the summer rates.

It was reported that material for a railroad, to be built either from Chena or Fairbanks, was shipped in by one of the last boats from Dawson. A road adapted to the conditions could apparently be built quickly and would prove of much benefit.

A telephone line was in process of installation and was reported to be in operation before the end of the season. The work in connection with this project had been done in a very substantial manner. The line was well cleared of brush and timber, the poles were solid and well placed, and when the district was visited the wires were being strung.

The results attained in the Fairbanks district have stimulated prospecting throughout the Yukon-Tanana region. Gold has been found in widely scattered localities, but not necessarily in quantities of economic importance. Work was in progress above Fairbanks on tributaries of the Tanana from both sides and in the foothills of the southern side of the Tanana Valley 40 to 50 miles south of Fairbanks. A stampede was under way to the southern limit of the Yukon Flats, where prospects had been found on a tributary of Beaver Creek; coarse gold had been found on Ester Creek, a small tributary of the Chena River, about 4 miles from Chena, and a small output was reported from this creek, but production has been confined thus far mainly to the same creeks—Pedro, Cleary, and Fairbanks—which were producing gold in 1903. The following description of these creeks includes only the most general geographic and geologic facts and is concerned chiefly with the economic development.

GEOGRAPHIC SKETCH.

Pedro Creek.—Pedro Creek is formed by the union of small tributaries sunk deeply within the inclosing ridges. The main creek has a southwesterly course, and Gold Stream, its continuation, flows in the same direction for several miles, then bends toward the west and several miles farther joins the Chatanika. The distance from its sources to Gilmore Creek, the most important tributary from the east, is about 8 miles, and the name Pedro is confined to this upper portion. The valley of the main creek is open and has a depth of about

A. SLUICING ON PEDRO CREEK.

B. THAWING APPARATUS ON CLEARY CREEK.

,000 feet below the ridges which bound it unsymmetrically on either ide. The ridge to the southeast is about 2,000 feet above sea level, vith short spurs which descend rather abruptly from it to the creek. The ridge to the northwest is about 1½ miles back from the creek; it eparates the drainage of the Pedro from that of other tributaries of he Chatanika and culminates in Pedro Dome, 2,585 feet high. Long, broad, timbered spurs slope gradually from this ridge toward the reek and merge smoothly into the valley floor, which is in places leveloped to a width of several hundred feet. The stream, which is a small one, carrying usually about 200 inches of water, follows an irregular course over a willow-covered surface and has a fall of 100 feet or less to the mile. There are several short tributaries from the west which enter the main creek through narrow valleys, V shaped in cross section. Twin Creek, the most important one, has its rise in the divide which separates it from Fairbanks Creek, and has a length of about 3 miles.

A light growth of spruce, poplar, and some birch suitable for fuel and cabin material covers the slopes, but there is only an occasional tree large enough for mining purposes. Grass grows abundantly on the upper portion of the northwest side of the valley.

The wagon road to the town of Fairbanks leaves Pedro Creek at the mouth of Gilmore Creek; another wagon road follows Gold Stream and traverses the lower country to Chena, on the Tanana River, about 19 miles from Pedro Creek. There are also wagon roads and pack trails to Fairbanks and Cleary creeks. There is a road house at the mouth of Gilmore Creek, and a picturesque collection of cabins, tents, road houses, and saloons is located at the mouth of Twin Creek. The population of this place in 1904 was about 75.

Cleary Creek.—The opposite side of the ridge which bounds Pedro Creek on the northwest is drained by several small tributaries of the Chatanika. The sources of one of these, Cleary Creek, are nearly opposite those of Pedro Creek. Cleary Creek is about 8 miles long; for about 3 miles it flows northeast, then bends gradually to the west and flows in a direction nearly at right angles to its former course, a distance of about 5 miles, to the Chatanika. The creek is a small one, carrying ordinarily from 100 to 200 inches of water; the quantity may vary, however, under extreme conditions from less than 50 to over 400 inches. There is a fall of about 100 feet to the mile in the upper portion of the valley. The valley at the head is rather openly V shaped; lower down there is a gradually sloping bench several hundred feet wide between the stream and the foot of the ridge on the west; below the bend the valley attains a width of 1,000 feet or more before it merges into that of the Chatanika. The stream above the bend flows close to the east side of the valley; below the bend it keeps

along the base of the ridge, which here bounds the valley to the south. The tributaries are small and all enter the stream from the east; Chatham and Wolf creeks are the most important. Chatham Creek enters the main stream about two miles below the source; it is a mile long and is formed by two small streams, whose short, steep gulches are in the opposite side of the divide to that drained by Twin and Fairbanks creeks. The creek is straight and flows over a willow-covered flat about 300 feet wide. Wolf Creek heads in the same divide and enters Cleary Creek about a mile below the mouth of Chatham Creek. It is formed by the union of two small, short creeks, which drain an amphitheatral area in the divide, is about 1½ miles long, and flows in a northwesterly direction through an open valley to Cleary Creek. The valley is limited on the south by the steep-sided spur which separates Wolf Creek from Chatham Creek and on the north by a slope which rises gradually to the ridge north of Cleary Creek.

The slopes and portions of the valley of Cleary Creek are covered with a light growth of small spruce and some birch and poplar. In the valley of the Chatanika timber is more abundant and larger than in Cleary Creek Valley. There is fairly good feed for stock high up on the sides of the ridges which face toward the south and east, and on one of these slopes ground was being cleared for early vegetables.

The distance from Twin Creek, on Pedro Creek, to the mouth of Chatham Creek is nearly 5 miles. A pack trail leaves Twin Creek about a mile above the mouth, climbs steeply to the ridge, and follows it to the descent along a spur to the mouth of Chatham Creek. A wagon road more generally used follows a more circuitous course from the mouth of Twin Creek along the ridge on the east side of Twin Creek and reaches Cleary Creek, also at the mouth of Chatham Creek.

There were only a few tents and cabins to indicate the presence of the miner in the fall of 1903. The dull tundra colors of the Cleary Valley were relieved only by the frost-tinted yellow leaves of the willows which line so characteristically the courses of all the streams, but in August, 1904, tents and cabins, thickly grouped where there was most activity, were strewn for several miles along the valley, and indicated in a most graphic way the progress of the year.

Fairbanks Creek.—Fairbanks Creek, which is about 10 miles long, heads in the divide opposite Twin, Chatham, and Wolf creeks, and flows in an easterly direction through an unsymmetrical valley to Fish Creek. It is small, carrying about 200 inches of water and has a fall of about 1,200 feet from source to mouth. The stream flat is narrow and is bounded on the south by a steep slope, broken by a few short narrow gulches, and on the north by broad, rounded spurs, which descend gradually to the creek from the ridge 2 miles to the north. There are several small tributaries from this side which flow

in rather open valleys about a mile apart; the most important ones are Moose, Crane, Alder, Walnut, and Deep creeks. The valley widens toward the mouth and merges into the extensive flat of the Fish Creek Valley.

As in the other valleys, the slopes in the vicinity of the stream are covered with small spruce, while higher up there is considerable poplar and birch. The main divides are comparatively bare. Timber for mining purposes has been obtained from the valley of Little Chena River at the mouth of Fish Creek, but the quantity is insufficient for extensive use. Grass is not abundant in the Fairbanks Valley. An extensive settlement has developed along the creek within the last year.

The distance from the lower part of Fairbanks Creek to Fairbanks is about 25 miles. A wagon road has been built around the head of the creek, connecting with other roads to Cleary and Pedro creeks.

GEOLOGIC SKETCH.

The principal bed rock of the region drained by Pedro, Cleary, and Fairbanks creeks and their tributaries is the quartzite-schist of the Birch Creek formation. This varies from a schistose quartzite to quartz-mica-schist, and contains numerous small quartz seams, which attain a thickness of a foot or more. Thin beds of impure limestone are rarely interbedded with the schists. The structure is complex, like that of the closely folded areas farther north; the strikes are variable and the apparent dips generally low. Gneiss with a well-defined "augen" structure occurs locally in close association with the schist. Hornblende-schist was observed at the head of Gilmore and Cleary creeks and a massive rock composed essentially of hornblende and garnet occurs in the ridge on the south side of Cleary Creek below the bend in association with schist and limestone.

A porphyritic granite forms the bed rock of some of the claims on Twin Creek, and a considerable area of a similar rock occurs along the ridge southeast of Gilmore Creek. A medium-grained granite forms the summit of Pedro Dome, and a finer-grained variety occurs at the head of Chatham Creek.

The schists occur all along the trail to the creeks of the Birch Creek region, and with garnetiferous schists, gneisses, and intrusive granites form much of the country rock to the east of the Fairbanks region drained by the Chena, Salcha, and Goodpaster rivers.

Gold has been found in quantities of economic importance in the schists of the Fortymile, Birch Creek, and Fairbanks regions, and wherever these schists occur they deserve the attention of the prospector. Surface prospects were found by the Geological Survey

party during the summer of 1904 on streams which showed no evidences of having been prospected or even staked, and the field for the prospector to the east of the Fairbanks region is still a large one. The study of the older camps emphasizes another important fact which must be borne in mind, and that is that even in a small area where the geologic conditions are apparently the same, the occurrence of gold in sufficient quantity to pay for working may be limited to but a few creeks, and while there is always the possibility of finding workable deposits in the schists of the Yukon-Tanana region, there is no reason for expecting a uniform distribution of such deposits.

On the trail to Rampart the schists were not observed after leaving the ridge which extends along the northwest side of Chatanika River. The country to the northwest is geologically and topographically of a different character and more closely related to the Rampart region than to that already described. The change is indicated by the jagged limestone ridge known as the "White Mountains," which extends in a northeast-southwest direction about 15 miles northwest of Chatanika River.

ECONOMIC DEVELOPMENT.

The present valleys have been formed by the physical and chemical work of the streams aided by the weathering of the rocks. Most of the resultant waste material has long since been removed, but mantling the bed rock of the valleys are unconsolidated deposits composed of rock fragments, of materials derived from rock decomposition and of resistant minerals originally disseminated in small quantities through the rocks. These deposits, accumulated and arranged largely through the agency of water, roughly represent the concentrates from large masses of country rock and within themselves have undergone a further concentration, until the heavier constituents lie on the bed rock or even within it to a depth of several feet along the cracks and crevices. The presence of considerable gold in these deposits has made them of much economic interest and a knowledge of their character, arrangement, and distribution becomes important with reference to the extraction of the gold.

There are several characters common to the stream deposits of all the creeks; the grade of the bed rock on which they lie is gradual; the grade of their surface is about 100 feet to the mile; they are mostly deep and in most localities frozen throughout the year; a section shows generally a layer of muck underlain by barren, and by gold-bearing, gravels; the gravels are composed of about the same kinds of rock, have undergone about the same amount of wear, are of the same degree of coarseness, and are similarly arranged. The thickness of the different layers varies widely and the maximum

otal depth to bed rock so far as determined by prospect holes is over 0 feet.

Pedro Creek.—The depth to bed rock has been found to vary from to 30 feet, and the deposits show generally the threefold division nto muck, barren gravels, and pay dirt. The muck varies in thickess from a few inches to over 20 feet, is made up of decomposed vegeable matter with a considerable proportion of sand and clay, and is natted together and interlaced with roots. Interbedded with it are ccasional thin lenticular beds of sand and fine "chicken feed" ravel. The gravels underlying the muck vary from 1 to 20 feet in hickness, but the average thickness in most localities is about 10 eet. They are composed chiefly of quartzite-schist and mica-schist, vith some granite, gneiss, and vein quartz. The pieces are rather ngular, mostly under a foot in diameter, and there are few bowlders. Much fine material of the same nature is mixed with the coarser fragnents and generally the gravels near bed rock are characterized by he presence of a yellow, sticky, micaceous clay, containing minute ragments of schist and quartz. The lower gravels are thus often ather sharply demarcated from those above them, and the fact that he occurrence of gold is limited to this portion of the gravels has led o their designation as the "pay dirt." The arrangement of the ravels, although often irregular, is due essentially to stream action.

The gravels containing the gold vary in thickness from 1 to 4 feet, nd gold is also found in the bed rock to a depth of from 1 to 5 feet. The width over which the ground has been found to contain sufficient gold for working varies from 40 to over 200 feet, and in several cases s over 100 feet. The values of the pay dirt vary up to 25 cents to he pan, and much of the ground which has been worked has probably veraged about $1.50 to the square foot of bed rock.

The gold occurs generally as small, flat pieces. No large nuggets have been found, but several were seen ranging in value from $6 to $14; a $19 piece is perhaps the largest that has yet been found. Black sand, garnets, rutile, and iron pyrites are the most common associates.

In the summer of 1902 gold was discovered on Pedro Creek, about one-half mile below the mouth of Twin Creek, at a depth of about 4 feet in sufficient quantity to yield 20 cents to the pan. The work of prospecting spread rapidly up and down the creek and along he tributaries. In the fall of 1903 claims were being worked on Twin Creek, on Pedro Creek from Twin Creek to Gilmore Creek, and below on Gold Stream. In 1904 developments were confined mostly to he main creek between Twin and Gilmore creeks, a distance of about 3 miles. No further work has been done on Twin Creek except near he mouth. Some work has been done on Gold Stream, but no extensive development has yet been undertaken.

Claims are in most cases staked lengthwise of the creek and include 20 acres. They are worked by open cuts and by drifting with steam points.

The ground at the mouth of Twin has a depth of about 12 feet. In 1903 a cut 300 feet long and 18 feet wide had been worked out, and in 1904 the work was continued. The open-cut method was used.

The depth to bed rock on claim No. 2 above Discovery on Pedro Creek is 14 to 16 feet. Eight prospect holes were sunk to bed rock during the winter of 1902–3 by thawing with wood fires, 4 holes being worked at a time, and sunk at the rate of 1 foot per day. Ground sluicing was commenced in June, 1903, and about 4 feet of ground was sluiced off. A bed-rock drain 800 feet long, 1 foot in diameter, and 16 feet below the surface was constructed at a cost of about $1 per foot. Shoveling in commenced about July 20, when most of the ground had become thawed to bed rock, and a cut was worked 120 by 32 feet. Two sets of sluice boxes were used, into which the dirt was shoveled directly as shown in Pl. XV, *A*. The boxes were 12 feet long and 11 by 13 inches in section, and were set with a grade of 7½ inches to the box. The gold was caught in the 4 sluice boxes in the proportion of 16, 4, 2, and 1. A waste ditch had been constructed, and a ditch 1,200 feet long brought water to the upper end of the claim from a small tributary down the creek on the west side. An area 400 by 80 feet was being stripped for work during 1904. The stripping of the muck gives the ground an opportunity to thaw out rapidly in the spring. A 30-horsepower boiler was in use in 1904 to operate a steam hoist, which raised the gravel a distance of 30 feet to the sluice boxes in iron buckets having a capacity of 8 cubic feet. By this method 700 buckets a day could be handled. A mud box 20 inches high, 50 inches wide, and 20 feet long was used. Several steam points thawed the ground in advance of the work of excavation, and a small steam pump was in use to help drain the cut. On claim No. 1 A[a] and Discovery claim preparations were being made in 1903 for future work by the construction of bed-rock drains and by stripping. In 1904 4-horsepower boilers were in use operating as many as 4 steam points with a capacity of about 10 to 14 cubic yards in nine hours. Similar work was in progress on No. 4 below. On Nos. 5 B[a] and 6 B, where the depth to bed rock is about 10 feet, preparations had been made in 1903 to work by open cut. A bed-rock drain 850 feet long had been constructed, but frozen ground had been encountered and the work brought to a temporary standstill. In 1904, however, extensive work was under way both by open cut and by drifting with points. On No. 7 the depth to bed rock is about 24 feet, and the muck is nearly 20 feet thick. The drifting method is employed, and with four points about 12 cubic yards a day can be thawed. On No. 8 B four holes

[a] "A" and "B" indicate claims above and below Discovery, respectively.

were sunk to bed rock in March, 1903, to depths of 25, 20, 10, and 12 feet. A bed-rock drain 740 feet long was constructed and about 2,000 cubic yards of dirt worked out by ground sluicing and shoveling in. In 1904 work was continued here along the same lines.

The ground on Gold Stream is 30 feet or more in depth. Work was being done on several claims. Pay is found there, but the results do not seem to have been sufficiently attractive under present conditions to lead to active development. It is probable that as conditions improve considerable work will be done in this portion of the valley.

Wages were ostensibly $10 a day during 1904. The gold, however, was often given a higher value on the creeks than at the stores, where it was accepted in trade at $16 per ounce, and a man would often find his wages had less than $10 worth of purchasing power. The winter freight rate to Pedro Creek averaged about 2 cents a pound; the summer rate during the latter part of the season of 1904 was 10 cents a pound.

Cleary Creek.—Insufficient work had been done on Cleary Creek and its tributaries in 1903 to determine the average depth or value of the ground. It was known to be deep and, in a few places, at least, to carry good values. Since that time the depth to bed rock on Cleary Creek has been found to vary from 14 to over 80 feet. Twenty-nine holes, scattered irregularly along the creek from near the head to within 2 miles of the mouth and laterally to a distance of 600 feet from the creek, gave an average depth of over 50 feet. The material consists of muck, barren gravels, and pay dirt. Muck has been found to a depth of over 50 feet. The gravels, including the pay dirt, have an average thickness of about 20 feet, and, like those of Pedro Creek, are composed mostly of rather angular fragments of quartzite-schist and mica-schist. A considerable proportion of massive hornblende-garnet rock is found in them below the bend. Bowlders are uncommon, but a few of vein quartz up to 5 feet in diameter are found. The yellow clay is generally found in the lower portion of the gravels, where also is found the pay. The thickness of the pay gravels varies from 1 to 7 feet and averages about 3 feet. Gold is also found to a depth of 1½ to 4 feet in the bed rock. The width over which gold is found in workable quantities has been determined in a few instances and is found to vary from 35 to 150 feet. The fact seems to be rather well established that the pay streak is a wide one. It is located on the low bench on the west side of the creek above the bend and below the bend on the opposite or north side of the creek.

There are generally two grades of gold, a flat variety, which occurs in small pieces up to a quarter of an inch or more in diameter and constitutes the bulk of the production, and a coarse variety, which is generally rather well worn and frequently has an oxidized surface. One nugget has been found worth $233. Values in the pay dirt

range from 2 to 25 cents to the pan and occasionally run much higher.

Black sand, iron pyrites, garnet, rutile, and a mineral which proved, on being tested by Mr. Hess, to be cassiterite, the oxide of tin, are found associated with the gold.

The depth to bed rock on Chatham Creek varies from 10 to nearly 30 feet. There is but a thin covering of muck on the gravels, which consist mostly of angular fragments of quartzite-schist with a small proportion of fine-grained granite, which outcrops near the head of the creek. The pay gravels average about 3 feet in thickness, and the values do not range as high as on Cleary Creek. Some good ground has been worked, however, and the creek, in proportion to its size, has been a good producer during the past season. The gold is rougher than that on Cleary Creek and is apparently close to its source in the bed rock.

The conditions on Wolf Creek are similar. The depth to bed rock near the head of the creek is about 10 feet. There is little muck and the gravels are composed of angular fragments of quartzite-schist, with some vein quartz. The gold is very rough and gritty, and the occurrence here is interesting in bearing on the origin of the gold from the quartzite-schist, which is the only kind of rock observed about the head of the creek.

In 1903 several claims were being worked on Cleary Creek, notably Discovery claim, and on Chatham and Wolf creeks. Only drifting methods had been used on Cleary Creek, on account of the great depth to bed rock. Open-cut work had been done on portions of Chatham and Wolf creeks.

Discovery claim, on Cleary Creek, is located near the bend, about opposite the mouth of Wolf Creek. A good season's work was done here in 1903. The depth to bed rock is about 18 feet. A 6-horse-power boiler was used to operate 5 steam points, which in ten hours thawed about 16 cubic yards of dirt, which were hoisted by a hand windless to a dump box 18 feet long by 3 feet wide, and washed through the sluice boxes by a stream of water entering from the side of the box. A scrubbing brush was in frequent use to wash the sticky gold-containing clay from the larger rock fragments. At least one sluice head, equivalent to about 50 miner's inches, was required to wash the dirt, and at times during the season of 1903 the supply had fallen short of this quantity. About 600 cubic yards of dirt had been washed from July to September, 1903. The outfit is shown in Pl. XV, *B*. Prospect holes were being sunk on a few claims below Discovery claim. Thawing was accomplished by the use of hot rocks. About three 10-pan bucketfuls were thrown into the holes which were being sunk, and on cooling were shoveled out along with the thawed gravel. Two fires a day were used, and the

rate of sinking was about 1 foot to the fire. Only a few holes had been put down above Discovery claim.

Gold was discovered on Chatham Creek in August, 1902. The depth to bed rock at the mouth is only about 6 feet, and an open cut 180 feet long by 20 feet wide was worked out during the season. Claims were being prospected above the mouth, but had not reached the producing stage. Work was being done at a few localities on Wolf Creek by open cuts, and at the head of the creek about 500 cubic yards had been worked over. Most of the ground here required no thawing.

In 1904 Cleary and Chatham creeks were developing rapidly and producing good results. Cleary Creek had developed in both directions from Discovery claim, and from No. 16 A to 13 B, a distance of over 7 miles, the creek and benches were under careful investigation. The ground above Discovery claim for a distance of 2 miles or more is deep, and most of the claims are still in the prospecting stage of development. Most of the work was being done on the low bench to the west of the creek and in some cases at points several hundred feet back from it. Good values have been obtained in some portions of this ground. Development was carried on frequently by small 8-horsepower boilers operating 2 points. Most of the production thus far has been confined to the portion of the valley between Discovery and No. 4 B, inclusive. An important feature is the occurrence of pay not only on the creek but along the base of the hill 400 to 600 feet north of the creek.

On Discovery claim the work of 1903 was continued. The power had been increased, and a steam hoist with 20-pan buckets had taken the place of the hand windlass. A suction pump was used to drain the ground. On the hillside, opposite Discovery, an 8-horsepower boiler operating 5 points had been installed. Two shafts had been sunk 30 feet to bed rock, and the ground was being drifted. No. 1 B had been sold and preparations were being made for work under the new ownership. On the fraction opposite the upper end of No. 1 the the depth to bed rock is 35 feet, and pay had been struck 250 feet back from the creek bed. Work was being carried on in two shafts, and 6 points were in use capable of thawing 150 ten-pan buckets of dirt every ten hours. About 50 inches of water were in use, and the boxes, 10 in number, were set with a grade of 8 inches to the box to wash the clayey gravel. At the upper end of No. 2 B a 5-horsepower porcupine boiler was in use, operating 4 points. The dirt was hoisted 20 feet, and 200 ten-pan buckets were worked in a shift. On the lower part of No. 2 B, with a depth of 40 feet, a plant had been installed capable of handling 100 twenty-four-pan buckets in ten hours. On No. 3 B two holes 40 feet apart had been sunk 38 feet to bed rock, and work was carried on in both at the same time. There is here 20 feet of muck

and 18 feet of gravel. No. 4 B has been worked since October, 1903, and has the reputation of being the best producer on the creek. The ground consists of 2 creek claims and 2 bench claims. The depth to the soft graphitic schistose bed rock is 30 feet, and there are 15 feet of muck and 15 feet of gravel. A 20-horsepower boiler, burning a cord of wood every twenty-four hours, furnished the power for the numerous points and the hoist. Two hundred 38-pan buckets were handled a day; they were hoisted 30 feet and run on a trolley 30 feet to the mud box. The boxes were set with a grade of 8 to 11 inches to 12 feet. Twenty men were employed, and wages for miners were $5 a day and board.

Between No. 4 and No. 8 only preliminary prospecting has been done.

From No. 8 to No. 13 work has been done mostly from 300 to 500 feet to the north of the creek. On No. 8 the depth is 52 feet, with about 30 feet of muck. A 20-horsepower boiler was in use, and from 180 to 190 13-pan buckets could be handled daily. The "live water" problem was causing some difficulty and the use of a pump was necessary. A combination ditch and flume brought water to the claim from Cleary Creek. The depth on No. 9 is 50 feet. There is 20 to 28 feet of muck overlying the gravel. Two holes had been sunk and about 30 feet drifted in each. On the upper end of No. 10 the depth is 60 feet; about 20 feet of muck and 40 feet of gravel, 10 feet of which is "chicken feed" gravel. A 10-horsepower boiler was in use. Occasional thin layers of muck in the gravel made trouble, as the muck does not thaw as readily as the gravel. A ditch 1 mile long had been constructed, at a cost of $2,000. On the lower portion of No. 10 three holes had been sunk in a direction crosswise of the bench to depths of 56, 57, and 62 feet. The layer of muck varied from 17 to 22 feet in thickness. The gold here is usually of the finer variety, but a 2-ounce nugget had been found, and it is important to note the occurrence of the coarse gold in this lower wider portion of the valley. A 4-horsepower boiler and 4 points were in use; dirt was hoisted by a hand windlass, fitted with a one-fourth-inch wire cable, and it was possible to handle nearly two hundred 9 and 11-pan buckets a day. On No. 11 bed rock is 70 feet below the surface, and about 80 feet had been drifted. There is 26 feet of muck. Pay had been located on No. 12 about 500 feet north of the creek, where the deposit is over 80 feet thick, consisting of 25 feet of muck, 30 feet of "chicken feed" gravel, and the rest reddish gravel and pay gravel. On the upper end of No. 13 a hole had been sunk 80 feet to bed rock, 400 feet back from the creek, and about 2 miles from Chatanika River. It penetrated 18 feet of muck and 62 feet of gravel, in which some gold had been found. It seems probable that as the conditions of development become more favorable, there may be considerable ground in this lower portion of the valley that can be worked at a profit.

Several of the claims on Chatham Creek which were being prospected in 1903 turned out well. Small boilers were in use and the shallowness of the deposits made the cost of working considerably less than on the main creek. Some trouble was experienced with "live water," and on one claim work had been stopped on this account.

The pay gravels in the Cleary Valley are generally at a considerable depth and probably could not be worked at a profit under present conditions for a gold content of less than 5 cents to the pan. The steam-point method is the one most extensively used for thawing the frozen ground, and by this means holes can be rapidly sunk to bed rock at a rate of 3 feet or more a day. The construction of ditches in the frozen muck has been a difficult problem. The grade must be very low, otherwise the water breaks through the frozen muck, and in one instance was seen flowing at a level 15 feet or more below what had been the bottom of the ditch. The presence of ground water has frequently caused difficulty and increased the cost of production to a considerable extent by the extra expense of pumping.

The creek is about 22 miles from the town of Fairbanks, and the winter and summer freight rates are 2½ and 15 cents a pound, respectively. Wood for fuel has been as high as $10 a cord, delivered, and sawed lumber $200 a thousand. Wages for miners were being reduced to $5 and board.

Fairbanks Creek.—The depth to bed rock on Fairbanks Creek increases rather uniformly in a downstream direction from about 15 feet in the upper portion of the area, where development is in progress, to 60 feet or more about 5 miles lower down the creek. The material on bed rock is similar to the deposits on the other creeks. There is an upper layer of muck, an intermediate zone of barren gravels, and, underlying them and more or less distinctly marked by the presence of yellow clay, the gravels which contain the gold. The layer of muck is from 2 to 20 feet thick and often forms about half the deposit on bed rock. The principal rock outcropping in the valley of Fairbanks Creek is the schist, which has furnished the material for the greatest part of the gravels. Quartz seams are rather common in the schist and have contributed their share of the gravels. Gneiss is associated with schist in the ridge south of Fairbanks Creek, forms the bed rock on some of the claims in the lower portion of the valley, and has furnished some material for the gravels. The deposit of gravel occurs to a thickness of 15 feet or more and is composed of rather angular pieces, most of which are less than a foot in diameter. In the lower portion of the valley there is some coarser material, but the proportion of bowlders is

small. For over 4 miles along the creek over an area varying from 45 to 250 feet in width, pay has been found in gravel varying from 18 inches to 7 feet in thickness. The gold is similar to that of the other creeks. Coarse pieces are found and these are often in association with much quartz. One nugget has been found worth $190. Values are found ranging from 5 to 10 cents to the pan and occasionally much higher. The creek during the past year has been a strong producer.

Fairbanks Creek was located in October, 1902, but development work on it proceeded slowly, and as late as September, 1903, work was still in the prospecting stage. At that time from No. 15 A to No. 16 B more or less preliminary work had been done, most of it in sinking holes to bed rock. Thawing was accomplished by wood fires, hot rocks, hot water, and steam. Sometimes a combination of hot rocks and hot water was used. In the use of wood fires or even of hot rocks there is frequently a too rapid thawing of the sides. In the hot-water method 20 gallons were used at a time, which in 2 hours would thaw about two-thirds of a cubic yard of dirt. One boiler was in use on the creek, operating 4 points, and two others were about ready to commence work. Hand windlasses were used for hoisting the dirt. Very little sluicing had been done.

The creek presented a far different appearance in 1904. Many boilers had been brought in and developments were active along the portion of the valley from No. 8 A to No. 8 B, a distance of about 2 miles. The creek had passed from the prospecting stage to the producing one. The problems of extraction are similar to those of Cleary Creek and similar methods have been introduced. On No. 11 A the depth to bed rock is 15 feet and the deposit consists of 5 feet of muck and 10 feet of angular gravel. A boiler operating 3 points was in use and the ground was kept free from water by pumping. A ditch 1,200 feet long, 3½ feet wide, and 3 feet deep had been dug to confine the creek so far as possible to the middle of the claim. On No. 8 A there is 3½ to 4 feet of muck and about 11 feet of gravel. The ground was worked by means of a 5-horsepower boiler operating 4 points. Some of the best ground is said to be found along this portion of the valley, and a 10-ounce nugget has been found on this claim. On No. 7 A there is from 2 to 10 feet of muck and 10 to 16 feet of gravel. The gold is frequently coarse and a $190 nugget has been found. There was much activity here and two 15-horsepower boilers were furnishing steam for 20 points. On No. 6 A the depth to bed rock is 19 feet and the material consists of 8 feet of muck and 9 to 10 feet of gravel. A plant was in use capable of thawing about 14 cubic yards of dirt in ten hours. On No. 2 B there is a thickness of 28 feet of muck and gravel in about equal proportions. The plant consisted of a 12-horsepower boiler, points, self-

dumping hoist, and a trolley. About 250 thirty-pan buckets were handled in ten hours. The gravel is difficult to wash on account of the clay. Six boxes were in use, including the mud box. They were set with a grade of 10 inches to 12 feet. The mud box and platform were elevated about 12 feet above the ground. Pole riffles were used. A dam had been constructed which raised the water 9 feet and a ditch 900 feet in length brought water to the ground which was being worked. A modification of the steam-point method was in use on No. 3 B. The points were started with water and this was said to greatly reduce the time required in thawing. A pump was used here to elevate about 1 sluice head of water a height of 14 feet. Much work had been done on No. 5 B. The depth to bed rock is 36 feet and pay had been located over a width of 150 feet, partly in the stream and partly in the bench gravels. The gradually increasing width of the valley and depth of the deposit, which on No. 10 B is 60 feet, renders the work more expensive, and development has proceeded more slowly in this lower portion of the valley.

Some lumber had been obtained from the flat at the mouth of Fish Creek, but the supply there is limited. Wood for fuel was obtained from the northern slope of the valley and delivered on the ground. It brought as high as $10 a cord. The distance from the town of Fairbanks to Discovery claim is about 25 miles and the freight rates were about 3 cents a pound during the winter and 20 to 25 cents a pound during the summer.

SUMMARY.

As appears from the descriptions the conditions are practically the same on Pedro, Cleary, and Fairbanks creeks. The valleys are all rather open and sunk to a depth of about 1,200 feet below the ridges. All are limited on the one side by a steep slope and on the other by an indistinct bench of considerable width, and all carry about the same amount of water, which in dry seasons will probably be short of the demand. The growth of timber in all is about the same, and all are dependent on the lower valleys of the larger streams for sluice-box lumber. There is some horse feed along the creeks, and grass grows abundantly on the timbered ridge along the trail from Pedro Creek to the town of Fairbanks, where, in 1903, it was found in good condition as late as September 11. There is good feed in portions of the Tanana Valley, and the agricultural possibilities of the region are still largely untried.

The rock most common on all of the creeks and the divides between them is quartzite-schist belonging to the Birch Creek formation; porphyritic granite and gneiss occur locally; a rock composed essentially of hornblende and garnet occurs on the west side of Cleary Creek. The gravels on all of the creeks are apparently derived

entirely from the rocks outcropping in their drainage areas, and the conditions of their deposition by stream action were practically the same. No foreign wash was observed. The gold, too, is found on all of the creeks under about the same conditions. The pay gravels are generally distinguishable from the rest by the yellow, sticky clay which they contain. The gold found at the head of Wolf Creek is very rough and can have been carried but a short distance. It is believed the origin of the gold on all of the creeks is to be found in the small quartz seams which occur generally in the schists; that it has been weathered out from them, and finally become concentrated in the gravels where it is at present found.

The percentage of gold in the gravels and their extent seem sufficient to give the camp a permanence like that of the other placer camps in the Yukon-Tanana region. The depth of the deposit has made development slow and expensive, the cost consuming probably one-third to one-half the output. In this respect the creeks are having a history like that of Chicken Creek in the Fortymile region, which during the past two years has produced about $200,000.

It is impossible for the prospector to accomplish much by rushing hurriedly through this kind of a region. The establishment of stations at different points along the Tanana River where supplies can be obtained has rendered possible the slow, patient work necessary to secure results. Those who have done well in the Fairbanks region are mostly men who have worked hard for several years under the conditions of the country, and the one important point to be kept in mind by those who come into the country for the purpose of prospecting is that gold requires much time, hard work, and expense for its discovery and exploitation.

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[Bulletin No. 251.]

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WRIGHT, C. W. The mineral resources of Admiralty Island.
WRIGHT, F. E. The mineral resources of the Wrangell district.
——— The mineral resources of the Sitka district.

TOPOGRAPHIC MAPS OF ALASKA.

The following maps are on sale at 5 cents a copy, or $2 a hundred:

BARNARD, E. C. Fortymile quandrangle; scale, 1:250000.
PETERS, W. J. Juneau special quadrangle; scale, 1:63500.

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BARNARD, E. C. Cape Nome and adjacent gold fields; scale 1:250000. Contained in a special publication of the U. S. Geol. Survey, entitled "Reconnaisances in the Cape Nome and Norton Bay regions, Alaska, in 1900," Washington, Government Printing Office, 1901.
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no. 251. Prindle, L. M. The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska. 1905.

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