DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

BULLETIN 578

THE IDITAROD-RUBY REGION ALASKA

BY

HENRY M. EAKIN

WASHINGTON
GOVERNMENT PRINTING OFFICE
1914

CONTENTS.

ILLUSTRATIONS.

PREFACE.

By Alfred H. Brooks.

It is the purpose of the United States Geological Survey to extend its investigations to all parts of Alaska, yet the limitations placed on the work by the funds available do not always permit this to be done in advance of actual mineral discoveries by the prospector. Where pioneer work is lacking the Survey attempts to follow up the reported new discoveries of valuable minerals by surveys and investigations as soon as means permit. This volume is the third report based on work inspired by the discovery of gold in the Innoko district in 1906.

Although the region here discussed was not visited in advance of the prospector the adjacent valley of the Kuskokwim had been explored and surveyed by Spurr some 15 years ago. Spurr's rapid journey down Kuskokwim River in 1898 did not afford him opportunity to investigate the Innoko-Iditarod region, although he traversed its eastern margin. Nevertheless certain of his conclusions on the occurrence of metalliferous deposits in this field have since been found to be correct. Spurr clearly points out in his report [1] the close association of gold deposits with igneous intrusives. Moreover his broad generalizations on the geology of the province as a whole have aided the investigators who followed him in deciphering the geologic problems.

It fell to A. G. Maddren to continue the reconnaissance work in this province after the discovery of placer gold in the Innoko district, which led to an urgent demand for further information. His first journey, in 1908, was into the Innoko district; in 1910 a second trip took him again to the Innoko and also across into the then newly developed Iditarod district. At the same time C. G. Anderson, under Mr. Maddren's direction, carried a topographic survey from Ruby on the Yukon southwestward to the town of Iditarod. The more important economic results of these two expeditions, including a drainage map of the region, were promptly published.[2] For several reasons,

[1] Spurr, J. E., Reconnaissance in southwestern Alaska: U. S. Geol. Survey Twentieth Ann. Rept., pt. 7, p. 261, 1900.

[2] Maddren, A. G., The Innoko gold-placer district, Alaska: U. S. Geol. Survey Bull. 410, 1910; Gold-placer mining developments in the Innoko-Iditarod region: U. S. Geol. Survey Bull. 480, pp. 236-270, 1911.

but chiefly owing to the demands of other work, Mr. Maddren was not able to put his geologic notes into final form.

Meanwhile mining activity had continued in the province, and hence further field investigation seemed desirable. This work was assigned to Mr. Eakin, whose results, as well as those of Mr. Maddren, are summarized in this volume. Mr. Anderson's topographic map is also here published for the first time in complete form. (See map, Pl. I, in pocket.)

Owing to the fact that the full appropriation for the Alaskan investigations of 1912 was not made until late in the summer, Mr. Eakin's field work was much hampered. As there were no funds for organizing or transporting a party, Mr. Eakin attempted this survey almost unaided. His journeys in the Ruby district, and thence into the Iditarod district, were made without horses and with only one companion. When a geologist is forced by circumstances to act as burden bearer for his own provisions and equipment, his investigations can not be made with the same degree of refinement as when he is provided with a pack train. Mr. Eakin deserves great credit for having brought his work to a successful conclusion under conditions so adverse to scientific inquiry.

These surveys seem to have established the fact that in the province extending from Ruby, on the Yukon, to Iditarod, gold is associated with two distinct series of rocks. An older complex, made up of more or less metamorphosed sediments and volcanic rocks, which can be provisionally correlated with the metamorphic Paleozoic and possibly older rocks of the Yukon-Tanana region, forms the source of gold in the Ruby district. A younger series of sediments, in part, at least, Cretaceous and probably all Mesozoic, forms the bedrock of the Innoko and the Iditarod gold districts. This occurrence of gold in Cretaceous rocks does not find any definite counterpart in the Yukon-Tanana region, though there is evidence that some of the gold-bearing rocks of the Rampart district are of Mesozoic age.[1] A closer analogy to this occurrence is found at Bonanza Creek, on Norton Sound, where the placer gold has been derived from Cretaceous sediments that have been intruded by igneous rocks.[2]

In the following report Mr. Eakin shows that the bedrock sources of the placer gold of the district include the igneous intrusives and the Cretaceous sediments at or near their contacts with the igneous intrusives; also that the auriferous lodes thus far found are closely associated with dikes and other intrusive rocks. These facts point to a genesis of the metalliferous deposits similar to that of the auriferous deposits of southeastern Alaska and of other parts of

[1] Eakin, H. M., A geologic reconnaissance of a part of the Rampart quadrangle, Alaska: U. S. Geol. Survey Bull. 535, p. 38, 1913.

[2] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska: U. S. Geol. Survey Bull. 449, pp. 104-109, 1911.

the Territory.[1] Igneous intrusive rocks are widely distributed in this and adjacent provinces.[2] In short, it may be said, from the evidence in hand, that geologic conditions favorable to the occurrence of auriferous deposits are repeated in many places in this part of Alaska, a fact that augurs well for the future of the mining industry in this region, notwithstanding the fact that the workable gold placers thus far developed are limited to comparatively few small areas.

---

[1] Brooks, A. H., Geologic features of Alaskan metalliferous lodes: U. S. Geol. Survey Bull. 480, pp. 58-70, 1911.

[2] It is worthy of note that similar geologic conditions prevail in the Alaskan Range. See The Mount McKinley region, by A. H. Brooks: U. S. Geol. Survey Prof. Paper 70, 1910.

THE IDITAROD-RUBY REGION, ALASKA.

By Henry M. Eakin.

FIELD WORK.

The term "Iditarod-Ruby region" designates an area in west-central Alaska between the mining settlements on Iditarod River and those on the Yukon at Ruby. This region was visited in the summer of 1913 by the writer, who began field work at Ruby on July 18 and ended it at Iditarod on September 10. During this time a geologic reconnaissance was made of that part of the Ruby mining district that lies near the mines and a lineal traverse was carried from Ruby to Iditarod by way of the Innoko mining camps. Nearly all the producing creeks were visited and geologic data were gathered along the entire route of travel.

A circuit made of the mines in the Ruby district east of the line of traverse from Ruby to Iditarod permitted the geologic mapping of a wider area in that region than in the region farther south, where the lineal traverse alone furnished the data. The work of the writer was expanded also in the Innoko district, but still farther southwest the extension of geologic mapping of the area away from the lineal traverse made by the writer is based on the notes of other investigators.

PREVIOUS INVESTIGATIONS.

The earliest geologic work that touches definitively upon this general region was that of Spurr,[1] who explored the Kuskokwim Valley in 1898 (Pl. I, in pocket). Collier in 1902 took some notes on the rocks that outcrop in the bluff near Ruby Creek, but these notes were not published, being foreign to the special study of the coal-bearing terranes in which he was engaged. In 1908 Maddren spent a short time in an investigation of the region about the southern headwaters of Innoko River, and in 1910 he visited both the Innoko and the Iditarod districts.[2] During 1910 a topographic reconnaissance was

[1] Spurr, J. E., Reconnaissance in southwestern Alaska in 1898: U. S. Geol. Survey Twentieth Ann. Rept., pt. 7, pp. 31-264, 1900.

[2] Maddren, A. G., The Innoko gold-placer district, Alaska: U. S. Geol. Survey Bull. 410, 1910; Gold-placer mining developments in the Innoko-Iditarod region: U. S. Geol. Survey Bull. 480, pp. 236-270, 1911; The Ruby placer district: U. S. Geol. Survey Bull. 520, pp. 287-296, 1912.

carried from Yukon River at the present site of the town of Ruby to the Innoko and Iditarod districts by C. G. Anderson. H. E. Birkner, of the Anderson party, made some geologic observations along the route of travel.

Although Mr. Maddren's data on the mineral resources of the Innoko and Iditarod districts were published in complete form, many of his more purely geologic data find their first publication in this report, and some of the geologic conclusions here set forth should therefore be credited to him.

GEOGRAPHY.

LOCATION AND EXTENT.

Plate I (in pocket) shows the Iditarod-Ruby region in its relation to the general province of west-central Alaska. The area between the headwaters of the Iditarod and the Yukon at Ruby, whose topography is shown by contours, is that specially treated in this report. Plates II and III (in pocket) are respectively a topographic and a geologic map of the same special area on a larger scale.

The area presented on Plates II and III is made up, for the most part, by the Iditarod, Innoko, and Ruby mining districts, which are practically contiguous and lie in the order named from southwest to northeast.

TOPOGRAPHY.

FEATURES OF RELIEF.

The topography of the region is diversified by broad lowlands, rolling uplands of moderate elevation, and local mountain groups (Pl. II). The lowlands are developed chiefly along the larger streams at altitudes of less than 500 feet. The rolling uplands are made up of uneven divides and interstream ridges that commonly range between 1,000 and 2,000 feet in elevation. The mountain groups occur in erratic fashion, chiefly along the main divides. Some of these groups have great prominence, owing to the general low relief of the region, although their maximum elevations are only about 4,500 feet.

UPLANDS.

The uplands range northeast to southwest across the region in two principal belts, of which the northern is related to the Kaiyuh and the southern to the Kuskokwim Mountains.

The northern or Kaiyuh upland belt extends in width from the Yukon southward to the flats of Innoko and Nowitna rivers and thus covers the entire Ruby district. Within the Ruby district the upland features consist of broad ridges and domelike hills of moderate relief. The headwater tributaries of the larger streams are singularly few and widely spaced, the smallest streams being of considerable length and free of laterals and gullies. Stream grades are low and their headward steepening very slight. The slopes of the hills and ridges diminish toward the summits, which are nowhere actually flat, and toward the stream bottoms, where flood plains of considerable width are common, even along the smallest streams. The flood plains generally widen downstream, and those of the larger streams are commonly several miles across.

The gentle topography typical of the northern upland belt is broken in two localities. In the western part of the region is a prominent group of hills of more rugged outline, which is the northeastern extension of the Kaiyuh Mountains proper. Their maximum elevation is about 2,200 feet. In the vicinity of Ruby the rolling hills break off along Yukon River in steep and in places precipitous bluffs, 300 to 400 feet high. The Kaiyuh upland belt extends southwestward from the Ruby district for about 175 miles, nearly to the junction of Innoko River with the Yukon. The lowlands of the Yukon to the north and of the Innoko to the south give mountain-like prominence to the belt, although its actual elevation nowhere greatly exceeds 2,000 feet.

The erosion of the Kaiyuh uplands long ago carried their topography past maturity, so that it is now approaching old age, a result that has probably been hastened by changes in the major drainage features in late geologic time, which have caused an adjustment of the smaller streams to a higher base level of erosion.

The southern or Kuskokwim upland belt extends in width from the Innoko and Nowitna River lowlands southeastward to Kuskokwim River. The part of this belt shown in contour on Plate II includes both the Iditarod and the Innoko mining districts. It extends from these districts northeastward beyond the headwaters of Nowitna River and southwestward to the lowlands that lie between the lower reaches of the Yukon and the Kuskokwim.

In the Iditarod and Innoko districts the Kuskokwim upland has in general a rolling topography, with here and there a group of prominent mountains 3,000 to 4,500 feet high. The principal mountain groups are the Cripple Creek Mountains, at the head of Colorado Creek, the Twin Mountain group, 10 miles east of Ophir, the Beaver Mountains, 20 miles southwest of Ophir, and an unnamed group near the Iditarod mines. Each group is the topographic expression of granitic intrusions and the rocks affected by them.

The topography of the lower rolling country of the districts is closely dependent upon the structure of the sedimentary rocks that form it. In the area between the Cripple Creek Mountains and the Twin Mountains the structure is simple. This area is marked by hogback ridges that break off sharply on one side and have long dip slopes on the other. The valleys are broad and widely spaced and conform to the structural trends of the bedrock. Near Ophir the dips are higher and the interstream ridges are comparatively narrow and steep-sided.

The influence of structure upon topography is especially evident in the valley of Spruce Creek, a cross section of which is illustrated in figure 1. The stream follows a straight course on the line of strike of the bedrock. The bedrock dips westward and in its downcutting the stream has migrated in that direction. The west valley wall is now a steep scarp along the base of which the stream runs. The opposite side of the valley slopes gently upward away from the stream over a series of gravel-covered benches. The chief gold concentration in the valley antedates the latest rejuvenation of the stream. Consequently the placers are found in the bench gravels along the east side of the valley up the dip from the stream, and little gold is to be expected in the stream itself.

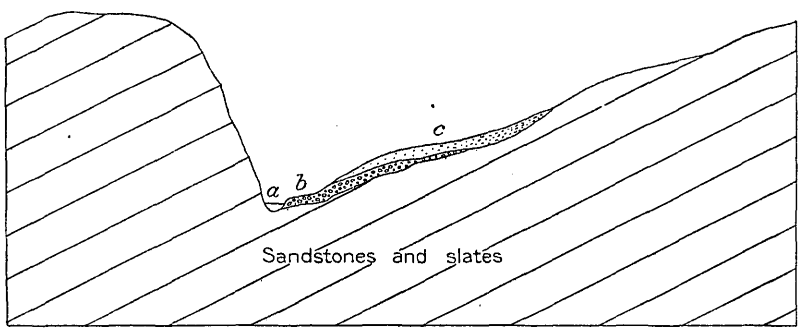


FIGURE 1.—Diagrammatic cross section of the valley of Spruce Creek. *a*, Present stream level at foot of scarp; *b*, auriferous bench gravel; *c*, overburden of frozen silt.

An effect of structure similar to that seen in the form of Spruce Creek valley can be noted at places on the other streams of the Kuskokwim uplands. It should be borne in mind that in downcutting the stream shifts its position in the direction of the dip; that, as a result of such shifting, concentrations of gold are most likely to occur in the gravel benches of the broadly open side of the valley; and that where dips are vertical or nearly vertical the stream does not shift its bed, and any concentration will be found in its present gravels.

In and near the Beaver Mountains a set of topographic features of exceptional type, described by Maddren,[1] has been developed by glaciation. The mountain valleys have broad U-shaped forms and the adjacent depressions are filled with morainic débris. Drainage lines have been changed, and the basin of Ganes Creek has gained a considerable area that formerly drained into Beaver Creek. In its

[1] Maddren, A. G., The Innoko gold-placer district, Alaska: U. S. Geol. Survey Bull. 410, pp. 13-14, 1910.

adjustment to the new condition, Ganes Creek cut a box canyon through the old divide and established a lower grade in its lower course, giving origin to extensive stream terraces.

LOWLANDS.

Practically all the large streams of the region flow through broad alluvial lowland plains in their lower reaches. There are three principal lowland belts, trending in general from northeast to southwest. The northern belt includes the Yukon Valley; the central, the valley of Innoko and Nowitna rivers; and the southern, the valleys of part of the Kuskokwim and of some of its tributaries.

The lowland plains are the result of a partial filling of erosional depressions that antedate the present arrangement of drainage systems. The principal lowland areas represent the trunk valleys of the older drainage system. Their actual outline is very irregular in detail, owing to the extension of embayments up the valleys of the larger tributaries of the trunk streams and of their laterals. This is illustrated in the distribution of alluvium. (See Pl. III, in pocket.)

The Yukon lowland belt narrows upstream and almost disappears at Ruby. Coincident with this narrowing, the embayments in the valleys of tributaries become less pronounced, until at Ruby they are absent. The Yukon lowland widens again upstream from Ruby and merges into that of the Nowitna.

The Innoko and Nowitna lowlands lie between the Kaiyuh and Kuskokwim uplands and form a practically continuous belt across the region. The full extent of the Nowitna lowland is not well known, but its extensions up the valleys of tributaries reach far up Solatna River and Long Creek of the Ruby mining district. The Innoko lowland extends the whole length of the trunk stream and far up the North Fork and its tributaries northeastward toward the Innoko-Nowitna divide. It has a width of more than 30 miles along the central reaches of the river and narrows somewhat in the upper and lower reaches. The lowland is broadly developed on the lower Iditarod and reaches up that stream beyond the mouth of Otter Creek. It extends up the other tributaries of the Innoko in similar fashion and probably has a total area of more than 3,000 square miles. The Innoko lowland belongs very largely to the present flood plain of the river. Along the main stream and the larger tributaries are natural levees, back of which lie broad basins. During the annual spring floods the streams overflow the levees into the basins and form extensive lakes. The basins thus receive an annual deposit of sediment, and it is apparent that the Innoko lowland is still being aggraded at a comparatively rapid rate.

The Kuskokwim lowland is represented in the region only by its extensions up the valleys of some of the larger tributaries of

Kuskokwim River. This lowland has an immense extent beyond the Iditarod-Ruby region in the area between the Kuskokwim upland and the Alaska Range.

DRAINAGE.

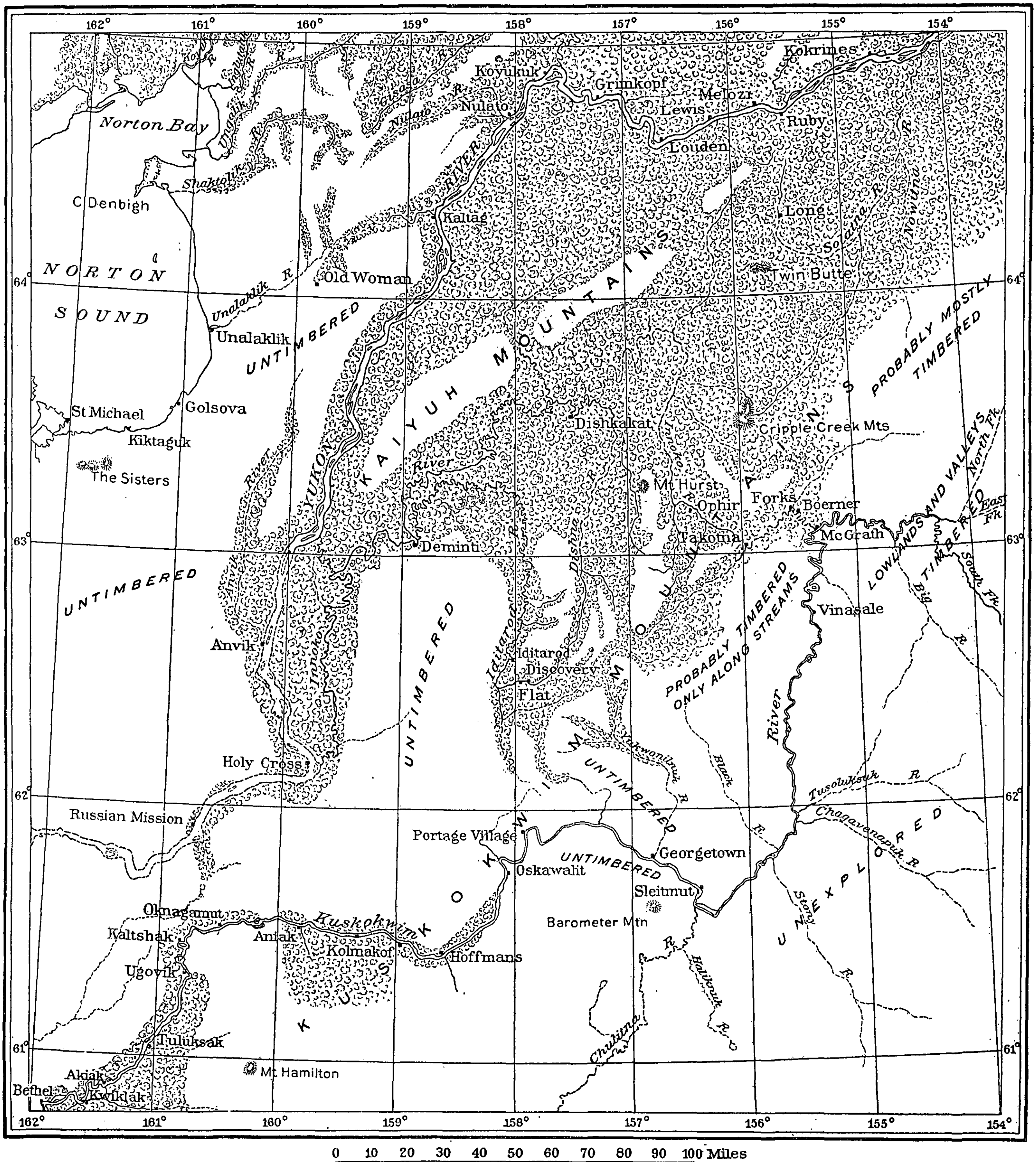
The Iditarod-Ruby region is drained by the Yukon and Kuskokwim River systems. The main divide is in the Kuskokwim upland near the south margin of the area mapped. The northeastern part of the region, including most of the Ruby district, is drained by Nowitna River, a large tributary of the Yukon from the south. The central and western parts, including the Innoko and Iditarod districts, is drained by Innoko River, a tributary of the Yukon from the east, and the south margin of the area mapped is drained by Donlin, George, and Takotna rivers of the Kuskokwim River system. Nearly all these streams head in the Kaiyuh and Kuskokwim uplands and debouch upon the lowlands of the trunk streams. In the upland areas the streams have relatively straight courses and swift currents and carry well-washed gravel and bowlders. In the lowlands they have broad meanders and sluggish currents and transport only silts and fine sand.

The thick vegetal mantle covering the region acts as a reservoir for the rain water, and consequently the flow of the streams is remarkably even. As the subsoil is frozen practically all the rainfall escapes as surface water, so that some streams which drain very small areas are available for use in mining operations.

CLIMATE.

The Iditarod-Ruby region, in common with the greater part of central Alaska, has a subarctic climate, marked by great seasonal variation in temperature, a rather scant rainfall, and an infrequency of storms. Winter weather may be experienced from October to April. During the other months the weather is usually mild. The larger streams generally thaw early in May and freeze over late in October. The intervening period, comprising generally about 120 days, is available for mining operations. The growing season for the hardier forms of vegetation extends from early in May to early in September.

The annual precipitation may be as little as 10 inches and is probably always less than 20 inches. It comes mostly as rain, in the months of July and August. Thunderstorms may occur for a short time in midsummer and may be accompanied by considerable precipitation. The later rains are general, and although they are not usually violent they may continue for several days or even weeks and they contribute the greater part of the year's precipitation. In the summer of 1912 the rainfall was probably exceptionally heavy, only five days between July 17 and September 2 having been without rain in some part of the region.



MAP SHOWING DISTRIBUTION OF TIMBER, LOWER YUKON AND MIDDLE KUSKOKWIM REGION.

Contrary to the popular conception of the climate of all high latitudes, violent storms are comparatively rare in central Alaska in both summer and winter. The periods without gales or even strong winds are commonly longer than in temperate latitudes.

The mean annual temperature is so low that the ground below a slight depth is permanently frozen, except where special conditions prevail. Extremely permeable gravel deposits are usually thawed, owing to the circulation of ground waters.

FORESTS AND VEGETATION.

The timber line, the maximum elevation at which trees grow in the Iditarod-Ruby region, stands about 2,000 feet above sea level. Many factors besides altitude affect the growth of timber, so that much of the region below this elevation is barren or only sparsely timbered. The general distribution of timber in the region is shown on Plate IV.

Most of the Ruby district is forested by a scant growth of spruce, which is accompanied by scattered tamarack and birch. Only the higher and flat-topped ridges are barren.

In the Kuskokwim upland belt a greater proportion of the land is above timber line. In favorable places, like the heads of valleys, trees grow at an elevation of about 2,000 feet (see Pl. V, *A*), but the tops of ridges much below this elevation are bare. Throughout the region spruce trees 2 feet or more in diameter, suitable for lumber, grow along the banks of streams or on the steep slopes at the heads of valleys. Willow and alder thrive along the streams and at timber line.

Throughout the region the mosses common to Alaska are especially abundant and, except on the highest ridges, the traveler finds a soft, laborious footing. Grasses suitable for forage are not abundant. The best growth is on the south slopes at the heads of valleys, and it is necessary to select camp sites with this fact in mind if grazing grounds for pack animals are desired.

FISH AND GAME.

Salmon, pike, whitefish, and other kinds of fish are caught in Yukon and Kuskokwim rivers and their larger tributaries. Grayling are plentiful in the smaller streams, and brook trout may be taken in most of the clear, swift streams.

Only the smaller forms of game, including ptarmigan, grouse, and rabbits, are plentiful. Two moose were killed on Long Creek, in the Ruby district, in 1912, but their presence there was considered exceptional. Moose are common on the eastern headwaters of the Innoko and possibly in the main valley. Caribou were encountered by the writer in the mountains northeast of Twin Mountains but are not plentiful in the region as a whole. Bear are found but are not numerous. Wolves, foxes, martens, and weasels are at home in parts of the region.

AGRICULTURE.

The possibility of growing agricultural products, other than common garden vegetables, in this region has not been well tested. The summer temperatures are lower and the rainfall is a little greater than at Rampart, where agricultural experiments have been broadly successful. The Iditarod-Ruby region is probably on the whole not so well adapted to agriculture as the regions farther inland, but lettuce, radishes, turnips, and potatoes were seen growing in gardens on Innoko River and Ganes Creek.

SETTLEMENTS AND POPULATION.

The white inhabitants of the region are confined almost entirely to the vicinity of the mines. In the Iditarod district there are three principal settlements—Iditarod, at the head of steamboat navigation on Iditarod River; Flat, at the mouth of Flat Creek; and Discovery, on Otter Creek. Recent changes in methods of mining and in ownership in the district have occasioned a considerable loss in population. At present Iditarod may have an average population of about 500, Flat of about 300, and Discovery of about 50, exclusive of the miners. About 750 men are employed in mining in the district, so that its total population is about 1,600.

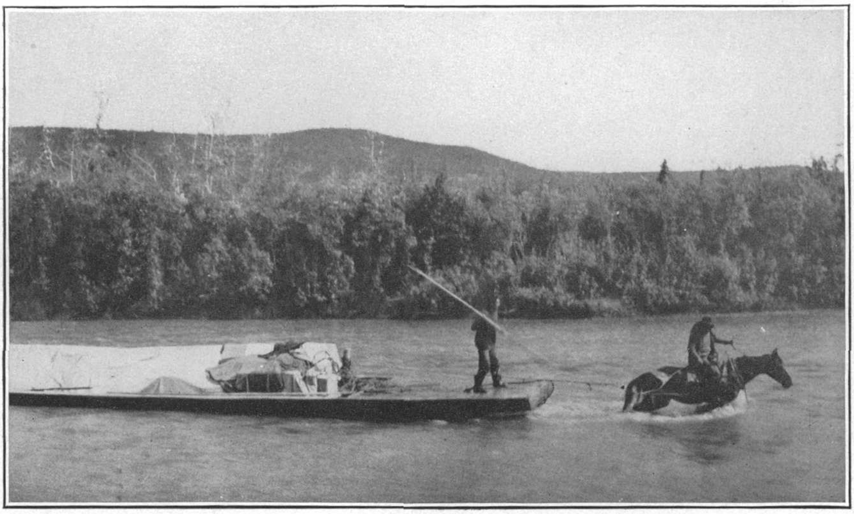
The chief settlement of the Innoko district is Ophir, on the south bank of Innoko River, at the mouth of Ophir Creek. It has an average population of about 50, and in addition about 150 people are engaged in mining in the district. A small community was established near the Cripple Creek Mountains, where gold was discovered in 1912. There are several small settlements, principally of native population, on the main Innoko River. The most important of these is Dishkakat, about 20 miles below the mouth of Dishna River.

The principal settlement of the Ruby district is the town of Ruby, on the south bank of the Yukon opposite the mouth of Melozi River. Its average population during 1912 was probably about 1,000. The district had an additional population of about 300, mostly engaged in prospecting and mining on a group of streams 25 to 30 miles south of Ruby. Part of this number were localized in a small settlement known as Long, near Discovery claim, on Long Creek.

TRANSPORTATION.

Steamboat service is maintained on Yukon, Kuskokwim, Innoko, and Iditarod rivers. The Yukon traffic is delivered at Ruby and also connects with that of Innoko River. Steamboat traffic on the Innoko is carried up as far as the mouth of the North Fork. Horse

A. TIMBER LINE AT HEAD OF CARTER GULCH, INNOKO DISTRICT.



B. HORSE SCOW ON INNOKO RIVER.

scows afford the chief means of transportation above this point. (See Pl. V, *B*.) On Iditarod River the head of navigation during the greater part of the open season is Iditarod. During low-water stages of the river the larger steamboats may only reach Dikeman, a point about 80 miles below Iditarod. At such times small gasoline boats are used on the upper section of the river. The Kuskokwim traffic is delivered at Takotna River, in proximity to the Innoko mining district.

The Iditarod district receives all supplies by the river route. A tramway is in operation between Iditarod and Flat. From both Iditarod and Flat wagon roads have been built to all important mines. The road on Flat Creek is especially good, having been built for hauling heavy dredge machinery. Moore Creek receives supplies from Discovery over a pack trail. The total freight charges on goods from Seattle laid down at the mines is 4 to 6 cents a pound (1912).

The Innoko district receives supplies by way of both Innoko and Kuskokwim rivers. The latter route is coming largely into use owing to the lower charges. The total charges in 1912 on goods from Seattle laid down at the mines were 10 to 15 cents a pound.

The Ruby district gets all its supplies from Ruby. The ordinary freight charge on merchandise from Seattle to Ruby is $45 a ton. The rate charged for freighting from Ruby to the creeks in summer is 10 to 15 cents a pound. In winter the rate drops to 5 cents a pound or even less.

MEANS OF COMMUNICATION.

Mail service extends to all the settlements of the region during winter. In summer Ruby and Iditarod have a scheduled mail service; but Ophir, in the Innoko district, has no authorized mail service and depends upon a carrier who is compensated by public subscription.

The Iditarod district has a local telephone service between settlements and mines. A wireless-telegraph station at Iditarod gives long-distance service in connection with the United States military telegraph stations at Nulato and St. Michaels. The Innoko district is without telegraph or telephone service. The Ruby district has local telephone service and telegraphic connection with the Government lines.

OTHER CONDITIONS AFFECTING MINING.

Labor is plentiful in all the districts. In 1912 ordinary miners in the Ruby and Iditarod districts were paid $5 a day and board. In the Innoko district $6 a day and board was commonly paid.

The whole region is dependent for fuel upon cordwood, which ranges in price from $6 to $15 a cord, according to the availability of the timber supply. Rough lumber sold at Ruby in 1912 at $50 a thousand feet; dressed lumber at $80 a thousand feet.

Sufficient water for sluicing is usually available on all streams of the region that are 3 or 4 miles long or longer. Shortage of water is not uncommon on the smaller streams during the dry part of summer. Some of the mines in each district are so situated that the shortage of water is felt keenly. The greater proportion of the mines and those of most importance are on streams that give a water supply constantly adequate for the required uses.

GENERAL GEOLOGY.

OUTLINE.

The solid rocks of the region may be assigned to three main groups—the metamorphic rocks that are of probable Paleozoic age; the Cretaceous rocks, including less altered sedimentary and volcanic rocks; and the undeformed intrusive rocks. Quaternary unconsolidated deposits overlie the solid rocks in much of the region.

METAMORPHIC ROCKS.

Metamorphic rocks form the Kaiyuh upland and occupy all the Ruby district. They outcrop in the bluffs of the Yukon near Ruby and extend southward almost to Cripple Creek Mountains. They continue southwestward in the Kaiyuh upland and northeastward beyond the field examined. They form the north margin of the Kuskokwim upland in the vicinity of Iditarod River and occupy a small area surrounding Hurst Mountain.

The metamorphic rocks may be divided into four groups—the undifferentiated metamorphic rocks, which include schists, slates, limestones, and greenstones, and occupy most of the metamorphic areas; the greenstones of the Kaiyuh Mountains; the cherts of the region south of the Innoko-Solatna pass; and the volcanic rocks of the area south of the cherts. The areas occupied by these groups are shown on the geologic map (Pl. III, in pocket).

UNDIFFERENTIATED METAMORPHIC ROCKS.

The undifferentiated metamorphic rocks extend from Yukon River southward for about 10 miles south of Twin Butte Mountain, where the smooth, rolling topography gives place to a series of sharp hills and ridges composed of chert and igneous rocks. Westward they extend to the border of the Kaiyuh Mountains. They outcrop north of Innoko River below Dishkakat, along the Iditarod, where it leaves the uplands, and about Hurst Mountain. Eastward they extend beyond the boundaries of the district. The exposures along the Yukon bluffs near Ruby are mainly of a black quartzitic slate and limestone. The absence of slaty cleavage in places gives black quartzite and quartzite schist phases of the same original member as that forming the slates. The schists and slates are much contorted and contain numerous quartz veins and lenses and unaltered dikes of varying composition. The limestones are crystalline, are banded bluish and white in color, and have complicated structures indicating a dynamic history similar to that of the schists and the slates.

The prominent hills about the head of Long Creek are mostly formed of a light-colored quartzose schist, which in places contains much mica. A little northwest of this locality, on the Beaver-Main Creek divide, there is a dark-colored limestone with which is associated more or less sheared chert.

Exposures of bedrock are not numerous on Long Creek and Bear Pup, near the mines, but those that occur are of the usual metamorphic type. A considerable part of the bedrock here is greenstone, but limestone and schists predominate. The greenstones have developed more or less schistose cleavage and grade into greenstone schists.

On Glen Gulch the bedrock is mostly a crenulated graphitic schist cut by numerous quartz veins. The stream gravels contain pebbles of greenstone and mica schist, which probably form the bedrock in parts of the valley.

The bedrock geology of Trail Creek basin is like that of Glen Gulch with respect to the metamorphic rocks, presenting an association of limestones, greenstones, and black crenulated schists, with the same abundance of quartz veins.

The greenstones of this group are altered volcanic rocks of basic composition. Their original character is evident in a few places; on Midnight Creek they are diorites; at Twin Butte Mountain they are diabase; on Long Creek and on the Bear Pup–Glen Gulch divide they are altered to actinolite-epidote schists. Presumably the greenish schists that are common throughout the region are similar in composition and are derivatives of original basic flows and tuffs.

The structure of the metamorphic rocks is rarely evident but is uniformly complex wherever recognized. The principal structural axes trend in general N. 25° E. Along these axes intense folding and faulting have taken place. There has also been much shearing on a small scale, and the secondary structure thus developed conforms in general with the major axes. The metamorphism of the original sedimentary and igneous rocks now represented in the group is largely due to the processes attending their deformation. A similar effect has also been induced by igneous activities accompanying their intrusion by large granitic masses and various dikes.

The structural trend of the metamorphic rocks of the Ruby district is northeast, toward the Gold Mountain and Rampart districts, where similar rocks are found. Some fossils were obtained from a limestone knoll on the Yuko-Solatna divide. They were determined by Edwin Kirk, of the Geological Survey, whose report is as follows:

Fossil coll. 12 AE–1. Limestone knoll, Yuko-Solatna divide.
Cladopora sp.
Fragments of crinoid columns possibly referable to the genus Melocrinus.

These fossils indicate the Devonian age of the containing beds. Material quite similar to this both as regards lithologic character and fossil content has been obtained in the Nulato-Council region of Alaska.

Limestone outcrops similar in character to that from which the fossils were obtained are widely distributed in the areas of undifferentiated metamorphic rocks, and it would appear that the group is largely of Devonian age and probably all of early to middle Paleozoic age. These rocks are probably the equivalent of some of the metamorphic rocks of the Gold Hill district, north of the Yukon and of the Yukon-Tanana region.

GREENSTONES.

Most of the rocks of the northeast extension of the Kaiyuh Mountains in the Ruby district are more or less altered basic lavas. Secondary minerals generally give them a greenish color, but locally they include phases in which the original minerals are well preserved. Most of these rocks are diabase and gabbro. Some are quartz gabbro and still others are acidic, approaching rhyolite in composition. Textures vary from medium granular to aphanitic, and some of the finer-textured rocks contain considerable glass. This group of rocks not only forms the mountains, but extends northeastward and forms the landmark known as the Thumb, near the head of Beaver Creek. These rocks outcrop also north of Innoko River above Dishkakat. They are probably closely related in age to the greenstones of the undifferentiated metamorphic group.

CHERTS.

Cherts occupy an area on the north flank of the Kuskokwim upland between the Cripple Creek Mountains and the Innoko-Solatna Pass. Near the mountains, where there has been severe deformation, the structure of the cherts is complex and their relations are obscure. Farther northeast they are thrown into sharp but regular folds and show thin, even bedding. With them are thin beds of slate and some greenstone. Cherts like these are reported[1] to occur also in a small area south of Mount Hurst.

The age of the cherts is uncertain. They are less altered than the chert members of the undifferentiated metamorphic group. In places their structure and physical conditions differ but slightly from those of the Mesozoic rocks that overlie them. In general, however, the facies of the cherts accord most closely with that of the least-altered Paleozoic rocks.

[1] Maddren, A. G., unpublished notes.

VOLCANIC ROCKS.

Volcanic rocks form the Innoko-Solatna divide for about 10 miles south of the boundary of the cherts. The east-west extent of the volcanic rocks was not definitely determined, but the topography indicates that they occupy the area indicated on the geologic map (Pl. III, in pocket).

The volcanic rocks are chiefly rhyolite, rhyolite porphyry, and rhyolite breccia. They also include dark-colored igneous rocks that were originally diabase but are now altered to greenstones. Presumably the light-colored rhyolitic rocks are volcanic flows and the greenstones are intrusive.

The alteration seen in the greenstone members indicates that the group as a whole is older than the later Mesozoic rocks. They probably belong to some Paleozoic system.

CRETACEOUS ROCKS.

Cretaceous rocks flank the metamorphic rocks on both the north and the south. The northern area is along the north side of Yukon River west of Melozi River delta. The southern area includes the Iditarod and Innoko districts and extends southward beyond Kuskokwim River and westward to the Yukon-Kuskokwim lowlands.

The Cretaceous rocks are chiefly sedimentary, but include volcanic strata, which are irregularly distributed among them. The sedimentary rocks comprise coarse and fine conglomerates, sandstones, shales, and slates. The volcanic strata are basic flows, breccias, and tuffs.

The conglomerates are developed chiefly near the base of the sedimentary series and are in proximity to the old metamorphic rocks from which their component materials have been derived. They outcrop in a ridge of rugged topographic form that trends northeast-southwest along the west side of Iditarod River above the town of Iditarod. A similar ridge appears on the east side of the river in the direction of the strike, and this ridge may represent a continuation of the same beds. Conglomerates also occupy considerable areas in the vicinity of the Cripple Creek Mountains and in the Cretaceous area north of the Yukon.

The conglomerates vary in texture; some are fine grained and others contain bowlders as much as 3 feet in diameter. The thickness of the conglomerates was not measurable in the exposure seen, but in places it amounts to several hundred feet.

The rest of the Cretaceous sedimentary series, by far its larger part, is composed of sandstones and shales or slates. The sandstones are for the most part impure. Arkosic types are the most common and are widespread. There are also locally calcareous and argillaceous sandstones. The slates and shales are all dark colored, and some are notably graphitic.

The relative amount of sandstone and slate varies from place to place. Near the margins of the areas, as in the Iditarod district and in the region about the Cripple Creek Mountains, the rocks are massively bedded sandstones and minor amounts of slate. In the Innoko district, especially near Twin Mountain and about the mines, the slates predominate and the rocks are thinly and evenly bedded.

Throughout the series, in both sandstones and slates, well-rounded chert pebbles are scattered. These are abundant in some strata, and at one locality south of the Cripple Creek Mountains they form a bed of conglomerate that lies at least 2,000 feet above the base of the series.

In the region southwest of the Beaver Mountains the series includes thick beds of basaltic flows, breccias, and tuffs, interbedded with massive sandstones and shales. Similar volcanic rocks are said to occur also along Innoko River above the mouth of North Fork.

Presumably the massively bedded sandstones immediately overlie the basal conglomerates and underlie the upper thinly bedded part of the series.

The volcanic rocks are absent from thick series of strata in some localities. They indicate the activity of rather widely separated volcanic centers and form an important part of the series only in restricted areas.

Fossils from Ophir Creek, in the Innoko district, determined by T. W. Stanton, indicate Upper Cretaceous age. Collections from the Yukon section below Melozi River indicate ages ranging possibly from Lower Cretaceous to Eocene.

Spurr [1] collected Cretaceous fossils from the Kuskokwim section. The whole series of sedimentary and volcanic rocks was evidently deposited in the great inland sea that occupied much of Alaska in late Mesozoic time. Its members are therefore in some measure analogous to the widely distributed Cretaceous beds of the upper Yukon basin and to the Ungalik conglomerate and the Shaktolik group of the Norton Bay-Nulato region,[2] and also to the Chignik formation of Alaska Peninsula.[3]

UNDEFORMED INTRUSIVE ROCKS.

Intrusives cut both metamorphic and Cretaceous rocks at numerous localities throughout the region. There are two general types of intrusives—batholiths, or thick lenticular dikes and sills, and attenuated dikes and sills. The areas of the intrusives of the first type are

[1] Spurr, J. E., A reconnaissance in southwestern Alaska in 1898: U. S. Geol. Survey Twentieth Ann. Rept., pt. 7, pp. 159-163, 1900.

[2] Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region: U. S. Geol. Survey Bull. 449, pp. 54-60, 1911.

[3] Atwood, W. W., Geology and mineral resoorces of parts of the Alaska Peninsula: U. S. Geol. Survey Bull. 467, pp. 41-49, 1911.

shown on the geologic map (Pl. III, in pocket). Those of the second type are widely distributed but could be shown only on a map of much larger scale.

The massive intrusives in the Cretaceous areas are in general rather coarsely granular medio-silicic rocks. Their mineralogic composition in most places is that of monzonite, which differs from granite in having relatively less quartz and more of the plagioclase feldspars. Variations into granite, on the one hand, and into diorite, on the other, occur. The specimens from the head of Flint Creek are granite and biotite granite. Massive intrusives in the Paleozoic areas are as a rule more coarsely crystalline than those in the younger rocks.

The massive intrusives of the Iditarod district have an important economic significance, for the chief mineralization of the region is closely related to them. The introduction of mineralizing solutions into the rocks of the region was probably a later phase of the same igneous activity that formed the monzonites, for the igneous rocks themselves are cut by auriferous veins.

The more attenuated forms of intrusion include dikes and sills, which cut the stratified rocks in all parts of the region. They have a great range in composition; those of the Yukon section near Ruby are rhyolite porphyry and quartz diorite; south of Cripple Creek Mountains there are basalt and andesite porphyry dikes; and in the Innoko and Iditarod districts rhyolitic and granitic dikes occur generally. Their genesis is probably in large measure related to that of the massive intrusives, and their greater abundance near the batholiths indicates that, in part at least, they may be merely apophyses of these larger intrusive masses.

The undeformed intrusive rocks of the whole region probably belong to the same general period of volcanism. This period postdated that of Cretaceous sedimentation. Its length is not indicated by the available evidence in the region. However, there is a marked resemblance between the undeformed intrusive rocks of this region and those of the Rampart-Hot Springs region, which are known to be very late Cretaceous or earliest Tertiary.

QUATERNARY DEPOSITS.

The Quaternary deposits of the region include alluvium, terrace gravels, glacial and glaciofluviatile deposits, and residual breccias and clays. These are widely distributed in the region and form the superficial covering of most of its area. Alluvium is common both in the valleys that lie within the highland areas and in the lowland areas. The lowland deposits are the deeper and in places are probably hundreds of feet deep; except in the lowland embayments that extend up the larger valleys the alluvium of the upland areas is of moderate depth. The alluvium of the valleys of the uplands is mainly gravel; the alluvial deposits of the lowlands are gravel in part but include clays, silts, and sands.

Practically the entire surface of the Ruby district is mantled by unconsolidated deposits. Gravels commonly form the lower part of the alluvium of the present valleys. High gravels have been discovered on top of the river bluffs near Ruby and at Skookum Bar, on a ridge at the head of Big Creek, about 5 miles south of Ruby. Silts form a large part of the valley filling of the streams, especially near the Yukon, and may also constitute part of the upland mantle throughout the district. Residual clays are widespread in the whole region and cover much greater areas than either the silts or the gravels. They mantle the lower hills and ridges and have crept down into the valleys. The gravels of the valley bottoms are covered as a rule by a considerable thickness of clay, much of which has come from the adjacent hillsides.

The alluvial deposits increase in depth downstream in all of the valleys and are deepest in the trunk valleys and in the valleys immediately tributary to them. They are exceptionally deep on the streams near the Nowitna and Solatna lowlands. On White Channel Creek, a tributary of Trail Creek near its mouth, a shaft penetrated 45 feet of silt and 140 feet of gravel without reaching bedrock. About 7 miles upstream on White Channel Creek another shaft penetrated 182 feet without reaching bedrock, and 7 miles farther upstream the alluvium is 60 feet deep.

On Long Creek the depth of alluvium ranges from 30 to 40 feet (at points farthest upstream that have been tested) to 70 feet 5 miles below the mouth of Bear Pup. The depth probably increases even more rapidly farther downstream on Long Creek, for the bedrock slope of Midnight Creek is so much greater than the surface slope that the alluvium at the mouth of Midnight Creek must be considerably over 100 feet in thickness.

In general the depth of alluvium corresponds rudely with the width of the valley. In the lower reaches of the Solatna and its tributary streams depths of over 100 feet are commonly to be expected, and depths of 200 feet and more should not be surprising at the border of the more extensive flats.

Terrace gravels occur along many of the streams of the Innoko district, notably along Ganes Creek. The terraces increase in height from the lower end of the valley up to the vicinity of the preglacial divide (see pp. 14–15), where they disappear. Terraces occur also on Little, Spruce, and Ophir creeks. The bedrock structure has caused the downcutting streams to shift their channels, so that the former stream gravels now stand in terraces slightly above the present stream levels.

Glacial and glaciofluviatile deposits are developed chiefly about the Beaver Mountains. The longest glaciers left terminal moraines probably 5 or 6 miles out from the center of the range, or about 2 miles from its front. The older topography has been obliterated by the deposition of material furnished by the glaciers, so that the mountains are now bordered largely by broad gravel plains. The buried topography probably had considerable relief, and there must be a corresponding variation in the depths of the glacial deposits.

Residual mantle deposits are widespread in the region, but only those covering the slopes and hilltops at the heads of Flat, Chicken, and Happy creeks in the Iditarod district are known to have economic value. At this locality a gold-bearing deposit ranging in depth from a few feet to 20 feet has been developed by the weathering of the monzonite batholith and the associated rocks. The igneous rock weathers first along the joint planes, and as weathering continues it forms large spheroidal masses, which are separated from each other by disintegrated rock. This weathering has been accompanied by more or less creeping of the loosened materials on the slopes, and the action of water has removed some of the finer particles.

The long-continued action of these processes has produced residual bowlders of various sizes that illustrate all stages in the transformation of the angular blocks of bedrock to spheroidal forms. Mixed with the monzonite bowlders are weathered fragments of other types of rocks that have crept down from the hilltop above. The interstices are filled with granular sands and angular fragments of quartz stringers. The local removal of the sands has caused a concentration of the bowlders at the surface in some places.

VEINS AND MINERALIZATION.

The character and distribution of veins and the examples of mineralization vary from place to place in the Iditarod-Ruby region. There is much less variation within the separate mining districts, and the characteristics of each district will be treated in turn.

IDITAROD DISTRICT.

In the Iditarod district quartz veins are common in the Cretaceous sedimentary rocks, especially close to the monzonite areas, where igneous metamorphism has been intense. The largest are a foot or more thick and appear undeformed and continuous for considerable distances. Small quartz veins are much more numerous than large ones, and nowhere were veins seen of sufficient size to suggest possible lode development. The veins are gold bearing in places and have evidently supplied much of the gold of the placers.

The monzonites are in places cut by very numerous quartz stringers, the largest noted being 3 or 4 inches thick. They are distributed as though they had been injected along the planes of an original joint system. They are generally gold bearing and have supplied the gold of the residual placers at the heads of Flat, Chicken, and Happy creeks and also of the creek placers near the head of Flat Creek.

In places there is a mineralized zone at the contact of the monzonite bodies with the sedimentary rocks. Such a zone was discovered at the bottom of an open-cut placer near the head of Flat Creek. It is several feet wide and carries, besides gold, considerable amounts of cinnabar and stibnite.

Cinnabar occurs with placer gold in many of the mines of the district and is probably a vein mineral in both the igneous and the sedimentary rocks.

The availability of any of the veins or mineralized zones as minable lodes has not yet been demonstrated; but little attention has been paid to this form of deposit, and further prospecting may reveal auriferous veins large enough for mining or may disclose stockworks of small, closely spaced veinlets in the monzonites or along their contacts rich enough to work. The local richness of some of the residual placers on the hill at the head of Flat, Chicken, and Happy creeks supports this view, but it can be established only by actual tests of the bedrock along the zones of more abundant mineralization.

INNOKO DISTRICT

Quartz veins cut the rocks of the Innoko district generally and are especially common in the acidic dikes that intrude the sedimentary rocks. The veins that cut the dikes are usually not of massive form but occur as close stockworks. The mineralizing solutions that permeated the dikes and deposited the veins also changed the composition of the adjacent rock profoundly. Specimens in which the original structure of typical dike rock can be seen are now composed almost entirely of quartz and iron carbonate about equally divided in amount. Iron carbonate is also abundant in the veins. The quartz veins and the altered dikes are in places gold bearing. At least one quartz vein along a dike—that of the Independence mine—is a workable gold lode, and the dependence of rich placer accumulations upon other lodes seems evident.

The Independence mine is near the head of Carter Creek, an eastern tributary of Ganes Creek. The ore body is a quartz vein, averaging about 2 feet in thickness, that occurs along the hanging wall of a rhyolite dike intrusive in the sedimentary series. The microscope shows that the gold lies in iron-stained crevices and vugs in the quartz and is also embedded in grains of magnetite within the quartz vein. Veinlets of iron carbonate cut the quartz, and iron carbonate is abundantly present in the altered sedimentary rock on the one hand and in the altered dike on the other. The dike is much altered in places so that the original character of the rock is obscure.

The altered sedimentary and igneous rocks both contain more or less gold. The workings show that the vein is continuous to a depth of more than 90 feet, and there are no evident geologic reasons that it may not extend to a much greater depth.

Several other mineralized dikes and quartz veins within a few miles of the Independence mine have been located as mining properties, and very encouraging assays are said to have been obtained from samples taken from some of them. The geologic conditions are favorable to the occurrence of metalliferous veins in considerable areas of the Innoko basin and of adjacent portions of the Kuskokwim basin.

RUBY DISTRICT.

Quartz veins are a common feature of the metamorphic rocks of the Ruby district. They are especially abundant in the black crenulated schist member that outcrops at the head of Boston Creek and on Trail Creek. Many brecciated quartz veins are exposed in the bedrock of the placer mines on all the creeks, and quartz bowlders form a large part, if not all, of the stream gravels wherever exposed. A few large quartz veins were noted in the Ruby bluffs. One, about 15 feet wide, is penetrated by an abandoned prospecting drift. Another vein, 6 feet wide, about 10 miles south of Ruby, had also been prospected, apparently without favorable results.

The quartz veins are commonly iron stained on the surface. Hematite vugs were noted in some and pyrite and arsenopyrite in others. Arsenopyrite is probably the most abundant of the iron minerals. The quartz veins carry gold in the placer areas, for many nuggets containing quartz are found. Nuggets composed partly of hematite are also found, which suggests that the hematite vugs noted in the quartz veins may be auriferous.

Cassiterite, the oxide of tin, is found in the concentrates on Midnight Creek and is probably a phase of vein mineralization.

GEOLOGIC HISTORY.

The earliest recorded events in the geologic history of the region were the deposition of Paleozoic sediments and volcanic rocks. The details of the history of this period are obscure. The character of the deposits indicate that marine conditions prevailed most of the time. Volcanic outbursts occurred occasionally during the period, perhaps most extensively near its close.

It is impossible to assign the close of Paleozoic sedimentation to any definite age, but it occurred after the deposition of beds that have been determined as Devonian. The interval between this time and Cretaceous time—possibly late Cretaceous—is without a sedimentary record in the region. During this interval, however, intense diastrophism occurred, as is shown in the structure and metamorphism of the Paleozoic rocks. For a great part of this time the region was probably a land surface exposed to erosion.

In Cretaceous time the surface of the region was depressed below sea level and a great series of marine sediments was formed. Then followed, probably in early Tertiary time, a period of diastrophism in which the Cretaceous beds were deformed, the deformation having been accompanied by the intrusion of magmas that formed monzonites and granites into both Paleozoic and Mesozoic rocks. At about the same time the region became a land surface, and there is no evidence of its subsequent submergence. It seems, therefore, that erosion has been in progress continually since the post-Cretaceous uplift.

The rate of denudation in this great period probably has not been uniform. The region includes large areas that have a rather uniform relief and contain many long, level ridges, which may be taken as indications of a former base-leveled condition, but the evidence is not conclusive.

During this period of erosion the region was degraded thousands of feet. Degradation of the uplands is still going on, and the lowlands are in general being built up. The beginning of the aggradation of the lowland areas probably dates back to early Quaternary time, when the main drainage systems of Alaska were apparently profoundly changed. Crustal movements may have deranged the gradients of streams to some extent and have thus caused them to aggrade.

In early Quaternary time normal stream erosion was interrupted in the Beaver Mountains by the development of glaciers. Ice tongues reached down the valleys of this mountain group and out upon the adjacent lowlands. The drainage of a considerable area east of the Beaver Mountains that formerly belonged to Beaver Creek was diverted into Ganes Creek.[1]

The adjustment of Ganes Creek to its new and larger drainage basin has involved a general downcutting in all parts of its valley and the formation of a box canyon where it formerly headed.

The placer deposits of the region have accumulated during a long period of time. Those of the Ganes Creek benches antedate the time when glaciers existed in the Beaver Mountains. The placers of the other streams are probably equally ancient. It seems likely that practically all the placers were in their present form in early Quaternary time.

---

[1] Maddren, A. G., The Innoko gold-placer district, Alaska: U. S. Geol. Survey Bull. 410, pp. 13-14, 1910.

ECONOMIC GEOLOGY.

MINERAL RESOURCES.

Gold is the only proved mineral resource of the Iditarod-Ruby region, and it has been derived almost entirely from placer deposits. A single lode deposit in the Innoko district has been exploited in a small way.

Cassiterite, the oxide of tin, occurs with placer gold on Midnight Creek in the Ruby district, but the amount of the mineral contained in the gravels that have been worked is too low to be of commercial importance.

Cinnabar and stibnite occur as vein minerals in the Innoko and the Iditarod districts. Cinnabar is found in considerable quantities in many of the gold placers of the Iditarod district. The amount is too small apparently to be of much value.

The mining industry in the Iditarod-Ruby region centers in three separate localities, the Iditarod, Innoko, and Ruby districts.

IDITAROD DISTRICT.

AURIFEROUS DEPOSITS.

CHARACTER AND DISTRIBUTION.

The auriferous deposits of the Iditarod district that have been worked are all of the placer type. Most of them occur in the alluvium of the present streams, but there are residual placers whose concentration has been little influenced by water action.

The residual placers cover much of the top and the upper slopes of the mountainous mass in which Flat, Chicken, and Happy creeks head, and they merge with the alluvial placers at the heads of these streams. The chief alluvial placers are on Flat Creek and on Otter Creek at a locality 2 miles above the mouth of Flat Creek. Deposits of this type have been worked also on Glen Gulch and Black Creek, of the Otter Creek basin above Flat Creek; on Willow Creek, a tributary of Iditarod River next above Otter Creek; on Happy Gulch, the chief tributary of Willow Creek; and, 30 miles eastward, on Moore Creek, a tributary of Tokatna River. (See map, Pl. II.)

The stream gravels throughout the district are of medium or shallow depth and all are workable by open-cut methods. The streams have well-developed flood plains, and where the gold occurs the valleys are usually much wider than the pay streaks. Some of the deposits are permanently frozen and some are not.

STREAM PLACERS.

Otter Creek.—The Otter Creek placers extend about 1½ miles along the south side of the valley opposite the town of Discovery. A general view of this part of the valley is shown in Plate VI, *A*. The depth to bedrock near the stream is usually about 10 feet. Near the side of the valley the depth increases and may be as much as 20 feet. The bedrock is mostly igneous and is usually much weathered. The gold is found in the weathered bedrock and in the stratum of gravel a few feet thick overlying it. The overburden in the placers of greater depth is largely silt and muck.

Frost is irregularly distributed in the deposit, and occasionally much live ground water is encountered.

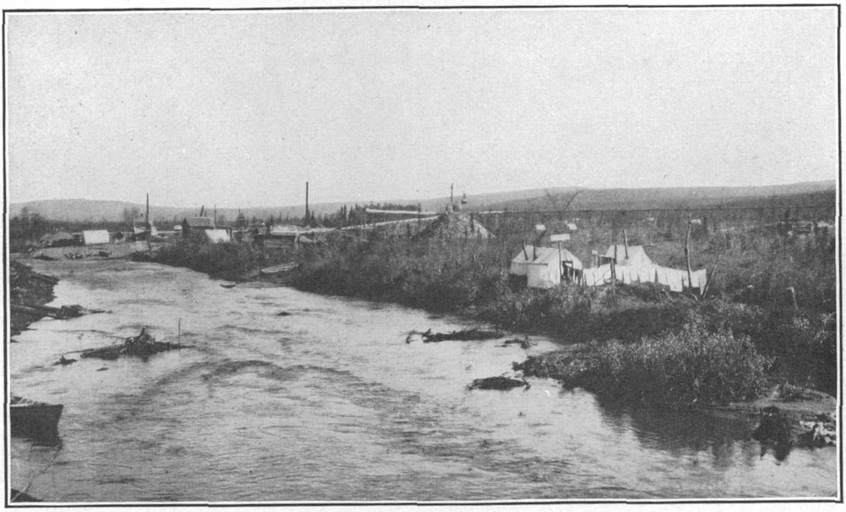
Flat Creek.—The alluvial gold placers of Flat Creek extend continuously from a point near its mouth to its extreme head, where they merge with the residual placers. The total length of the stream is about 5 miles. The deposits through nearly their entire extent are between 12 and 16 feet in depth. The greatest depths occur near the mouth of the stream.

The bedrock of Flat Creek valley is mostly sandstone and slate of the Cretaceous sedimentary series, except at its extreme head, where it is monzonite. The total production of gold from Flat Creek will be very large in proportion to the size of the stream, owing in part to the great length of its placer area and in part to the extreme richness of the gravels locally. The original Marietta Association mine near the head of Flat Creek is shown in Plate VI, *B*. A dredge is now installed in this ground.

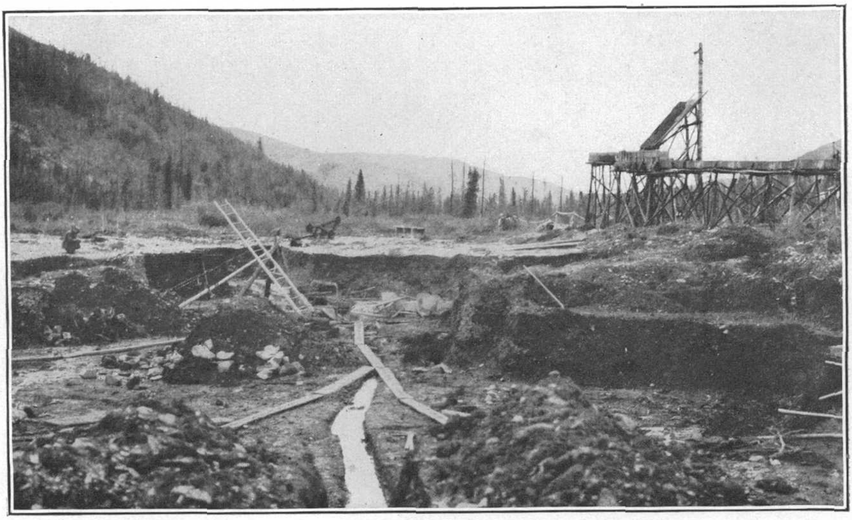
Glen Gulch.—The auriferous deposits of Glen Gulch are mainly within the area of a single claim. The bedrock is monzonite and, as on Otter Creek, its surface is disintegrated. The gold occurs in the disintegrated material and in a thin stratum of overlying gravel.

Black Creek.—The placers of Black Creek are not well defined as to extent. It seems likely that continuous placer deposits do not extend for any great distance in the valley. However, workable deposits have been discovered locally at several places. The bedrock in general consists of members of the sedimentary series and of local bodies of intrusive monzonite. As on the other creeks, the depth of the Black Creek placers is not great, the usual range being 12 to 16 feet.

Willow Creek.—There are two distinct areas of auriferous alluvium in the Willow Creek basin, one on the broad flood plain on the left side of the stream between 3 and 4 miles from its head and one at the head of Happy Gulch, a tributary of Willow Creek that heads against Flat Creek. The lower placer area is relatively wide and has a linear extent of several claim lengths. The depth of the alluvium generally ranges from 16 to 18 feet. Its coarse materials are not much worn as a rule, but consist of angular flaggy fragments of the local sedimentary bedrock. There is considerable overburden of sands and frozen silts.



A. OTTER CREEK VALLEY AT THE PLACER MINES.



B. TYPICAL OPEN-CUT MINE, FLAT CREEK.

The Happy Gulch placers occupy most of the width of the relatively narrow headward portion of the valley for a distance of about a mile. The stream heads against Flat Creek and in the same monzonite area, but in a short distance crosses the contact into Cretaceous sedimentary rocks. In the monzonite area the stream and its valley have but slight development and the placers are mainly residual. Below the contact stream action has had more effect in forming the placers. The gravels are shallow and include numerous monzonite bowlders, besides angular detritus of indurated Cretaceous sediments.

RESIDUAL PLACERS.

The residual placers of the district are all within an area about a mile square, which includes the top and the upper slopes of the mountainous mass in which Flat, Chicken, and Happy creeks head. They have been formed by the disintegration of a mineralized igneous bedrock and the removal of rock materials by solution, soil creep or solifluction, and the action of numerous small rivulets. The capacity of the rivulets has been limited to the transportation of fine soil particles and sands. Other processes than stream action have dominated in the movements of rock waste and have prevented the development of marked erosional depressions by stream action. The residual placers are therefore widespread, and the distribution of gold in them corresponds more closely with its original distribution in bedrock than with drainage lines.

The depth to solid bedrock in these placers ranges from a few feet to 20 feet. Gold is commonly distributed in varying quantities throughout their vertical extent. The greatest values are usually, but not always, near the surface of solid bedrock. Neither gold nor rock materials show evidence of much water near.

SOURCE OF THE GOLD.

The gold of the placers has been derived from quartz veins and stringers and mineralized zones that cut both igneous and sedimentary rocks or lie along their contacts. Quartz stringers, in which free gold is frequently seen, cut the monzonite batholith that forms the hill at the head of Flat Creek and are clearly the source of the gold of the residual placers. Quartz veins that may be mineralized, the largest a foot or more in thickness, cut the sedimentary rocks at a number of places. At one locality where the monzonite is in contact with slate there is a zone of mineralization several feet wide. This zone carries considerable amounts of cinnabar and stibnite as well as some gold.

The introduction of gold into the rocks of the region mainly followed the intrusion of the monzonites, and the two occurrences are probably closely related.

HISTORY OF MINING DEVELOPMENT.

Gold was first discovered in the Iditarod district on Otter Creek late in 1908 by W. A. Dikeman and John Beaton. During the following summer a number of prospectors who had learned of the discovery came into the district from other parts of Alaska. The first systematic development was begun during the winter of 1909–10. The reports that were given the public regarding the results of this work aroused widespread interest and probably 2,500 persons entered the district during the summer of 1910. Extensive mining operations were begun at this time and since have been continued with gradually increasing success.

The gold and silver production of the district in 1910, 1911, and 1912 is given in the following table:

Gold and silver production of the Iditarod district, 1910–1912.[a]

	Gold.	Silver.	Value.
	Fine ounces.	*Fine ounces.*	
1910	24,108	4,254	$500,000
1911	120,540	21,270	2,500,000
1912	168,756	29,778	3,500,000

[a] Data regarding the histories of all the districts are taken largely from the notes of A. G. Maddren.

MINING IN 1912.

Otter and Flat creeks were the largest producers in 1912, as in previous years, the production of the former being slightly greater than that of the latter. Happy, Glen Gulch, Willow, and Black creeks, in the same neighborhood, and Moore Creek, 30 miles to the eastward, all report considerable production. Systematic prospecting was done on the head of Chicken Creek, but little actual mining was accomplished.

Otter Creek.—Three claims were worked on Otter Creek, leased in small tracts to 10 operators. Heavy steam machinery was used in open-cut work. About 450 men in all were employed.

Flat Creek.—The year 1912 witnessed a great change in the mining operations on Flat Creek, owing to the extensive purchase and leasing of ground by the Yukon Gold Dredging Co. A great number of plants discontinued work, and there was a great reduction in the number of men employed.

The Yukon Gold Dredging Co. installed a dredge on the Marietta group of claims, near the head of the creek. It began operating the last of August and continued until near the freeze-up.

Eight other creek claims were worked by steam plants, open-cut methods being used and the material being hoisted in buckets to the sluice boxes. On the hillside above the head of Flat Creek five claims were worked by five outfits, which operated by groundsluicing and shoveling into sluice boxes. About 400 men were employed.

Happy Gulch.—Five claims were worked on Happy Gulch, two of them being on creek placers and the others on ground of the residual type. All used open-cut methods without steam machinery. About 50 men were employed.

Glen Gulch.—The operations on Glen Gulch were confined to the early part of the season. A considerable production is reported for this creek, but the work was discontinued before the end of the season, owing to the exhaustion of available placer ground.

Willow Creek.—Two claims were worked on Willow Creek by two outfits. About 20 men in all were employed. A prospecting drill was in use on Willow Creek most of the summer.

Black Creek.—A single outfit worked on Black Creek part of the summer. No details of the operations are available.

Moore Creek.—One claim was operated on Moore Creek by a single plant employing 12 men. The ground is shallow and work is done by manual methods.

Chicken Creek.—Systematic prospecting with a drill was done on Chicken Creek during the summer, and a little mining was done. Two outfits were operating part of the time. In all 12 men were employed.

Summary.—Twenty-nine claims, located on eight different creeks, were worked in the Iditarod district in 1912. Thirty-six plants were engaged in the work. Of these, one was a dredge, 22 were equipped with steam machinery, and 13 used manual methods. A total of about 975 men were employed. The value of the total gold production of the district, including Moore Creek, for the year 1912 was probably a little in excess of $3,500,000.

INNOKO DISTRICT.

AURIFEROUS GRAVELS.

Prior to the summer of 1912 the only workable placer-gold deposits known to exist in the Innoko district were those on Ophir, Spruce, Little, Ganes, and Yankee creeks. These streams are practically parallel and are tributary to Innoko River from the southwest—except Little Creek, which is tributary to Ganes near its mouth—in the order given, progressing upstream. The placers on all are within a few miles of the Innoko. Gold prospects are said to occur on several other streams in the same neighborhood.

During the early spring of 1912 alluvial gold was discovered on several small streams that run out of the Cripple Creek Mountains. The chief placers at this locality that have been tested are on Cripple Creek at the mouth of Fox Gulch and on Colorado Creek. The existence of a large extent of placer ground at this locality has not yet been demonstrated.

All placers of the Innoko district are of medium or shallow depth. The bedrock throughout the placer areas consists of members of the Cretaceous sedimentary series and of igneous intrusives. The latter are mainly acidic dikes and sills. Large igneous masses occur in the Cripple Creek Mountains that are more basic than the widely distributed dikes.

PLACER MINES.

Ophir Creek.—The mines of Ophir Creek have been among the chief producers of the Innoko district, but the available placer ground is now nearly exhausted.

Auriferous gravels formerly extended almost continuously along Ophir Creek valley for about 2 miles. They ranged up to 70 feet in width. The alluvium is 30 feet deep at the lower end of the valley. Its depth gradually becomes less upstream, and in the upper mines it is less than 20 feet.

Bench gravels have been exploited at a single point at claim No. 6 above Discovery. The bedrock floor of the bench is 7 feet above the flood-plain level and is overlain by a 10-foot thickness of gravels.

The alluvium of Ophir Creek is largely composed of slightly worn materials of the local bedrock. Well-worn gravels are rare. Silt and muck are also included in the upper part of the deposits. Practically all the alluvium is permanently frozen.

Spruce Creek.—The developed placers on Spruce Creek are on a low bench on the east side of the valley about 3 miles above the mouth of the stream. (See fig. 1, p. 14.) Two claims have proved rich enough to support mining by economical open-cut methods. A ditch delivers water from a point farther upstream, at the upper margin of the bench deposits. The overburden is groundsluiced off and the gold-bearing material is then shoveled by hand into lines of sluice boxes.

The gold occurs in the shattered surface of bedrock and in an overlying stratum of gravels 2 to 6 feet thick. The gravels are overlain by 10 to 15 feet of very wet frozen muck or silt. The width across valley of the deposit available for mining differs from place to place, but is at some places more than 100 feet. The gold tenor of different parts of the deposit depends largely upon the roughness of the bedrock surface beneath, and is extremely variable from place to place. Little is known of the gold tenor of the gravels farther downstream, where the bench continues for the length of several claims.

Little Creek.—Auriferous deposits occur for about 2 miles along the valley of Little Creek. They have proved to be rich enough to support mining through much of this extent. They are in part the gravels of the present flood plain and in part bench deposits. The flood-plain deposits are relatively narrow and those of the benches relatively broad.

The lower creek claims and the bench claims contain shallow placers worked by open-cut methods. The stream gravels are 18 to 30 feet deep farther upstream, where underground methods of mining are employed.

The alluvium in the lower creek placers is made up almost entirely of gravels. It includes a few large bowlders, but they offer no special hindrance to mining by the methods in use. There is usually a slight overburden of muck. The greater depth of the creek placers farther upstream is due chiefly to the greater thickness of muck above the gravels.

The benches are best developed along the middle reaches of the stream's course, and where widest they extend 500 feet from the creek. About 300 feet of this width is said to carry values sufficient for profitable mining. The gold occurs throughout a considerable thickness of gravel that is overlain by a thin deposit of muck. In mining a method is employed that is similar to that used on Spruce Creek; that is, the overburden is removed and the gravels are concentrated as much as possible by groundsluicing, after which the gold-bearing materials are shoveled by hand into lines of sluice boxes.

Ganes Creek.—Ganes Creek has a pronounced development of gravel-covered benches along the right side of the valley and below the canyon a rather broad gravel-covered flood plain. Gold occurs in the gravels of both types of deposits, but thus far only the bench gravels have proved available for mining. It seems likely that the flood-plain gravels may contain fairly high values in places, but the work of prospecting them is difficult because they are thawed.

The original concentration of gold in the Ganes Creek valley occurred in preglacial time, when the stream was much shorter and had less volume. Apparently a continuous pay streak was formed at that time extending for miles along the stream. When the stream cut down to its present level, part of the old pay streak was carried down and reconcentrated in the present stream gravels and should be found in the reaches between the gold-bearing benches. Parts of the original concentration remain in the bench gravels. Where lateral streams cross the course of the old pay streak they have concentrated its values from the width of the tops of their recently cut valleys to the narrow gravel deposits in their bottoms. This form of reconcentration has probably produced some of the richest spots of the Ganes Creek valley.

The Ganes Creek placers have been worked almost entirely by open-cut methods. Water for sluicing is taken from the small tributaries of Ganes Creek, and in many places work has progressed slowly on account of the small supply. The bench gravels have now been nearly worked out, and the future of Ganes Creek as a producer will depend largely upon the gold tenor of the flood-plain gravels. If systematic prospecting should prove their worth, these gravels would be admirably adapted for dredging.

Yankee Creek.—The Yankee Creek placers are between 6 and 7 miles above the mouth of the stream and are all included apparently in two association groups of claims each comprising 160 acres. Yankee Creek has an exceptionally broad flat valley, and the auriferous deposits have a correspondingly wide cross-valley extent. The alluvium consists of a stratum of gravel 5 to 7 feet thick, which is overlain by a thin bed of muck. The ground is mostly thawed in summer and is worked exclusively by open-cut methods.

Cripple Creek Mountain locality.—The work that has been done in the vicinity of the Cripple Creek Mountains on Cripple Creek, Fox Gulch, Colorado, and Butte creeks has been all prospecting. Workable deposits of placer gold apparently exist on some of these streams, but the existence of large placers has not yet been demonstrated. The gravels on the streams range in depth from 10 to 20 feet. Values vary and probably range in places up to $2 a square foot of bedrock surface. The future of placer-mine development in this locality will depend upon the extent of such deposits, which will be known only when much additional work has been done.

GOLD LODES.

A single gold lode has been developed in a small way (pp. 28–29) in the Innoko district at the Independence mine, near the head of Carter Creek, an eastern tributary of Ganes Creek. The lode consists of a quartz vein averaging about 2 feet in thickness, that occurs along the hanging wall of an altered rhyolite dike intrusive in the Cretaceous sedimentary rocks.

SOURCE OF THE GOLD.

The introduction of gold into the Innoko district is closely related to the post-Cretaceous intrusive rocks. The later stages of this period of volcanism were apparently accompanied by the invasion of the rocks, especially of the intrusives themselves, by mineralizing solutions from which the auriferous quartz veins were derived. The dependence of rich placer accumulations upon mineralized dikes carrying auriferous quartz veins is very evident in places, especially on Little Creek, where the broad bench placers occur. In other places the gold may be derived from quartz veins that cut the sedimentary rocks. Heavily mineralized veins occur in the vicinity of the Cripple Creek Mountains and they are the probable source of the placer gold of that locality.

HISTORY OF DEVELOPMENT.

Gold was first discovered in the Innoko district in 1906. As report of the discovery spread, prospectors flocked to the region from other quarters. At first attention was given to Ganes Creek alone, but the available ground was all soon located.

During the summer of 1907 many people flocked to the district. Attention was turned to the other streams, and a great deal of ground that has since proved valuable was located on them. Active mining began on Ganes Creek, and workable placers were first discovered on Little Creek.

During the summer of 1908 valuable placer ground was located on Ophir Creek, and mining was begun on this stream and also on Little Creek. In the summer of 1909 discoveries were made and mining was begun on Spruce and Yankee creeks.

The total production of gold dust in the district during and prior to 1910 was valued at about $750,000. The annual production since 1910 has been about $250,000. The total gold and silver production of the district to the end of 1912 is as follows: Gold, 60,270 fine ounces; silver, 10,635 fine ounces; total value, about $1,250,000.

MINING IN 1912.

GOLD PLACERS.

No new creeks were added to the list of producers in 1912. Operations were continued on Ophir, Spruce, Little, Ganes, and Yankee creeks, but the ratios of their production differ considerably from those of previous years. Ophir Creek fell off in production, owing to the fact that most of the available ground is exhausted. Little Creek largely increased its output, owing mainly to the discovery of rich bench ground admirably situated for rapid mining. The other streams continued about as before.

Ophir Creek.—Five claims were worked on Ophir Creek by the same number of plants, all equipped with steam machinery. A total of 25 men worked on this creek most of the summer.

Spruce Creek.—Two bench claims were worked on Spruce Creek by open-cut methods. A ditch from the upper course of the creek delivers an excellent supply of water to the claims for groundsluicing. By this method the overburden of muck and lighter gravels is removed. The remaining gravels are then shoveled by hand into the sluice boxes. Thirteen men in all were employed.

Little Creek.—Both the stream gravels and the bench deposits were worked on Little Creek. Operations were in progress on five claims and a total of 26 men were employed. Especially fine progress was made on the bench claims and the lower creek claims where open-cut methods are in use.

Ganes Creek.—On Ganes Creek only the bench claims and the reconcentrations in the valleys of side streams near their mouths were worked. A large percentage of the available ground of this character was exhausted during the summer. Ten claims were worked in all by a total force of about 50 men.

Yankee Creek.—Two groups of claims were worked on Yankee Creek by two plants both using open-cut methods. About 25 men in all were employed.

Summary.—In all, 24 claims were worked in the Innoko district in 1912, located on five creeks, by a total force of about 140 men. Eighteen plants used open-cut methods, and six used steam machinery in hoisting from drifts. The total value of the placer gold production for the year was probably in excess of $250,000.

GOLD-LODE MINING.

A single gold-lode mine was operated near the head of Carter Creek, an eastern tributary of Ganes Creek. The works consisted of a 60-foot tunnel, a 60-foot winze driven at its end, and two drifts of about 50 feet and 30 feet, respectively, at two lower levels. The equipment included a 12-horsepower engine and boiler, and a Little Giant crusher and stamp mill. An average of five men were employed.

RUBY DISTRICT.

AURIFEROUS GRAVELS.

Auriferous gravels have been discovered thus far only in the alluvial deposits of the valley bottoms. The localities where gold is known to occur have been platted on the map (Pl. I) so far as data are available. The localities where the deposits have proved rich enough for mining are indicated by a special symbol. The auriferous gravels are widely distributed in the district, but those rich enough to support mining are limited to the valleys of Ruby Creek, Long Creek and its tributaries, Glen Gulch, and Trail Creek.

Ruby Creek.—The auriferous deposits of Ruby Creek are confined to a small area on a low bench on the right of the stream, near its mouth. The alluvium is 12 to 15 feet deep, and includes beds of large well-rounded bowlders, lenses of angular detritus, sands, and silts. The coarse materials of the deposit are composed of metamorphic and igneous rocks and vein quartz, all of which occur in the local bedrock. There are no unusual mining difficulties, and the scant production accredited to the creek is apparently due to the low gold tenor of the gravels.

Long Creek and tributaries.—The valleys of Long Creek and its tributaries contain remnants of older alluvial deposits that stand considerably above the present flood plains of the streams. The bedrock floors of the valleys are practically level in cross section, so that the depth to bedrock often increases away from the stream toward the valley wall. There is also a general increase in depth to bedrock downstream.

On upper Long Creek the auriferous deposits are from 100 to 500 feet from the stream and are at a depth of 30 to 40 feet below the surface. The gold lies close to bedrock, beneath 4 to 6 feet of gravel. The rest of the overburden is clay, in which there is much unworn brecciated vein quartz.

The valley of lower Long Creek has a more or less continuous pay streak extending at least 5 miles downstream from the mouth of Bear Pup. All the discoveries have been on the left side of the stream and most of them at a considerable distance from it. It is about 50 feet to bedrock at the upstream end of the pay streak, as represented in the Windy Bench claim. The depth increases to about 70 feet 5 miles below Discovery claim, although the surface of the alluvium at the latter locality is more nearly at the creek-bottom level than it is on Windy Bench. The slope of the bedrock surface downstream is much greater than that of the present stream, and it is probable that the depth to bedrock will increase at least 10 feet per mile below the last workings on Long Creek. In the upper claims the gold is pretty well concentrated on bedrock, but farther downstream the thickness of the auriferous stratum increases and in places 5 or 6 feet of gravel are hoisted and washed. The width of the deposit also increases downstream from 50 to more than 100 feet.

The extent and richness of the gravels of Long Creek are not fully known, but there is apparently considerable ground that will yield from \$1 to \$3 per square foot of bedrock, or from \$5 to \$15 a yard of mined material. The deposits are all frozen, so that timbering is rarely required in the workings. By economical methods of mining some ground that yields even less than \$1 per square foot of bedrock surface can be worked at a profit.

The stream gravels of Bear Pup are auriferous for at least 2 miles above its mouth. The valley is narrow as compared with that of Long Creek, and the pay streak follows closely the course of the present stream. The older filling of the valley has been largely removed, so that the gravels are now only 6 to 12 feet deep. The upstream claims have the shallower ground, which is mostly thawed. The width of the pay streak at some localities is as much as 15 feet and in some places the tenor of the gravels is probably quite as high as on Long Creek. Open-cut methods are practicable along the entire creek, so that gravels of very low tenor are available for mining.

The gold-bearing gravels of Midnight Creek resemble those of Long Creek in being at considerable depth. About 2 miles above its mouth the depth to bedrock is 18 to 22 feet. A mile below this locality the depth is about 60 feet, and farther downstream it is probably still greater. The richest part of the deposit is not on bedrock but lies between 6 and 8 feet above it. The stratum below that which carries most of the gold consists of large quartz, quartzite, and greenstone bowlders with the interstices filled with a stiff greenish clay. The gravels are gold bearing clear to bedrock, but so far as known only the stratum between 6 and 8 feet above bedrock carries sufficient gold for mining. This stratum probably represents a reconcentration of an older valley filling that was removed to within a few feet above bedrock, after which the stream again aggraded the valley to its present level. Workable deposits have been discovered on a single claim on Midnight Creek, but as only a small amount of prospecting has been done it seems likely that more extensive deposits may be found in its valley.

Glen Gulch.—The gravels of Glen Gulch are gold bearing practically throughout its entire length, a distance of about 2½ miles. Some of the deposits have proved rich enough to encourage mining by the comparatively expensive method of drifting and hoisting the gravels to the surface by hand and by steam machinery. However, a large part of the placer ground will be available only for the more economical open-cut methods. This is especially true of the upper part of the creek, where the gravels are only 10 to 15 feet deep. The stream gravels deepen downstream to about 25 feet. Several prospecting shafts have been sunk about 50 feet to bedrock on a bench on the left side of the creek near its mouth, apparently without satisfactory results. All the deposits except those very near the head of the stream are frozen.

If further prospecting should prove the existence of sufficiently large bodies of auriferous gravels to justify the project water could be brought from Flint Creek, probably under sufficient head for hydraulic mining.

Trail Creek.—Auriferous deposits rich enough to support mining have been discovered in the stream gravels of Trail Creek for a distance of about 2 miles along the valley. Prospects have been found farther down the valley for a distance of about 17 miles.

The valley filling is commonly a stratum of gravel on bedrock several feet thick and overlain by muck. The depth to bedrock on upper Trail Creek is about 40 feet. Seven miles down the valley it is 70 feet, and probably continues to increase farther downstream. All the deposits are well frozen and are adapted for drift mining. The gold occurs close to the bedrock, so that a minimum amount of hoisting is necessary in the recovery of the values.

Other creeks.—Auriferous gravels are said to occur on a number of streams other than those where mining has been done.

On Tip Creek, which heads between the Flint and the Trail in their lower courses, considerable prospecting has been done. The valley of Tip Creek is said to be broad and flat and to have a deep alluvial filling. Prospects found in a few holes near its head are rich enough to stimulate further work.

Quartz Creek is the next large tributary of Solatna River above Trail Creek. Prospecting has been done on the main stream and on several tributaries, and the outlook is said to be encouraging, by those interested. The ground is 50 to 180 feet deep and, except in the deepest places, is frozen.

Several of the southerly tributaries of Solatna River have received attention from prospectors, who report encouraging prospects at a number of localities. Rather deep but well-frozen ground seems to be the rule on these streams.

SOURCE OF THE GOLD.

The placer gold of the Ruby district has been derived largely if not entirely from quartz veins, which are widespread and in some places in the region abundant. Some quartz veins have been tested and have proved to be gold bearing. Gold nuggets containing quartz are often found. Nuggets composed partly of gold and partly of hematite are also found. Hematite vugs that may be auriferous are present in many quartz veins.

The quartz veins may not all be of the same age. However, most of them are unsheared, and possibly they are related genetically to the undeformed intrusive rocks that are presumably of post-Cretaceous age. None of the veins yet discovered have proved to be workable.

HISTORY OF DEVELOPMENT.

The first discovery of gold in the Ruby district was probably that made on Ruby Creek near the site of the present town in 1907. The value of the production from this locality is uncertain, estimates ranging from a few hundred to two thousand dollars. The deposit first discovered proved to be of no great value, and it was not until 1910, when the discoveries on Long Creek and its tributaries were made, that a widespread interest was aroused in the region and led to the development of the present mining district and the settlement of the town of Ruby. The discovery was made by Fernander and Johnson near the mouth of Bear Pup, a tributary of Long Creek, late in July, 1910. A large influx of people occurred during the following summer, and valuable deposits were located on several other creeks in the neighborhood. A substantial town was built in a single summer on the banks of the Yukon at the mouth of Ruby Creek and was called Ruby. Since then the population of the district has remained over a thousand.

The business of the town has assumed good proportions, stores and hotels have been built, sawmills installed, a telephone line put into service between the town and the creeks, and telegraphic connection has been made with the Government line on the opposite side of the river.

Active mining began during the winter of 1910–11, but the work was handicapped by the lack of suitable machinery. A great deal of machinery was delivered at Ruby during the summer of 1911 and was hauled to the creeks and installed during the following winter. The summer of 1912 therefore witnessed the first operations under fairly favorable circumstances.

MINING IN 1912.

In the Ruby district mining was in progress in 1912 on six creeks, all located in a small area about 25 miles south of Ruby. Four of these creeks belong to the Long Creek system; namely, Long Creek, Upper Long Creek, Bear Pup, and Midnight Creek. The other two creeks are Glen Gulch, a tributary of Flint Creek heading against Bear Pup, and Trail Creek, which is the next creek east of Flint.

Long Creek.—On Long Creek below the mouth of Bear Pup nine claims were worked by as many plants using steam thawing and hoisting gear. About 50 men were employed most of the summer. Early in the summer several of the plants were prospecting rather than mining. Later reports indicate that considerable new ground yielding good values was opened and that the whole summer witnessed a general improvement in results along the creek.

On Long Creek above the mouth of Bear Pup three outfits, employing about 10 men in all, worked claims Nos. 2, 3, and 4 above Discovery. These outfits used small prospecting boilers for thawing, running three or four points each. Hoisting was by hand windlass. Water for sluicing was obtained from Long Creek and was carried to the claims by a ditch over 2 miles in length.

Bear Pup.—On Bear Pup five claims were worked by about 30 men. One plant used steam hoisting gear to raise the gravel to the sluice boxes after the overburden had been groundsluiced off The other four outfits also used open-cut methods, groundsluicing the overburden and shoveling into the boxes. A large area on No. 1 Bear Pup was being stripped of vegetation preparatory to groundsluicing. Considerable harm was done some of the workings by midsummer floods, but on the whole the Bear Pup operations were successful.

Midnight Creek.—Only a single claim was worked on Midnight Creek, by two men using a small prospecting boiler for thawing and a windlass for hoisting. An excellent ditch from the same stream furnished abundant water for sluicing, and, considering the equipment, fine progress was made, apparently with good results.

Glen Gulch.—On Glen Gulch six claims in all were worked. A steam hoisting plant worked on the lower part of the creek. Upstream were four small outfits, using the usual prospecting type of boiler for thawing and the hand windlass. Near the head of the stream a claim was being worked by open-cut methods without machinery. Not all of these plants worked continuously throughout the summer. About 25 men in all were employed.

Trail Creek.—On Trail Creek seven claims were worked by three steam hoisting plants and four hand outfits with small thawing boilers. About 30 men were employed. Good progress was made by most of these outfits throughout the summer.

Summary.—In all, 31 claims, employing a total of 150 men, were worked in the Ruby district in 1912. Fourteen steam hoisting plants operated; on 12 claims hoisting was done by hand; and five claims were worked by open-cut methods by hand.

Exact data regarding the gold and silver output of the district are not available, but in total it probably exceeded $150,000 in value. About 7,250 fine ounces of gold and 550 of silver were produced.

MINING IN 1913.

The Ruby district was revisited by the writer late in the summer of 1913, when the following notes on more recent progress were made.

The mining industry on the whole showed considerable advance in 1913 over the condition of the preceding year. The six streams that produced in 1912 were worked again in 1913, most of them on a largely increased scale of operation. The changes were brought about mainly by the installation of heavy steam machinery in place of the light hoists and hand windlasses used before. New placers, some of them very promising, were discovered on eight new creeks. Prospecting is being done on still other creeks, and the results obtained in places suggest the likelihood of a further increase in the number of producing creeks.

All told, 41 plants, operating 38 claims on fourteen different creeks and employing a total of about 230 men, were engaged in actual mining in the Ruby district in the summer of 1913. Of these 41 plants, 33 were equipped with steam machinery that aggregated over 750 horsepower. The other eight plants used manual methods.

During the winter of 1912–13 twelve plants were operated on as many claims situated on three creeks. About 40 men were engaged on this work.

The winter production of the district was $102,200. Data regarding the summer's production are still incomplete, but it is estimated at $750,000.

O