GOLD PLACER MINING DEVELOPMENTS IN THE INNOKO-IDITAROD REGION.

By A. G. MADDREN.

INTRODUCTION.

Although several of the pioneer American prospectors of interior Alaska are known to have entered and passed through parts of the Kuskokwim Valley as early as 1889, and others are said to have visited the Innoko Valley as early as 1898, placer gold in paying quantities was not discovered in this part of Alaska until 1906. In the summer of that year gold was found on Ganes Creek, one of the principal headwaters of Innoko River, and since then a placer camp, with an average population of 150 working miners, has been maintained in the upper part of the Innoko Valley. (See map, Pl. XI.) A settlement named Ophir, situated on the main river at the mouth of Ophir Creek, has been the center of this community since the spring of 1908. The Innoko district, in spite of many discouraging circumstances, due chiefly to its isolation and difficulty of access, has established itself as a worthy producer, and from 1908 to 1910, inclusive, its placer-gold output has totaled about $750,000. This has served to stimulate interest in the gold-bearing possibilities of the streams which drain either side of the Kuskokwim Mountains and flow into Yukon and Kuskokwim rivers. Up to the present time, however, the Innoko district has suffered from a chronic scarcity of both provisions and mining equipment, and in consequence of the high costs that have prevailed very few persons have felt justified in expending much time or money in prospecting the outlying parts of the district. The result is that after three years very little is yet known about the gold-bearing possibilities of a wide extent of country that is drained by the northeastern headwaters of the Innoko and the tributaries of Nowitna and Kuskokwim rivers adjacent thereto. Prospects of placer gold are reported to occur upon the headwaters of the Nowitna, a tributary to the Yukon that lies northeastward from the northeastern headwaters of the Innoko, and upon the Tuentna or Nixon Fork, the large northeastern branch of the Takotna, situated east of the upper Innoko, but no productive

MAP OF SOUTHWESTERN ALASKA, SHOWING LOCATION OF INNOKO AND IDITAROD PLACER DISTRICTS

Scale 2,500,000
50 0 50 100 Miles

1911

mining has been developed within these basins to date—in fact, no genuine prospecting has been done within them, although considerable wholesale locating of ground, especially in the Tuentna Valley, has been done by a few speculative individuals using powers of attorney in the unrestricted manner now practiced in Alaska.

Prospects of gold also occur on small streams that drain the northeast end of the Kaiyuh Mountains, which bound the west side of the Nowitna Valley. Several thousand dollars' worth of gold has been mined from a short gulch stream named Reeley Creek, tributary to the Yukon, opposite the mouth of Melozitna River.

Southwestward from the Innoko district more has been accomplished than toward the north and east. Some prospecting has been carried on at intervals since 1907 on eastern tributaries of Tolstoi Creek, a large branch of Dishna River, and it is said that fine colors of gold are so widely distributed within the deposits of the valleys of Madison and Mastodon creeks that prospects may be obtained at a number of places. So far, however, no concentrations of gold of sufficient worth to pay to mine have been found on any of the tributaries of Tolstoi Creek.

Since 1908 a little prospecting and a great deal of locating have been done along both the northwest and southeast flanks of the Kuskokwim Mountains where they separate the headwaters of the Dishna and Iditarod, tributaries of the Innoko, from those of Takotna, Black, and George rivers, tributaries of the Kuskokwim. (See map, Pl. XI.) During the winter of 1909–10 colors of gold were found on Deadwood Creek, a headwater of the southwest fork of the Dishna, and some open-cut pick and shovel work was done there in the spring of 1910 by several men but was soon discontinued because it did not prove profitable under present conditions. Extensive locations for placer mining have been made in this vicinity on Deadwood, St. Patrick, and other creeks tributary to the southwest fork of the Dishna and also across the divide at their heads to the south on July, Willow, and Moore creeks, which are headwaters of Takotna River, a tributary of the Kuskokwim. Very little work has been done on these locations—in fact, on most of them none at all. Moore Creek is the only one upon which gold in paying quantities has been found to date, but no production to speak of had been made there up to 1910. This general locality, however, appears to be worthy of careful prospecting.

In the later part of the summer of 1908 two prospectors, W. A. Dikeman and John Beaton, who had been to the Innoko district earlier in that year but were not encouraged by the outlook there, descended the Innoko in a small steamboat. Upon reaching the large southwestern branch of the Innoko, now named the Iditarod, these two men decided to explore that stream and prospect on its

headwaters. They ascended the Iditarod as far as the low stage of water of that season would permit their boat to go and there prepared for winter by building a log house which has since been called "Discoverers' Cabin." This house is situated on the main river about 8 or 9 miles below the present town of Iditarod, or some 25 miles below the mouth of Otter Creek. During the early winter they sledded a prospecting outfit southward from their winter quarters across several low ranges of hills to Otter Creek and decided to look for gold in the valley of that stream at a point about 12 miles above its mouth. Their choice of a location to prospect, decided upon at haphazard, as it was in midwinter, proved most fortunate, for they were rewarded by finding gold at a depth of only about 12 feet in the first holes they dug to bedrock, the discovery being made on Christmas day, 1908. The discoverers then located a moderate number of claims for about a mile along Otter Creek for themselves and a few friends.

Owing to the distance of Otter Creek from settlements or routes of travel and to the fact that the discoverers were practically alone, information about the newly found prospects of gold did not spread rapidly. It was not until the summer of 1909 that other prospectors gathered there from the Innoko and Yukon districts. The result of their arrival was the locating of claims that covered practically all the valley lands of Otter Creek, its tributaries, and the adjacent streams. Almost no mining was done during the summer of 1909 because of the lack of equipment and supplies. During the later part of this summer most of the several hundred people on the Iditarod were chiefly concerned with getting enough supplies at hand to enable them to remain through the coming winter. Considerable amounts of supplies that were shipped to the new district did not arrive because Iditarod River was at a low stage during the open season of 1909 and navigation was closed by ice earlier than usual that autumn.

In spite of these handicaps some systematic prospecting of the claims on Otter Creek was undertaken during the winter of 1909–10 and some gold was mined from small underground drifts. The reports about this work were either sent out in such optimistic form or became so magnified in transmission that a great deal of interest was aroused about the new district, with the result that when navigation opened on the Yukon in May, 1910, a couple of thousand people and a considerable amount of supplies and machinery were bound for the Iditarod. Until the middle of July the traffic to the new camp taxed the capacity of the available steamboat transportation on the Yukon and for a time the movement threatened to reach the proportions of a so-called stampede. The total gold production of the Innoko and Iditarod districts in 1910 is estimated to have a value of $825,000.

GEOGRAPHY.

When gold was discovered on Otter Creek in 1908 all of the Innoko basin constituted a subdivision known as the Innoko precinct and was included in the second judicial division of Alaska, whose court offices are at Nome. This precinct, with its recording office at Ophir, was bounded and described as follows:

> Beginning at a point on the eastern bank of the Yukon River, about 50 miles above the village of Anvik and opposite the divide between the Innoko and Yukon rivers; thence following the divide northeasterly to the divide between the Innoko and the Nowi rivers; thence in an easterly direction or southeasterly direction following the divide between the Innoko and the Nowi rivers to a point on the divide between the Innoko and Kuskokwim rivers; thence in a southwesterly direction following the divide between the Innoko and Kuskokwim rivers to the western bank of the Yukon River at a point south of Holy Cross, this last-mentioned line being identical with a part of the northern boundary line of the Kuskokwim precinct; thence northerly along the western bank of the Yukon to the place of beginning.

An act of Congress taking effect July 1, 1909, resubdivided Alaska into four judicial divisions instead of three and placed the original Innoko precinct in the fourth division under the court at Fairbanks. A new adjustment of several precincts was made necessary by this redivision and to facilitate recording matters the Innoko precinct as formerly defined was divided into two precincts, the recording office at Ophir being retained to accommodate the miners in the eastern headwater portion of the Innoko Valley, and a new precinct named Otter being formed to include the Iditarod placer-gold district or western part of the Innoko basin. The recording office for the Otter precinct is at the town of Iditarod.

The Iditarod gold-placer district is situated along the upper valley of Iditarod River, about 65 miles east of the settlement of Holy Cross or Koserefski, on the lower Yukon. (See map, Pl. XI.) Iditarod River is the largest branch of Innoko River, which is the largest eastern tributary of the lower Yukon. The Innoko joins the Yukon about 300 miles from Bering Sea. It flows into the Yukon through two or more divergent and crooked channels in which the currents are so sluggish that they are generally called sloughs. The channel most frequently used by the steamboats that ply the Innoko and Iditarod enters the Yukon a few miles below and opposite Holy Cross. This channel may be considered the mouth of the Innoko. The lower 150 miles of the Innoko is commonly but incorrectly called Shageluk Slough, owing to the fact that a side channel of the Yukon flows into the Innoko at that distance above its mouth. This channel, which is about 35 miles long and navigable for steamboats, leaves the main Yukon about 80 or 90 miles above Holy Cross. It delivers a considerable amount of Yukon water to the Innoko and is of considerable consequence in increasing the volume of the lower 150 miles of that river, but the Innoko proper furnishes by far the largest

amount, and although many persons consider the mouth of Innoko River to be at the confluence of Shageluk Slough with the Innoko and name the lower 150 miles of the Innoko channel Shageluk Slough also, this designation should be restricted to the side channel that carries Yukon water exclusively.

The main Innoko River is about 500 miles long and with its tributaries drains the largest part of an extensive area that lies between the central lower courses of Yukon and Kuskokwim rivers. Its principal or northeastern headwaters, upon which the Innoko placers are situated, lie between the Kaiyuh Mountains on the northwest and the Kuskokwim Mountains on the southeast, these ranges separating its upper valley from the drainage of Yukon and Kuskokwim rivers, respectively.

The southern portion of the Innoko basin is drained by Iditarod River and its tributaries. The chief or eastern headwaters of this stream rise along the divide of the Kuskokwim Mountains about 75 miles east of Holy Cross and drain an extensive area that lies along the northwestern slopes of these mountains. Iditarod River flows into Innoko River about 45 miles above Shageluk Slough, or 200 miles from Holy Cross by the regular steamboat route. In direct distance its source is not more than 100 miles south of its mouth, but the total length of the actual course of the Iditarod is probably 300 miles, as it has an extremely meandering channel, especially throughout its lower portion, for both the Innoko and Iditarod meander widely for many miles through sluggish channels across swampy plains that occupy the lower half of the Innoko Valley. During the spring freshets the whole lower valleys of these rivers are inundated, and after the floods have subsided large areas of swamps, shallow ponds, and lakes remain over its surface.

Iditarod River drains a considerable area on the southeastern side of lower Yukon Valley along its southeastern boundary, the Kuskokwim Mountains. The upper 100 miles of its course is along the northwestern foothills of these mountains and the river receives its chief headwater tributaries from them. Broadly considered the Iditarod district comprises an area of about 500 square miles that is drained by several of the larger eastern tributaries of this river. In upstream order these tributaries are named Caribou, Otter, and Bonanza creeks. Extensive locations for placer mining have been made throughout the valleys of these streams, but the area within which actual discoveries of placer gold have been made and mining operations undertaken is much smaller and may be included within a tract 10 miles square. Practically all the productive placer ground now known lies within the valley of Otter Creek and about the sources of several small streams just south of Flat Creek, which is the most important gold-bearing tributary of Otter Creek.

TRANSPORTATION, SETTLEMENTS, AND POPULATION.

The only practical way of transporting supplies to this district is by means of shallow-draft stern-wheel river steamboats plying Yukon, Innoko, and Iditarod rivers. During 1910 most of the freight was brought up the Yukon to Holy Cross on large steamboats and there transferred to smaller ones which ascended the Innoko and Iditarod to the supply points that have been established at several places along its course. Considerable freight, consisting largely of mining machinery, was also brought down the Yukon from Fairbanks and taken to the new district by way of Shageluk Slough and Innoko and Iditarod rivers.

During the stages of high water that prevail in these rivers in June and sometimes at other periods during the summer months steamboats of moderate size are able to ascend the Iditarod as far as the mouth of Otter Creek, a distance of about 216 miles above its mouth. During the average summer stages of water, however, the moderate-sized steamboats can not ascend the Iditarod so far, and the upper settlements can be reached only by much smaller steamboats and launches. This variable condition of the navigability of the river has determined the location of the supply settlements on the Iditarod.

At present there are three such settlements of importance on Iditarod River. These, in down-river order, are named Otter, at the mouth of the stream of that name, which is about 216 miles above the mouth of the river; Iditarod, situated about 16 miles by the course of the river below Otter; and Dikeman, which in air-line distance is only 29 miles but by the river 70 miles below Iditarod. Dikeman is about 130 miles up the Iditarod from its mouth, or 330 miles from Holy Cross by the steamboat route, and the town of Iditarod is about 400 miles from Holy Cross.

Dikeman is situated on the east bank of Iditarod River where it leaves the low foothills that border its upper course. The river from Dikeman to the Innoko flows sluggishly 130 miles by a very tortuous channel across the swampy plains of its lower valley. Its channel is deep enough at all stages of water for moderate-sized Yukon steamboats to ascend to Dikeman, and this point is considered the head of low-water navigation. Dikeman has been established as a storage and transfer point for freight and passengers to the placer district, and several of the larger commercial companies have built substantial warehouses and stores here for that purpose. Its population in 1910 numbered about 100 persons.

The town of Iditarod, with a population of 600 or 700 persons, has been, since its establishment in June, 1910, the commercial center of the district. It is situated on the east side of the river, 70 miles above Dikeman by the summer water route, or 31 miles by a winter sled trail recently laid out by the Alaska Road Commission. The

town site is on a rather unfavorable frozen boggy bank, whose only local advantage for the purpose of settlement seems to be that it stands high enough to be above the waters of spring freshets. A number of substantial warehouses and business buildings have been erected there, and all the activities of a boom town were much in evidence during the summer of 1910.

This town is 8 to 12 miles from the mines by an overland route that is too boggy in its present condition to be of much service for hauling supplies to the mining camps with horses and wagons. Although this method of transportation was carried on during the summer of 1910 it was accomplished with great difficulty and expense, and unless a good road is built this overland route can not compete with the water route by way of the river and Otter Creek.

The settlement of Otter, at the mouth of Otter Creek, is an important point for the distribution of supplies to the mines, as steamboats can reach this place at times of high water and from it freight can be transported up Otter Creek to the diggings by means of scows towed by horses. The distances from the mouth of Otter Creek to the mining settlements on that stream are from 16 to 20 miles by the water route or from 8 to 10 miles by land.

The most important mining settlement is named Flat. It is located on the east bank of Otter Creek about 16 miles above its confluence with the Iditarod just below the mouth of Flat Creek, which is the most important tributary of Otter Creek bearing placer gold. About 2 miles above Flat, on the west side of Otter Creek, is a place named Bowlder, and from 1 to 2 miles farther up Otter Creek, on the same side of the main stream, is a straggling settlement called Discovery because it is located at the mining claim so designated.

In 1910 the population of Otter numbered about 50, and Flat and Flat Creek probably had a population of 400. Bowlder, Discovery, and the near-by claims along Otter Creek had about 300 residents. During 1910 there was also a floating population of about 1,000 men in the district, who were temporarily camped at different places along the river and creeks. In August and September about 500 of these men were busy locating placer claims on tributaries of the Kuskokwim opposite those of the Iditarod to the south. It is estimated that on an average 2,500 people were in the Iditarod region during the summer of 1910.

Supplies are transported to the Innoko district by taking them up Innoko River on medium-sized Yukon steamboats as far as Dishkakat, which, like Dikeman, on the Iditarod, is considered the head of ordinary low-water navigation for such craft. At times of high water smaller steamboats may ascend the Innoko about 100 miles above Dishkakat to the vicinity of the North Fork, some 90 miles below

Ophir. From the North Fork the freight is carried to Ophir in lots of 4 to 6 tons on light-draft scows towed by horses.

A considerable amount of supplies for the Innoko placer district is now being brought up Kuskokwim and Takotna rivers to a settlement called Takotna Station, which is about 20 miles from Ophir by a winter sled trail that crosses a low divide between the Innoko and Takotna drainage. The Kuskokwim route appears to be the best way to supply the Innoko placer district.

GEOLOGIC SKETCH.

The Kuskokwim Mountains form a divide from 2,000 to 4,000 feet above sea level between the drainage of Innoko and Iditarod rivers and that of the central part of the Kuskokwim Valley. The hard-rock formations of the region are fairly well exposed along the crest of this range and the secondary ridges which separate the streams that flow therefrom. These mountains appear to be mostly made up of a widespread series of sedimentary formations largely of Mesozoic age, with which are intimately associated considerable amounts of volcanic rocks of various kinds, some of which, at least, are older than a large part of the sedimentary formations, because fragmental detrital materials derived from the volcanic rocks are commonly interbedded with the sediments as tuffs.

The sedimentary rocks of the Kuskokwim Mountains are a series of alternating beds of sandstones, carbonaceous and calcareous shales, shaly and siliceous limestones, granitic arkoses, volcanic tuffs, and conglomerates. The sandstones are generally rather thinly bedded and flaggy. The shales range from soft to fairly hard rocks and in the Innoko district appear to be partly altered to slates. Near their contacts with granitic intrusives they have been locally hardened into blocky quartzites and argillites.

The general structural trend of the sedimentary series is northeast and southwest, with southeasterly and northwesterly dips at angles varying from 20° to 80°.

The volcanic rocks of these mountains are more or less altered rocks of basaltic types. They all have a general greenish color such as naturally belongs to ancient and somewhat altered lavas that are considerably decomposed. Closely associated with these volcanic rocks in many places occur large amounts of more or less consolidated fragmental igneous material which appears to be directly derived from the volcanic rocks and so may be classed as tuff. These beds of tuffs in places appear to change laterally into shales and sandstones of undoubted sedimentary origin, or to be at least interbedded with such rocks. The definite relations of the sedimentary formations to one another and to the volcanic rocks have

not been determined, and so far as the evidence goes they may be provisionally considered as essentially contemporaneous in origin, their differences being accounted for by variations in local conditions. It may be noted, however, that the volcanic and intrusive igneous formations appear to be most extensively developed along the main divide of the Kuskokwim Mountains and that the sedimentary formations of these mountains become more free from mixture with either volcanic or intrusive rocks along both their outlying northwestern and southeastern flanks as they recede from the backbone of the range. These probable relations seem to indicate that the volcanic rocks and closely associated tuffs and sediments which lie along the center of the Kuskokwim Mountains may be older than the outlying sedimentary formations that make up the mountain flanks, and the presence of arkose sandstones, apparently derived from granitic rocks, in these flanking formations seems to indicate that the granitic masses distributed along the mountains, which may be the source of the arkose sandstones, are older than at least a part of the outlying formations. The few fragmentary fossil remains of land plants and marine-shell forms that have so far been found in these sediments point to an undoubted Mesozoic age for the series and a probable Cretaceous age for its younger members, of which the arkose sandstones appear to form a part. This meager evidence indicates that a large part of the granitic intrusive rocks are of early or pre-Cretaceous age; at any rate the older sedimentary and closely associated volcanic formations appear to have been the country rock which the intrusives penetrated.

Most of the highest areas throughout this general region are made up largely of mountainous masses of these intrusive granitic rocks. Dikelike bodies of these siliceous intrusives trend in different directions, but mostly northeastward and southwestward, across the intervening areas of sedimentary rocks in a manner that vaguely suggests that there may be a more or less connected network of intrusive dikelike bodies extending between the large intrusive centers. The dikes are ordinarily of siliceous varieties, such as biotite granites and hornblende diorites, sometimes porphyritic, although some are more basic, such as diabase porphyry and basalt. It is possible that these more basic dikes may belong to an earlier period of intrusion and be more closely connected with the volcanic flow rocks.

The sedimentary rocks are generally more or less metamorphosed near the intrusives, the degree of alteration becoming progressively less with distance from the contacts. The contact metamorphism that has occurred along these intrusives appears to have caused the conditions that have brought about, in places at least, the mineralization along the contact zones from which the placer gold has been derived.

The rocks of the Kuskokwim Mountains do not, in general, contain well-marked veins, but in the vicinity of some of the siliceous dikes the country rocks are altered, chiefly by silicification, at some places for only a few feet from the contact but at others for considerable distances, and there occur narrow vein deposits near the contacts of dikes with stratified rocks, and locally small gash veins within the dikes themselves. The material of these veins is generally quartz but in places calcite. The metallic minerals associated with these veinlets and zones of alteration are sulphides, of which iron pyrite, chalcopyrite, galena, and cinnabar are the most common kinds. Some of these minerals are presumed to be gold bearing because the placer gold is evidently derived from the decomposition and erosion of these mineralized contact zones.

OCCURRENCE AND DISTRIBUTION OF THE PLACER GOLD.

ORIGIN OF THE PLACERS.

The placer-gold deposits of the Iditarod district appear to be of distinctly local origin. As now developed, the commercially important stream concentrations of gold are small in extent and their distribution is evidently very closely dependent upon the apparent bedrock origin of the gold. The origin of the placer gold appears to be closely connected with the mineralization that has taken place locally along the contacts of siliceous intrusive rocks with the more basic igneous rocks and the sedimentary formations. For example, in the valley of Otter Creek the placer gold is found in very close association with bodies of granitic intrusive rock. Here two bodies of granite seem to be present, one lying across the valley of Otter Creek just below Granite Gulch and the other on the head of Flat Creek, a tributary on the south side of Otter Creek. These granitic masses have a width of at least half a mile and a length of 1 to 3 miles. Their longest dimensions have a northeasterly and southwesterly direction in conformity with the general structural trend of the sedimentary formations; they are in line with each other along this trend and may be connected, although this is not known to be the case.

In the Innoko district the direct local derivation of the placer gold from zones of contact mineralization is not so evident as it is in the Iditarod. There are no large intrusive bodies very near the Innoko placers, and the gold seems to be distributed farther from an apparent bedrock source. There are, however, some siliceous dikes cutting the country rocks within the valleys of the placer streams. Some of these dikes are known to be mineralized with pyrite, and it may be presumed there are more of them so mineralized. Vein quartz occurs along the walls of some of the dikes, and some of this quartz

is known to contain gold. Thus it appears that the placer gold is relatively local in origin and distribution.

INNOKO GOLD-PLACER DISTRICT.

An account of the Innoko district has already been published [1] in which a general description of this region has been given and its mining development up to 1908 outlined. Therefore only a brief review and summary of the progress of mining development up to 1910 is given here.

Practically all the mining in this district has been performed within the valleys of Ophir, Spruce, Little, Ganes, and Yankee creeks. The placer gold occurs in creek, bench, and gulch deposits. Various methods of mining have been practiced according to the position and character of the deposits; sinking and drifting, groundsluicing and open cut, scraping and hoisting by steam power, shoveling and hoisting by hand, and canvas-hose hydraulicking have all been used in different combinations upon the different creeks.

GANES CREEK.

Placer gold was first mined in the Innoko district on Ganes Creek in 1907, near the place where it was discovered the previous summer. It soon became apparent to those interested in claims on this stream that the gold-bearing deposits which could be mined most profitably were not those in the present stream bed, but older gravels which rest on bedrock benches that now stand from 30 to 60 feet above the level of Ganes Creek. These benches, which are remnants of an older valley floor, are situated for the most part on the east side of the creek about 7 miles above its mouth. They are from 100 to 500 or 600 feet wide and extend along the valley for several miles, with interruptions at intervals caused by gulches that have been cut down through them by nine short tributary streams. These bench gravels have been mined each summer since 1907 at the most favorable places by half a dozen or more parties, each composed of about three to six men. The mining operations have not been conducted upon an extensive scale because enough water can not be obtained from the short gulch streams that rise along the eastern side of the valley behind and above the benches for effective hydraulicking with a large plant, and because the capital with which to purchase and install the equipment of such a plant has been beyond the moderate resources of the men who are interested in the ground. The result is that all the mining has been conducted upon selected areas of small extent in as simple and inexpensive a manner as possible. A cover of muck and silt is sluiced off with streams of water led upon

[1] Bull. U. S. Geol. Survey No. 410, 1910.

the benches from small ditches that have been dug up the short gulch tributaries. The supply of water obtainable from these gulches varies much from year to year and even from week to week during the same summer; consequently the amount of mining that may be accomplished during a given season is always uncertain. On some of the bench claims enough water for the mines can be obtained only during the spring thaw and after uncertain rains. During dry summers all mining operations on the Ganes benches are greatly handicapped by scarcity of water.

After the overburden, which varies from 2 to 12 feet in thickness, has been removed the pay gravels, which are from 1 to 6 feet thick, are shoveled into lines of sluice boxes arranged to carry the tailings over the edge of the bench or dump them into gulches cut below the level of the bench—whichever is the more convenient. From 6 inches to 3 feet of splintered and flaky slatelike bedrock which contains gold is also shoveled into the sluice boxes. Considerable areas of these bench deposits that may be worked by these methods still remain, but a large part of the most favorable ground has been mined.

Several drift-mining operations of slight extent have been conducted along the base of the rock bluffs upon which the gold-bearing gravels rest, and from this source some gold has been obtained. There seems to be no doubt that the gold found in the lower-level gravels along the base of the bluffs that form the benches and in the present bed of Ganes Valley has been derived from the deposits on top of the benches.

The total gold production of the Ganes Creek placers up to the present time is estimated to be about $150,000.

LITTLE CREEK.

Little Creek lies northwest of and parallel to the lower part of Ganes Creek, which it joins about half a mile above the Innoko. It is approximately 7 miles long and is separated from Ganes Creek by a ridge about 2 miles wide and 600 feet high.

Gold was discovered on this stream during the summer of 1907 and mining has been conducted since 1908 on claims that occupy the middle 3 miles of its valley bottom. The unconsolidated deposits vary from 10 to 25 feet in depth. In some places they are frozen and in others thawed. They consist largely of mucks and silts, with a small quantity of gravel. In some localities gravel beds 2 to 4 feet thick rest on the bedrock beneath the silts, but in many places the silts lie directly on the bedrock and gravels are practically absent. The bedrock of Little Creek is a hardened shale or argillite that varies in texture from gritty to fine grained. In places it has slaty cleavage, but most of it is massive. Its upper 10 feet is generally very much shattered. It breaks into blocky slabs and shingle fragments and

also into roughly columnar 4-sided to 7-sided forms from 2 to 4 inches in diameter and from 10 to 18 inches in length. Many of these columnar pieces stand on end in the weathered bedrock, and where gold is present the best concentrations are generally found in this kind of bedrock, which acts as natural riffle blocks. From 2 to 10 feet of the upper part of the bedrock is generally thoroughly shattered in this blocky or slabby manner and the fragments are commonly separated, the spaces between them varying from one-tenth to 1 inch or more in width. These spaces are filled to a depth of 2 to 6 feet with sediment or silt, which appears to have filtered down from above. Most of the placer gold, which consists of flaky, fresh rough pieces of small size, occurs in these sediment-filled spaces in the bedrock, where it appears to have become concentrated along with the sediments that fill the interspaces. From 2 to 6 feet of the shattered bedrock is dug up in mining, and most of the gold output is obtained therefrom.

The Little Creek placers have been mined both by surface open-cut groundsluicing and underground sinking and drifting methods, the practice adopted depending upon the position, depth, and condition of the deposits. Along the valley bottom, where the deposits are deepest and contain more or less perpetual frost, considerable sinking and drifting work has been done; but this has proved profitable only where the gold happens to be concentrated in quantities above the average. Such concentrations appear to be distributed in disconnected strips and spots along the bedrock floor of the valley, but they are of uncertain extent and difficult to trace. As soon as drifts are extended beyond the limits of the richer concentrations or into thawed deposits, the underground work generally becomes unprofitable. Though it may be continued for some distance in the hope of finding other rich places, such work is more of the uncertain nature of prospecting than the mining of ground known to contain fairly uniform paying values, such as are essential to success, especially in a district like the Innoko, where all mining operations are expensive.

Underground mining would probably not be undertaken at all in the Innoko district if it were not for the lack of water in sufficient quantity for hydraulic mining and of sufficient grade to the valleys to afford dumping space for tailings. None of the workings on Little Creek is more than 30 feet deep, and if enough water could be readily obtained in this valley no doubt all its gold-bearing deposits might be cheaply mined by hydraulic methods if the tailings were elevated. But this stream is so small that the average supply of water is barely sufficient for ordinary sluicing operations, especially during summers of little rainfall. By taking advantage of the more abundant flow of water during the spring thaw and at uncertain times of heavy rainfall, surface open-cut mining has been carried on to a moderate extent at several places, both in the present creek channel and upon

either side of the stream. The deposits along either side of the present stream are termed "benches" by the miners; but they are not distinct terraces, such as occur along Ganes Creek, for on Little Creek there is no abrupt break in the vertical position of the gold-bearing deposits as there is on Ganes Creek. They rest on a fairly even bedrock surface that slopes up sufficiently from the lowest part of the valley to afford dumping space for the waste material it is necessary to remove in order to lay bare the gold-bearing bedrock that occurs on either side of the stream at some places. Practically all of the waste overburden consists of silts, clays, and vegetable muck, which varies from 3 to 10 feet in thickness. There is little or no gravel present and cobbles or bowlders are not plentiful.

The waste overburden is removed in the usual manner by ground-sluicing or washing it away with streams of water led upon it from small ditches that have been dug along the valley slopes above. After the bedrock in these open cuts has been laid bare, from 2 to 4 feet of the upper shattered part is loosened with picks and washed through lines of sluice boxes to recover the gold that is lodged in the sediment that fills its crevices.

An average of six to eight outfits have mined along Little Creek since 1908. The open-cut work can be done only during the season of flowing water and then only at the times of maximum flow, which are generally in the early part of the summer. The drift mining may be carried on more or less throughout the year.

Some of the open-cut mining has produced as much as $1 to the square foot of bedrock surface, but most of it yields less than this. In the underground drifts, as in the open cuts, about 4 feet of shattered bedrock is dug up and washed for gold, and good ground will yield $1.50 to the cubic yard, but the additional cost of steam thawing, of the labor to hoist the loaded buckets from the shaft by hand windlasses, and of the unproductive work performed in extending the drifts through ground that contains little or no gold reduces the profits of work of this kind. The total production of gold from Little Creek since 1908 probably amounts to about $150,000.

SPRUCE CREEK.

Spruce Creek is northwest of and parallel to Little Creek, being separated from it by a ridge about 2 miles wide and some 800 or 900 feet high. Its valley is about 6 miles long and is similar to that of Little Creek. The country rock within it is likewise the same hard blocky shale or argillite. The creek appears to carry a little more water than Little Creek but still not enough to permit very satisfactory hydraulic operations.

The alluvial lands along this valley have been located for placer mining since 1908, and although some prospecting has been done at several places along the stream from time to time nothing was

discovered that led to productive mining within its basin until the autumn of 1909, when good prospects were found on a low bench situated about 3 miles up the valley on its eastern side, about 200 yards from the present course of the stream. At this locality the creek now flows along the base of a steep bedrock slope that forms the western side of the valley, and the gold-bearing area extends eastward from it, the bedrock floor of the valley rising some 30 or 40 feet in this direction within a distance of about 500 feet. This sloping valley floor is covered by 5 to 15 feet of clay, silt, and muck, the greater part of which is frozen. The eastern rise of both the bedrock across the valley and the surface of its overburden make it practicable to groundsluice the waste mantle aside into the creek in the same manner as on Little Creek. As the supply of water obtainable from Spruce Creek is somewhat more abundant than that of Little Creek, the groundsluicing open-cut work may be carried on more continuously throughout the summer. The claims that are being mined receive water from above, brought by a ditch about 9,000 feet long that has been dug along the eastern side of the valley, so as to deliver water about 50 feet above the creek at its lower end, where it is led upon the sloping bench through canvas hose and the gold-bearing bedrock is cleared of its frozen mantle of clay and muck. The shattered bedrock, in which the gold occurs in the same manner as on Little Creek, is then loosened with picks and shoveled into lines of sluice boxes for washing.

About $20,000 worth of gold was mined from these so-called bench claims during the summer of 1910 by the open-cut groundsluicing method described above.

No productive drift mining has yet been done in this valley.

OPHIR CREEK.

Ophir Creek lies about 1½ miles northwest of and parallel to Spruce Creek. It is about the same length (6 or 7 miles) and size as Spruce Creek, and the ridge dividing them is about the same height as that between Spruce and Little creeks. In brief, all three of these valleys have very similar features of length, width, depth, direction, bedrock, and other general characteristics.

Ophir Creek differs from Spruce and Little creeks principally in that its placer gold is more abundantly and uniformly distributed along the bottom of its bedrock channel and that the valley is more evenly filled across and along its bottom with silts, clays, and muck, which for the most part are frozen and of uniform thickness. The valley filling averages 25 to 30 feet in depth. At some localities it is a few feet less than 25 feet and only in a few places more than 30 feet from the surface to bedrock. As a rule there is little gravel in the stream deposits, but occasionally some gravel is found on bedrock.

Most of the placer gold, as on Little and Spruce creeks, is lodged in the sediment that fills the numerous crevices in the shattered bedrock to a depth of 2 to 5 feet. The best concentration of gold, or the pay streak, varies from 20 to 70 feet in width across the rock floor, the wider distribution of gold appearing to be along the lower part of the valley. The pay streak is not always continuous or of uniform richness along the length of the valley. At some places the gold is concentrated more abundantly on one or the other side of the bedrock channel near what are called "rims," which are generally upraised portions of harder bedrock; at other places it is found somewhat restricted to small areas or patches of bedrock; but on some claims the gold is rather uniformly distributed in the shattered bedrock over considerable areas.

Although the placer-gold deposits in Ophir Valley are nowhere more than 35 feet below the surface and may be classed as comparatively shallow diggings, practically all the mining that has been performed along the creek has been done by sinking and drifting with the aid of steam thawing. Mining of this kind has been carried on continuously along Ophir Creek since 1908, in the spring of which year gold in paying quantities was first discovered in this valley. Most of the mining has been accomplished with very crude and inadequate equipment, various kinds of small boilers of the prospecting type being commonly used to generate the steam for thawing the frozen ground. Many of these boilers are of insufficient capacity for effective work. Most of the hoisting from the shafts has been done with homemade wooden hand windlasses operated by one or two men, but recently several operators have installed automatic-dumping steam-hoist equipment.

The largest part of the gold-bearing material is mined during the winter and accumulated on dump piles which are washed for their gold content at the time of the spring thaw, when water is more plentiful than at any other time of the year. The supply of water available for sluicing during ordinary summer seasons is never abundant and during dry periods is often entirely insufficient. At some places sluicing can be carried on during the summer season only after heavy rains and, as such times of increased water supply can not be predicted or depended upon, the amount of gold washing that may be accomplished during a summer is uncertain. Occasionally portions of a summer's output of gold-bearing material can not be washed until the spring after it is mined.

It is no doubt a fortunate circumstance that mining operations on Ophir Creek have not been handicapped by having the placer claims located in the objectionable form of large association groups, whereby the mining privileges to large tracts of land may be dominated by a few individuals, who generally have not the resources or initiative to mine the ground themselves and generally retard mining developments

by making unreasonable or even prohibitive demands of those who may wish to mine. All the properties on Ophir Creek are located in the form of single claims of about 20 acres or less, so the interests in mining ground are sufficiently divided to afford opportunities for independent mining to a number of individuals. There are two discovery claims on this creek, a lower and an upper. Eight claims are numbered in downstream order below Lower Discovery claim, and above this claim they are numbered upstream to "No. 12 above Lower Discovery." "No. 12 above" is the same as Upper Discovery, and upstream from this claim the numbers begin again with 1 and extend to the head of the valley.

Productive mining has been done along Ophir Creek since the summer of 1908, on nearly all the claims from "No. 4 below Lower Discovery" to "No. 4 above Upper Discovery," which cover 4 or 5 miles of the middle length of the creek. From 15 to 20 parties have been mining along the valley each year. These parties number from three to ten men each. The larger operators have frequently employed labor, but much of the mining has been done by three or four men working together on a partnership basis.

Ophir Creek has been the largest and steadiest producer in the Innoko district. The output of placer gold from it for the three years 1908 to 1910 totals about $350,000.

YANKEE CREEK.

Yankee Creek is a stream of considerable size and about 12 miles long that lies about 4 miles southeast of the lower course of Ganes Creek. Its valley trends in the same direction as that of Ganes Creek and the other three tributaries of the upper Innoko, upon which placer mining is being conducted. All five of these streams flow from the southwest toward the northeast. The general parallelism of these valleys and the ridges which divide them may be due to structural features of the sedimentary formations of the district, for these appear to extend in a general northeast-southwest direction throughout the region.

Although locations were made on Yankee Creek for placer mining in 1907, gold in paying quantities was not found in its valley until 1909. Most of the mining has been done upon parts of two large tracts located in the form of association-group claims, containing about 160 acres each, situated 6 or 7 miles above the mouth of the creek. The titles to some of this ground became a matter of litigation in court as soon as the land was learned to be of value, the questions involved being whether the first locators, who were not present when gold in paying quantities was found, had not forfeited their rights in the property by abandonment, whether they really knew there was gold on the claims when they located them, and whether they did any assessment work to show their intentions to mine the ground after they made their original

locations. The point worthy of notice is that the ground in dispute was located in the form of large association-group claims, so that the litigation involved a large area of land and thus retarded mining developments in a way that would not have occurred if the ground had been located in the form of single 20-acre claims by individuals.

The gold-bearing deposits that are being mined on Yankee Creek differ somewhat from those on Little, Spruce, and Ophir creeks in that they are more shallow, being only about 8 feet deep, and are composed largely of beds of coarse gravel from 5 to 7 feet thick, covered by only 1 to 3 feet of silt and muck. The valley bottom has a fairly broad, flat cross section and its sides have moderate slopes in most places, so the unconsolidated deposits have a uniform depth and considerable width. The stream has a good flow of water and more of a grade than the other placer creeks. The gravel deposits appear to be well drained and largely unfrozen, perhaps because the unconsolidated deposits are not deep, because there is a good circulation of water through the coarse porous gravel, and also because the silt and muck covering the gravels is comparatively thin.

The mining of these shallow placer deposits is summer open-cut work. After the deposits covering the surface are groundsluiced off for a width of about 100 feet the gravels are shoveled into wheelbarrows and then conveyed to a hoist bucket suspended from an overhead cable and elevated to a dump or rock box at the upper end of a line of sluice boxes erected on trestles. The coarser material is forked out of the rock box and the remainder washed through the riffle boxes. The general procedure is the same as that practiced on Flat Creek, in the Iditarod district (see pp. 255–258), but the operations have not been as extensive as those on Flat Creek, partly because some of the ground on Yankee Creek has been tied up by litigation, and also because there has not been an adequate supply of steam hoisting and scraping machinery available in the Innoko district. Only one steam hoisting plant was installed on Yankee Creek in 1910. The other operators were hoisting the gold-bearing gravel to the sluice boxes by hand windlasses.

Yankee Creek first became a producer in 1909, the output for that year amounting to about $15,000. During 1910 from $50,000 to $60,000 was mined. The total production for 1909–10 amounts to about $75,000.

IDITAROD GOLD-PLACER DISTRICT.

OTTER CREEK.

Otter Creek is in reality a small river whose valley has a length of about 30 miles and a width between the crests of its bounding divides of 6 to 8 miles. For the greater part of its length Otter Creek flows near the right-hand side of its valley bottom along the foot of abrupt

slopes that rise directly from the stream channel to heights of 500 to 1,500 feet within distances of 1 to 2 miles. At the scene of mining on Otter Creek the floor of the valley is about one-fourth mile wide and the placer claims practically all lie on the left side of the stream. Beyond these claims the left slopes of the valley rise gradually to the divide, 4 or 5 miles distant. The volume of water in Otter Creek is large enough to afford transportation for supplies by means of horse scows and poling boats from Iditarod River to the mines, but the grade of the valley is not sufficient to make this water available for hydraulicking the placer deposits.

The productive gold-placer ground lying along Otter Creek is of comparatively local extent when the length and size of the valley are considered. The present mining operations on this creek are confined to a limited tract of land about 2 miles long and one-fourth mile wide situated in the valley bottom about 12 miles above its mouth. Beginning at the upper limit of known productive ground, the mining claims included within this tract in downstream order are as follows:

The Gum Boot group, which consists of about 60 acres that extends across Otter Creek at the mouth of a right-hand tributary named Granite Creek, lies between claims located on the lower part of Granite Creek and the Otter Association group. The latter group, which is 1 mile long and one-fourth mile wide, extends along the center of Otter Valley Flat, with the mouth of Granite Creek about opposite the middle of its length. These two association groups have been prospected and the conclusion reached that gold in paying quantities does not occur in them above Granite Gulch.

Below Otter Association group there is a row of six single placer claims designated Nos. 2 and 1 above Discovery, Discovery claim, and Nos. 1, 2, and 3 below Discovery. Along the left side of these six claims is another line of similar claims with corresponding numbers and the additional designation "first tier of left-limit bench claims." There is also part of a second tier of left-limit bench claims and several small fractional claims. Altogether these claims cover the width of the valley flat for about 1½ miles along its length. Below No. 3 below Discovery there is a group of claims named the K. P. M. Association.

It is reported that prospects of gold are found as far down Otter Creek as the K. P. M. Association, but it is generally conceded by those who have prospected along Otter Valley that gold in productive quantities, in the sense that is now accepted in the district, does not occur below the vicinity of claim No. 2 below Discovery. Thus the general extent of the productive area on Otter Creek, as now defined, is that part of its valley floor that extends downstream from the mouth of Granite Creek for about 1½ miles. Throughout this area the country rock upon which the gold-bearing deposits rest is com-

posed largely of granitic rocks, the upper parts of which are considerably decomposed and overlain by a layer of residual sands derived from the granites. These sands grade into the solid country rock in many places and as a whole do not appear to be very much washed or sorted by running water. Mixed with them are some gravels and a considerable number of residual granite blocks, bowlders, and cobbles, which are evidently harder portions of the granite that have resisted decay and have not been moved any great distance from their original bedrock source. These deposits hold the placer gold, which also has the same residual character as the material in which it rests in that it consists mostly of sharp, rough, flaky pieces, rather than of smooth waterworn nuggets. Most of the gold occurs in the sands and decayed bedrock. Much of it has sifted down into crevices in the bedrock, where it is present in thin seams of fine sediment that fill these cracks to a depth of 3 to 6 feet. The gold also has a tendency to concentrate more abundantly upon layers of clayey sediment interbedded with the sands and gravels.

The gold-bearing placer beds vary in thickness from 1 to 6 feet. In mining them from 2 to 6 feet of the bedrock upon which the unconsolidated deposits rest is also taken up to recover the gold in its crevices. Covering these deposits is an overburden of sediment and vegetable muck from 4 to 12 feet thick. Altogether the unconsolidated materials of the placer area on Otter Creek have a total thickness of 10 to 20 feet and the placers are classed as shallow. They are in general frozen, but where mining is being done it has been found that the deposits are not frozen throughout and that considerable areas are thawed and wet. This may be caused by the presence in the valley of large quantities of flowing water. Where the gravels are thawed underground water is abundant, but as all the productive mining is done by open-cut methods the presence of flowing water and thawed ground does not hinder working them as it does in deep or underground mining.

FLAT CREEK.

Flat Creek is a southern tributary to Otter Creek, which it joins about 2½ miles below Discovery. It has its source on a wide-topped mountain mass at an elevation of about 1,600 feet above sea level and flows about true north for 5 miles. The elevation of Otter Creek at the mouth of Flat Creek is about 300 feet above sea level, but although there is a difference of about 1,300 feet between the mouth and source of Flat Creek about 1,000 feet of this difference occurs within 1 mile of its head, and the lower 4 miles of its valley has a comparatively low, even grade of about 100 feet to the mile. It is this characteristic of the valley that has suggested the name Flat. This name is also applied to the most important mining settlement

in the district, which is located on the south bank of Otter at the mouth of Flat Creek.

The head of Flat Creek valley is a semicircular, steep-sided basin whose catchment area is large in proportion to the size of the valley as a whole, and for this reason Flat Creek has a larger volume of water than is usual for so short a stream.

The body of intrusive granite previously mentioned (p. 245) as extending across the head of Flat Creek occupies practically all of the steep headwater slopes of this valley, or the upper mile of its length, but throughout the rest of the valley, or its lower 4 miles, the softer sedimentary formations of the region occur. Along the zone of contact of the granitic and sedimentary rocks considerable alteration has taken place, and mineralization appears to have occurred in both along a belt of considerable width. Quartz stringers from 6 to 12 inches thick occur in the granites, and the sandstones and shales have been hardened to quartzites and argillites or blocky slates. The hardening of the sedimentary rocks extends as far as a mile from the granite but gradually becomes less with increasing distance from the contact. This contact crosses the upper part of the valley in a diagonal northeast-southwest direction along the lower slopes of its headwater basin, then passes up through a saddle on the divide to the southwest and continues across Happy Gulch, a headwater of Willow Creek, a short tributary of Iditarod River west of Flat Creek. The southwestern end of the Flat Creek granite mass is a short distance southwest of Happy Gulch. Placer gold is found on Happy Gulch and Willow Creek.

The richest gold-placer deposits so far found in the Iditarod district occur on Flat Creek from 3 to 4 miles above its mouth. The bedrock origin of this gold is apparently the zone of alteration and mineralization along the contact of the granites with the sedimentary formations that cross the upper part of the valley. The placer mining claims that include the productive ground are of such irregular sizes and shapes that a general written description, unaccompanied by a detailed plat, can not give an intelligible idea of their location or extent with reference to one another, so individual properties will not be mentioned in this account. The side and headwater slopes of the valley are also covered by claims of various extent and area. About the head of the valley most of the claims are in the form of association groups that contain the equivalents of two to eight single 20-acre placer claims.

In general the prospected ground covers all of the valley floor of Flat Creek from mouth to source, but at present the most active mining development is on the upper part of Flat Creek, from 3 to 4 miles above its mouth. The gold-bearing deposits on this part of the creek are from 10 to 25 feet deep. They are composed largely

of gravels, sands, silts, and a considerable number of bowlders, mostly derived from the decomposition and erosion of the granite country rock that forms practically all the headwater slopes of the valley throughout the upper mile of its length. This granite is deeply decayed and its surface is thickly covered with large blocks and bowlders of the same rock, which are mostly residual accumulations of its more resistant portions. Some of these bowlders and slabs are fully 20 feet and a large number are more than 3 feet in their greater dimensions. To travel over these slopes often necessitates stepping from one bowlder to another, as there are many open spaces between them, although for the most part they lie as a closely packed mantle of débris from 5 to 20 feet thick with smaller fragments and cobbles wedged between them, and the slopes are partly covered by sandy soil and turf, on which grow some good spruce timber and dense thickets of alder and willow brush. A large part of the precipitation that falls about the head of the valley sinks beneath this mantle of loose rock and flows down by many underground channels between and under the bowlders, to reappear near the foot of the slopes and form Flat Creek.

Placer gold has been found in paying quantities along the lower slopes of the granite area, where the bedrock is decayed granite and the wash is of granite bowlders, cobbles, and gravels. This gold is, with little doubt, derived from the mineralized quartz veinlets that occur in the granite and where now found is concentrated from the residual granite sands by the numerous small streams that flow down the slopes. The gold is in rough, flaky pieces, some of them attached to angular fragments of quartz that appear as if they may be freshly separated from vein matter.

The richest concentrations of placer gold, however, are downstream from the granite contact, where they rest upon and within the hard, blocky fractured sedimentary bedrock as successive outwash accumulations derived from the numerous small streams of the granite headwater slopes. The sands, gravels, bowlders, and gold have been fed into the upper part of Flat Valley by these small streams and spread out below along its course by the larger combined flow of water. The unconsolidated deposits along the lower 4 miles of Flat Creek become progressively finer in texture downstream. Along the upper part of the valley bottom bowlders, coarse gravels, and sands occur in larger proportion than fine sediments, while in the lower parts of the valley the finer sands, silts, clay, and vegetable muck become greater in amount.

The distribution of the placer gold in the unconsolidated deposits along Flat Creek has apparently occurred in the same order as the deposition of the coarser and finer sediments. The gold appears to be

most abundantly concentrated along the upper part of the valley and to become less in quantity and finer in size downstream from its source, the richest placers being located from 3 to 4 miles above the mouth of the creek. This is apparently due to the probable bedrock origin of the gold at or near the contact of the intrusive mass with the sedimentary rocks that cross the head of the valley and also to the fact that the headwater streams flowing over the mineralized granites have gathered and dumped gold-bearing wash into the upper part of the main valley, where the combined drainage loses much of its grade and transporting capacity a short distance below the mineralized contact belt. In consequence of this the ability of the running water to concentrate the gold in the gravels and sands is greater on the upper section of the stream than elsewhere.

On the upper part of Flat Creek the coarse unconsolidated deposits are not overlain by a very thick barren cover of frozen sediment. The transporting power of the creek appears to be sufficient to carry most of the fine sediment farther downstream, for such deposits of silt with vegetable muck become thicker and more widespread toward the mouth of the valley.

The best pay layers in the washed deposits are the lowermost beds of gravels and sands from 1 to 3 feet thick that rest upon the bedrock surface and underlie from 16 to 20 feet of less productive or locally barren material. However, at some places on the upper part of the creek nearly the whole thickness of washed material contains more or less gold, fine light particles of it being found in the soil just beneath the turf. Much of the placer gold is also found from 3 to 6 feet down in the fracture cracks of the hardened sedimentary bedrock, where flaky pieces are embedded in thin seams of fine sediment that have been deposited therein. Without doubt this gold has been sifted down from the overlying sands and gravels by circulating water that has filtered through them into the crevices in the bedrock, the water washing the finer sediment and particles of gold from the sands into the bedrock crevices, where the sediment clogged the spaces and held the gold and the water passed away beneath.

WILLOW CREEK.

Willow Creek is a stream of about the same length and size as Flat Creek and has its source immediately southwest of the head of Flat Creek over a divide about 1,000 feet high. It flows into Iditarod River about 7 miles above Otter Creek. The principal headwater tributary of Willow Creek is named Happy Gulch.

Happy Gulch has its source on the west side of the same broad, gentle slope of the mountain mass on which rise the southern headwaters of Flat Creek, and like them it drains part of the same granite area. The southwest end of this granite mass is only a short distance southwest of the head of Happy Gulch. Along its northwest side

the granite is in contact with the same sedimentary formations that occur on lower Flat Creek and these sedimentary rocks likewise form the country rock throughout the lower valley of Willow Creek. The contact between the granite and sedimentary rocks crosses Happy Gulch near its head. In fact, the gulch topography of this tributary begins near this contact and extends downstream as if it may be due to the fact that the sedimentary rocks in which it is cut are more easily cut down by stream erosion than granite. Although the sedimentary formations are softer than the granite, they nevertheless have been hardened to a considerable degree along their contact with the granite. This alteration is the same as that on Flat Creek. The metamorphism gradually diminishes away from the contact and at a distance of a mile the sandstones and shales are of ordinary hardness and texture.

Mineralization appears to have occurred at and near the contact. The granites are deeply decayed, and accumulations of partly residual and partly waterworn granite sands, gravels, cobbles, and bowlders, similar to those on the slopes of upper Flat Creek valley, occur throughout the upper mile of Happy Gulch. Placer gold of the same rough, angular, little-worn appearance as that found on upper Flat Creek, many pieces showing faces of crystalline form, occurs in the granite wash deposits along Happy Gulch where it cuts across the contact belt. The best concentration of gold appears to be in more or less disconnected layers of gravels and sands from 6 inches to 2 feet thick, mixed with bowlders that lie near the bottom of the unconsolidated deposits. These deposits vary from 5 to 10 feet in thickness. Their surface is covered by a growth of moss and turf and dense thickets of willow and alder brush.

A small amount of open-cut, ground-sluice, pick and shovel mining was performed on Happy Gulch during August and September, 1910, on what is named the Summit claim, which is near the head of the gulch and a short distance above the contact of the granite with the sedimentary rocks. This claim is about as far up the gulch as water in sufficient quantity for groundsluicing may be obtained. Even here the adequacy of the supply is largely dependent upon the occurrence of frequent rains on the mountain slopes above. Fortunately these slopes are extensive and of gentle grade, so the run-off is somewhat regular, and by digging small reservoirs enough water may be retained for small mining operations. The granite bedrock on the Summit claim is so deeply decayed that the action of running water quickly erodes down into it, and a ground sluice, if it is allowed to work in one channel too long, readily cuts below the gold-bearing waterworn material that rests on top of the decomposed bedrock.

Placer gold also occurs along the main valley of Willow Creek for several miles below Happy Gulch. The country rocks of this valley are shales and sandstones which are for the most part in a normal

unaltered condition; but within a zone which extends out about a mile from the granitic intrusive mass that crosses the upper part of Happy Gulch these sedimentary rocks have been altered and hardened by the deposition within them of considerable quartz in the form of numerous thin veinlets. This silicified condition of the sedimentary rocks appears to be more evident near the contact of the granitic intrusive mass and to become less marked away from it.

The present Willow Creek flows along the north or right-hand side of its valley, in a manner similar to Otter Creek, and cuts into a range of hills to form a line of low rock bluffs. Thus the greatest width of its valley floor, which is about half a mile, lies south of the stream, along its left side. The surface of the valley bottom rises gradually to the slopes of the bedrock ridge that bounds the valley on the south. This ridge separates Willow Creek from a southern tributary named Gold Creek, which joins Willow Creek about 1¼ miles below the mouth of Happy Gulch. This ridge between Willow and Gold creeks is composed of sedimentary rocks, and it lies within the zone that has been altered by the quartz mineralization which has apparently been induced by the intrusive granitic rocks that occupy the head of Happy Gulch.

The unconsolidated deposits of Willow Creek valley are largely frozen silts and clays, near the bottom of which are some thin beds of gravels composed mostly of partly worn fragments of the hard-shale country rock. Many of the pebbles in the gravel are angular, as if they had not traveled far enough to be well rounded, and may be derived from a neighboring bedrock source. In places they rest upon and grade by mixture into the broken-up and decomposed hard, shaly bedrock and locally they are mixed with sticky clay. Most of the frozen sediment is a dark-colored carbonaceous material that appears to be largely derived by disintegration from the shaly country rocks. These deposits vary in thickness from 10 to 25 feet. On top of them lies a cover of several feet of mucky vegetable humus and moss.

Some prospecting has been done by sinking and drifting on the claims that are located along the present course of Willow Creek near the low bluffs that border the north side of its valley, but the results obtained have not led to any noteworthy production of gold to date. Along the south side of the chain of claims that extend along Willow Creek from the mouth of Happy Gulch down to Gold Creek there is located an association group of placer ground about a mile long named the Haggerty Bench claim, which occupies practically all of the width of the sloping valley bottom that is not included within the creek claims already mentioned. On the lower end of the Haggerty Bench claim, a short distance above and between the forks formed by Willow and Gold creeks, an open cut about 12 feet deep has been

made by groundsluicing to test the value of the deposit. It is reported that this open cut yields about $1.25 to the square foot of surface. The bedrock in this open cut is a shattered hard shale or argillite, commonly called slate, which contains thin veinlets of quartz. The 12 feet of unconsolidated deposits exposed in the cut are frozen silts and clays. The clays are plastic and difficult to wash. The water for groundsluicing this open cut is obtained up Gold Creek by a ditch that brings it upon the upper margin of the sloping bench at an elevation sufficient to furnish enough pressure for hydraulicking the deposits with a canvas hose. It is planned to increase this water supply to about double the present quantity by digging a similar ditch from upper Willow Creek and joining the two ditches on the nose of the ridge that separates Willow and Gold creeks.

The placer gold on the lower end of the Haggerty bench is probably derived from either one of two sources, or possibly from both of them. One source may be the upper part of Happy Gulch, where the presence of gold in considerable quantity is evident, and the other source may be the ridge of altered sedimentary country rock that extends between Willow and Gold creeks from the granitic mass that crosses the upper part of Happy Gulch, although it is not known that the contact-mineralized sedimentary rocks on this ridge are gold bearing. However, if this is the case a concentration of placer gold from the ridge along the south side of Willow Creek valley would be a natural result to expect. In either case the gold that occurs along the south side of the valley appears to have been concentrated in its present position by Willow Creek at a time when it may have flowed nearer the south or left side of its valley. The present position of Willow Creek on the north or right side of its valley gives the impression that the channel of the stream has migrated across its valley bottom from left to right, and even now it is strongly inclined to work northward, as is shown by the low rock bluffs it is cutting along that side.

MINING METHODS.

The mining methods practiced in the Iditarod district may be briefly classified as prospecting and testing, stripping off overburden, excavating the stream-laid deposits and shattered bedrock which contain gold, conveying and hoisting the material to a washing plant, passing it through sluice boxes, removing the angular rock fragments that may clog sluices, and disposing of the tailings.

The prospecting or testing of the placer-gold deposits that have been mined in the Iditarod district is not difficult because they are comparatively shallow, their usual depths varying from 10 to 25 feet. Being shallow, they have been mostly mined by open excavations from the surface. A large part of the ground so far developed is in a

thawed condition, but frozen areas of large and small extent also occur. It is only in the frozen areas that underground or drift mining on bedrock may be done satisfactorily, for when thawed ground is opened the water it generally contains is liable to flood underground workings to such an extent that only expensive pumping will keep them free. Even in open pits seepage water often flows so abundantly that it has to be drained into a sump hole and pumped away. The original discoveries of gold in Otter Creek valley were made by sinking small shafts to bedrock, and most of the prospecting of properties preparatory to mining them has been done in this manner. During the winter of 1909–10 a moderate amount of sinking and drifting was done in Otter Valley to test the gold values in the ground, and at one or two localities this method has been continued in a small way during the summer, but in general this kind of work has been handicapped by encountering water in quantities large enough to flood the underground excavations. On the upper part of Flat Creek some prospecting has been done with a steam drill. Some ground was tested near the mouth of Flat Creek and on Willow Creek during the summer of 1910 by groundsluicing or washing out open cuts into the frozen deposits. These frozen deposits are mostly of silts and clays, the frost binder of which, when exposed to the action of air and running water, rapidly disintegrates them into flowing slimes that are removed in suspension by running water. This open-cut work, however, can be done only during the summer, or the season of running water, from May to October, and at localities where sufficient water is obtainable. If prospecting or mining is undertaken during the winter season it must be done by sinking to and drifting along bedrock, and if water seeps into these underground excavations in any considerable amount the work is generally abandoned at that particular place. Sometimes a short distance from a thawed place a solidly frozen spot may be found, where sinking and drifting may be carried on satisfactorily over a small area without interference by seepage water.

Owing to the shallowness of the gold-bearing deposits of the Iditarod and the largely thawed condition of the ground that contains the best values practically all the larger operations so far undertaken have been open excavations from the surface down to and into bedrock. This involves the mechanical removal and handling, in one way or another, of the whole thickness of the unconsolidated deposits and that part of the disintegrated and loosened bedrock which contains profitable amounts of placer gold.

It is generally necessary to remove a variable amount of more or less barren material, such as brush, moss, humus, soil, and silt, from the upper part of the unconsolidated deposits. This stripping off of the barren overburden is done by chopping and grubbing away the

vegetation and, if running water is available in sufficient quantity and the grade of the surface favorable, directing one or more streams over the ground by several channels until the surface material is washed away or groundsluiced. If this work can not be done with running water, horse or steam scrapers are used to move the barren material aside. The steam scrapers are similar to ordinary horse scrapers except that they are of larger capacity and are operated by a system of wire cables and steam hoisting engines so arranged that the scoop is filled by drawing it through the earth and then dragged aside to a dumping ground by a cable attached by a pulley to the top of a stout, securely guyed mast, the scoop being then automatically dumped by a tripping arrangement.

After the placer deposits are stripped of the barren overburden it is necessary to excavate and elevate the gold-bearing material into sluice boxes through which it is washed by water to separate the gold from the sands, gravels, and fragmentary bedrock. In the Iditarod placers the bottoms of the valleys are too flat to allow lines of sluice boxes to be set up on the bedrock grades and the gold-bearing material to be shoveled directly into them, as may be done in many placer districts. In order to get sufficient grade to the box lines for washing the gold-bearing material and room to dump the tailings from the lower ends of the sluices it is necessary to erect lines of boxes on trestles from 15 to 30 feet high and to elevate all the gold-bearing material to the upper end of the sluice boxes. The hoisting is done by means of a specially constructed sheet-iron dump bucket attached to a running cable that passes through a combination of pulleys mounted in a carriage which runs along a fixed cable that is stretched across the excavation from the top of a firmly guyed mast. This mast is placed so that the upper end of the fixed cable is suspended above a dump box at the head of a line of sluice or riffle boxes. The running cable is adjusted so that the bucket may be lowered or hoisted at different places in the excavation beneath the fixed cable and drawn along that cable to its upper end near the mast, where it automatically trips and dumps its load on an apron or steeply inclined platform. From this the material slides down into the upper end of the riffle boxes, to be washed through them by a stream of water conveyed to the sluice by a flume, which, like the sluice boxes, has to be elevated on a trestle in order to raise it to the required height.

Steam-boiler equipment varying from 20 to 60 horsepower has been used to operate the hoisting engines at the several plants. This amount of power is considered insufficient by some operators, who intend to install larger boilers in the future. Wood is the only fuel available, and as the supply is none too abundant or convenient it forms a considerable item of expense.

With the exception of the steam hoisting and scraping of the unconsolidated deposits as described above, practically all of the work of mining is accomplished by manual labor, from 10 to 60 men being employed in and about the different excavations according to the magnitude of the operations undertaken. Most of the men work in the open pits digging up the gold-bearing material with picks and shovels and conveying it to the hoist buckets in wheelbarrows. Several men are generally required at the sluice boxes to keep the water and gold-bearing material properly passing through them. Most of the larger angular pieces of bedrock are not allowed to go through the riffle boxes because they are liable to become wedged and clog them. To avoid obstructing the boxes with this angular rock material it is forked out near the head of the sluice after the gold-bearing sediment attached to it has been washed off either by the sluice water or by a stream of water from a hose. The rounded gravel, sand, and silt is washed through the boxes and allowed to stack up at their lower end as tailings. Generally the sluice boxes are erected high enough above the ground to afford space for the disposal of the tailings by gravity, by occasionally changing the arrangement of the boxes, but in some places the tailings must be moved aside mechanically by a scraper or hoist to prevent blocking the dump.

MINING COSTS.

The mining operations conducted in the Iditarod district during 1910, the first year of its development, can not be considered normal, because the district has suffered from the effects of many conflicting conditions such as often attend the opening of a new part of Alaska that is comparatively easy of access. The first year or so of the development of a new placer gold district in Alaska is generally a period of more or less confusion and uncertainty for both the mining operations and the dependent commercial activities. This is probably more pronounced in the Alaskan gold placers because there the natural conditions are more severe than in most other countries.

When placer gold is discovered at a new locality in Alaska, if a general opinion that the district offers considerable mining promise gains popular acceptance, the movement of population to the new locality during the first years of its development is often out of all proportion to its gold-productive possibilities. A condition of overpopulation has characterized the early history of many of the placer-gold districts of Alaska, especially those which are fairly accessible by summer routes of water transportation, and this condition often continues until a district has passed its period of maximum development. On the other hand, districts which are sufficiently removed from steamboat transit to be difficult to reach are seldom overpopulated, and the

mining development of such districts to their full possibilities generally lags for want of sufficient supplies and equipment. This prevents the exploitation of deposits which in more accessible localities could be mined with a profit that would sustain a considerable population.

As a rule the mining and commercial activities of an Alaskan placer-gold district, although closely interrelated and intimately dependent upon each other, are rarely in economic harmony. This lack of adjustment often continues throughout the history of a district and is directly reflected in the cost of mining. In most places, especially in the interior of Alaska, transportation is a primary factor governing mining development and is of most vital importance, a high cost of mining generally being chargeable to the lack of cheap and satisfactory facilities for the conveyance of ample supplies from the United States to the placer-gold districts. The mining industry is largely controlled by this factor, for no matter in what part of the Territory mining is undertaken the problem of transportation enters as a primary influence in determining the relation of the mining costs to production, and the difficulty or ease with which a particular locality may be supplied with the food, clothing, implements, and machinery required by a mining population determines the possibilities of exploiting deposits of different values. Practically all these supplies are obtained ready-made from the United States, and the freight charges for their carriage to points on the water routes of transportation, especially in the Yukon Valley, are considerable. The cost of transportation, however, is generally much increased before the supplies reach their final destination, for in most cases it is necessary to move them from 5 to 50 miles overland and the cost of this, especially for large or heavy pieces, such as boilers and hoists, increases enormously with the distance.

Probably it will never be possible to obtain the data necessary to present a complete analysis of the commercial mining condition of a placer-gold district in Alaska, especially for the first years of its development, because reliable evidence in the form of accurate figures is rarely obtainable. Some of the more systematic operators keep business accounts, but a great amount of placer-mining work is done without keeping records of the costs. The few statements of costs available show that the cheapest mining in the Iditarod during 1910 cost 22 per cent of the production of a particular operation. Another comparatively low-cost operation was performed for 32 per cent of the production. These costs are the lowest reported. On the other hand, much of the mining so far done has cost 70 per cent or more of the production. The general average cost of mining in the district for the season of 1910 probably was between 50 and 60 per cent of the total production. The cheapest operations are much below the

average of the district and are probably nearly as low as will ever be accomplished by the methods used. Although costs may be reduced if conditions become better balanced, such results probably will be attained only upon small tracts of favorably situated ground. The deposits mined at the lowest costs cited above are about 10 feet deep and rest upon a soft bedrock of deeply decomposed granitic rock that may be readily scraped up and very easily washed after an overburden of muck and silt is removed by groundsluicing. The actual cost of mining this deposit was about 28 cents per cubic yard. This is as low as the cost of some dredge mining on Seward Peninsula, where the lowest cost of placer-gold dredging so far attained is 18 cents per cubic yard. In the Iditarod district it will cost considerably more to install and operate dredges than on Seward Peninsula, as transportation and fuel will be far more expensive, so it is doubtful if dredge mining can be conducted in the Iditarod for 18 cents per cubic yard.

The possibility of placer-dredge mining on considerable tracts of the flat-lying stream deposits that cover the valley floors of Otter and Flat creeks, which are presumed to be gold bearing to a greater or lesser degree and extent, has been discussed in a preliminary manner by some of the persons interested in ground on these creeks. Such an enterprise should not be undertaken without first securing a satisfactory community of interests for considerable tracts of placer ground and prospecting them thoroughly enough to determine the extent and thickness of the gold-bearing beds, so as to enable reliable estimates to be made of the amount of gold that occurs, with known quantities of the material to be handled by a dredge, including the barren overlying deposits with which the gold-bearing material is associated. Due allowance must also be made for the difficulties that may be encountered by dredge buckets in digging up the shattered bedrock, in the cracks of which much of the gold lies, and also in handling the bowlders which are present in the Iditarod deposits in considerable numbers. Experienced dredger men should be consulted before such an investment is made.

PRODUCTION.

Commendable energy has been shown by the real mining element of the Iditarod district in overcoming the obstacles the mining situation presented to them; for the camp, so far, never has promised to produce enough new wealth to satisfy even the reasonable expectations of all the people who have interested themselves in the district in various ways. Before June, 1910, very little was definitely known about the occurrence of the placer gold and there was not an adequate supply of mining equipment at hand with which to work, but after the season opened no time was lost in commencing operations which

would demonstrate the mining possibilities of the district. The necessary boilers, hoists, etc., with which to perform effective work were brought to the head of steamboat navigation on Iditarod River and thence moved with considerable difficulty and expense to the better-known placer tracts on Otter and Flat creeks, where they were quickly installed and actively operated without delay until the freeze in October.

When it is considered that the district has been greatly overpopulated by a class of persons whose intentions are not to mine but to gain indirectly from the results of the miners' labor, the first season's gold production has been as large as could be expected. Of the 2,500 persons who entered the Iditarod district during 1910 not more than 1,000 engaged in work directly related to its mining development. The remainder, or much over half of the population, had no other intentions than to engage in parasitic pursuits of minor importance to mining, and it is probably unfortunate that the district has been thus overburdened, especially by so many persons who have shown overenthusiasm in town-site booming and kindred speculative enterprises.

The gold output of the Iditarod for 1910 amounts to about $500,000 in value, of which about $200,000 may be credited to Otter Creek and the remainder, $300,000, to Flat Creek. There was also a few thousand dollars' worth of gold mined from Black and Willow creeks in the course of preliminary development work.

OUTLYING PLACER-GOLD LOCALITIES.

The one significant result of the overpopulation of the Iditarod has been to stimulate a widespread search for placer gold throughout the surrounding territory, particularly south of the present center of mining on the headwater branches of large streams that flow into Kuskokwim River from the divide that separates them from the Iditarod drainage. The results of this movement, which during August and September, 1910, was participated in by over 500 men and reached the magnitude of a "stampede," indicate that prospects of placer gold occur in several areas of moderate extent within the valleys of Moore, Jualin, Donlin, and Crooked creeks, which are south of and opposite the headwaters of Otter and Bonanza creeks. Prospects are also reported to occur on Little Creek, a tributary of Iditarod River about 75 miles above Otter Creek. Although there appears to be little doubt that some prospects of placer gold have been discovered at particular spots of small extent on several of the smaller tributaries of the streams named above, it is not possible at this time to make any definite statements about the extent or richness of these new gold-bearing areas. The men who participated in this stampede movement did not apply their energies toward making or verifying discoveries of placer gold, but, after the

manner now commonly practiced all over Alaska in such cases, they devoted practically all their time to traveling rapidly over the country and hastily placing location stakes and notices so as to embrace vast tracts of land for placer mining without making any effort to determine its gold-bearing character (a primary requisite of the law), simply assuming that placer gold may possibly occur in some of the ground located from the meager fact that there may be an actual occurrence known within several miles, perhaps in the same valley or some adjacent basin. Oftentimes, however, not even this small stimulus is considered essential, the optimistic imagination characteristic of the gold seeker being enough to make him think that, to use the common expression, "the country looks good." Indeed, the custom of making wholesale locations of land in the form of countless association-group claims of 160 acres each, for the ostensible purpose of placer mining, has become so general throughout Alaska during the last four or five years that it is now unusual in many districts to find ground located as single 20-acre claims. It is not uncommon for several men in partnership or even one individual, sometimes provided with powers of attorney of a number of absent persons, to claim by priority of location from 25 to 50 and occasionally as many as 100 association-group claims of 160 acres each—in other words, to make ridiculous claims of intentional mining rights on 50,000 to 150,000 acres of the public domain. The manner in which this practice appears to be countenanced by Alaskans gives ground thus falsely claimed a sort of concessionary value that is considered as an asset, by which claimants hope to profit if by chance a genuine discovery of gold is eventually made upon or near some of their illegal holdings. It is a matter of common knowledge throughout Alaska that no actual discoveries of gold are made on 90 per cent of the claims staked when they are first located for placer mining. The apparent purpose governing the whole matter is to first get what is considered a prior control of large tracts of land with the idea that gold may be discovered upon some of it afterward, which discovery may then be turned to the financial advantage of the persons who claim priority of location but who have done nothing to deserve reward. In brief, the primary object of the mining laws, whose intent is to encourage citizens to search without restriction for mineral wealth upon the public domain and, if they actually discover it, to protect their rights as individuals therein as long as they give evidence of reasonable interest in the exploitation of such mineral wealth, is utterly ignored. The exploitation of Alaska's placer deposits at the present time is apparently suffering from the chaotic condition brought about by an utter contempt for both the mining laws and the common rights of the public in the matter.

Popular opinion throughout Alaska seems to strongly denounce the abuse of the locating privilege by the unrestricted use of powers

of attorney and association-group staking. The personal opinions expressed by most individuals are to the effect that such methods should be abolished, yet they do not intend to deny themselves such privileges as long as they have no guaranty that others will not take advantage of them.

CONCLUSION.

At present it is not possible to make conclusive statements regarding the future mining possibilities of the Iditarod district. During the summer of 1910 enough experience was acquired with the placer deposits on Otter, Flat, and Willow creeks to define fairly well the character of the unconsolidated stream deposits where mined and the conditions surrounding the occurrence of the placer gold in them. The work performed shows that there is a general similarity in the kinds of unconsolidated deposits on these three streams, but there are some variations in the relative proportions of the finer and coarser materials, in their thickness, and in the presence or absence of perpetual frost. All the deposits belong to the class of shallow placers, which may be best mined by open surface excavations.

Though considerable prospecting has been done to determine the extent of the placer-gold deposits and though their limits of distribution on Otter, Flat, and Willow creeks seem to be well defined in some directions, it can not be stated now with any degree of certainty how extensive they may be or how much gold they may contain. It may be said, however, that the mining situation on these three creeks is well in hand and without doubt will soon adjust itself to the conditions surrounding the occurrence of the placer gold. No doubt more ground may be mined with a profit in the future than would have been possible under such conditions as were prevalent during 1910.

From what is known of the occurrence of placer gold in the Iditarod and the adjacent districts of Innoko and Tuluksak it appears probable that there may be other similar but separate areas of auriferous mineralization of moderate extent distributed in a more or less scattered manner throughout the central part of the Kuskokwim Mountains. In this province the indications seem favorable for the discovery of gold-bearing stream placer deposits at or near mineralized zones of contact of granitic intrusive rocks with the sedimentary formations. These areas, however, do not appear to form a continuous gold-bearing belt.

The probable future expansion of placer mining in this region will depend chiefly upon the discovery of more occurrences of local gold-bearing mineralization in the vicinity of intrusive masses or dikes of granitic rocks such as are known to occur at several places along the Kuskokwim Mountains from the headwaters of the Innoko and Tuentna on the northeast to the Tuluksak on the southwest. At this date several new gold-bearing localities of this kind are reported.

Those nearest the Iditarod on Jualin, Donlin, Crooked, and Little creeks have attracted the most attention, but portions of the valleys of Moore Creek, a headwater branch of the southwest fork of the Takotna, and of the large northeast branch of this river, which is called the Tuentna or Nixons Fork, have also aroused enough interest to be extensively located upon in the customary wholesale manner for placer mining. The results of prospecting that will be carried on at all these new localities during the present year will be very important in determining the extent and activity of placer mining throughout the Kuskokwim Mountain region.

Northward from the Innoko district the Kaiyuh Mountains may prove a good field for prospecting, because granitic intrusive rocks similar in lithology to those that appear to have brought about the auriferous mineralization of the Innoko and Iditarod districts are known to occur there at many localities.