

GOLD PLACERS OF THE YENTNA DISTRICT.

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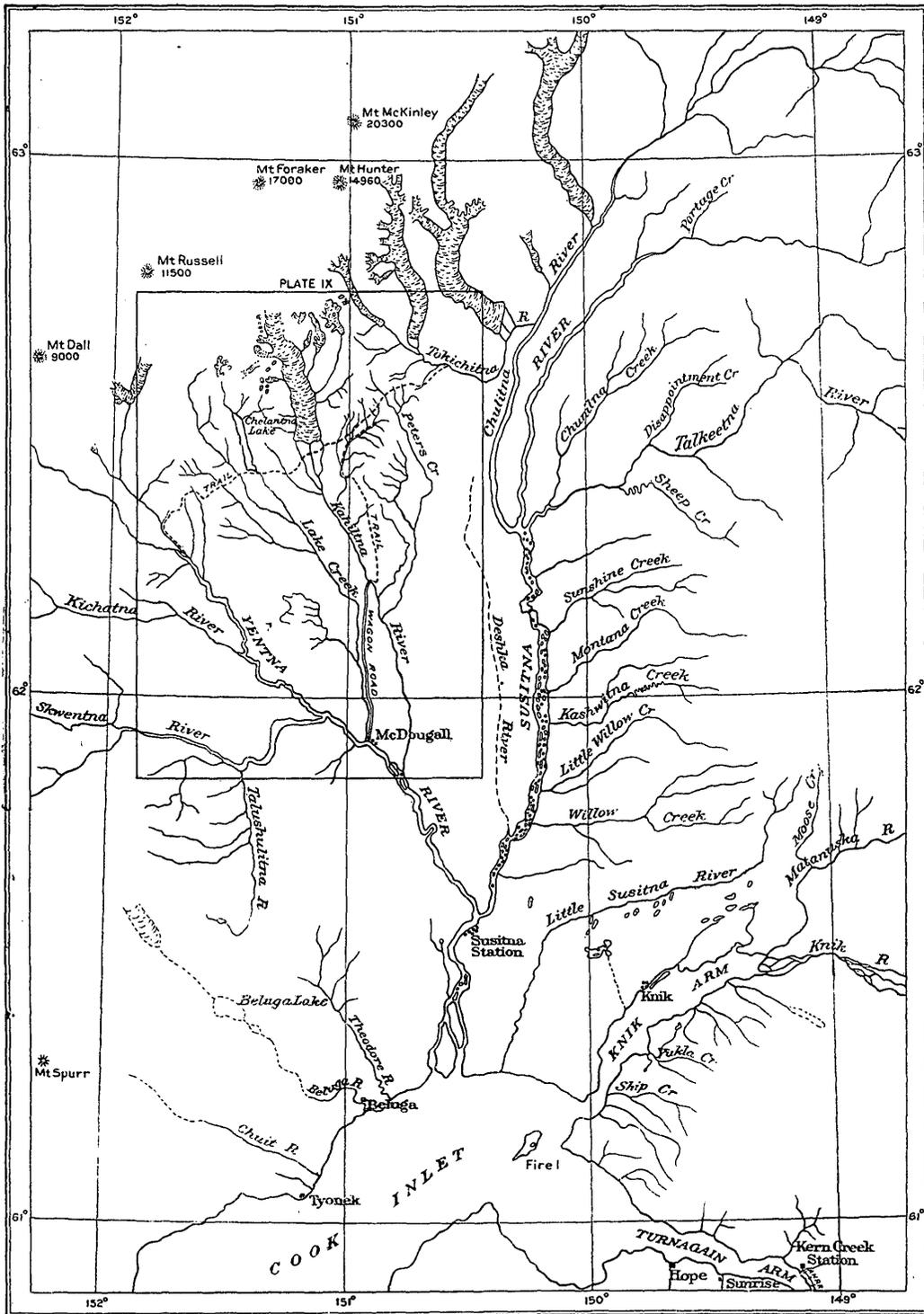
EXPLORATION.

The Yentna district, as the name is commonly applied, embraces all the area that drains directly to Yentna River except the basin of Skwentna River, the largest tributary of the Yentna. The higher parts of the Alaska Range in the Yentna basin are so inaccessible that they are still unexplored, and the lower portion of the basin, which forms a part of the great Susitna Valley lowland, is a heavily timbered, brushy flat which offers little attraction for either the prospector or the geologist. The region covered by this report has therefore a roughly triangular shape, one side lying along the Yentna Valley, the second stretching along the Susitna lowland, and the third lying parallel to the Alaska Range and including its more accessible parts (Pl. VIII). A more complete report, including a discussion of the geology and the mineral resources of the region and a geologic map, is now in preparation.

Since 1905, when gold was first discovered in this region, prospecting and mining have been carried on continuously by which gold has been found to be widely distributed through the area, yet it has been obtained in paying quantities only in the so-called Cache Creek country, in the basin of Twin Creek, and at a few points in the valleys of Lake Creek and Kahiltna River. A new impetus to prospecting was given in the season of 1911 by the discovery of rich placer ground in the benches above Dollar Creek. The present known economic value of the region lies entirely in its placer gold, no valuable lodes having been discovered. Lignitic coal occurs at many places but is too poor in quality to attract much attention, for better and thicker coal beds occur at easily accessible points on Cook Inlet. The coal beds, however, have some value as a source of local fuel.

Before the work on which this report is based was done little was known of the geology of the region between Yentna and Susitna rivers. In 1898 Spurr¹ ascended the Yentna to the mouth of the

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



SKETCH MAP OF SUSITNA BASIN.

Skwentna, but in his journey along that stream was able to obtain little information in regard to the geology of the country to the north. During the same year Eldridge¹ made an exploratory trip up the Susitna and into the Tanana basin, and recorded many facts concerning the geology of the range in the northern part of the Susitna basin. In 1902 Brooks and Prindle² went up the Kichatna and obtained a geologic section of the Alaska Range along their route. In 1906 R. W. Porter made a topographic map of the Yentna district, and this, with some additions and corrections by the writer, was used as a base map for the present investigation. The conditions under which all of these explorations were carried on, however, made it impossible to extend the geologic work more than a short distance on either side of the route of travel, and as both the Yentna and Susitna rivers lie in broad, alluvium-filled basins, with few bedrock exposures along the streams, the geologic conditions in the upland area between them were unknown, except as they were indicated by a few facts gleaned from reports of prospectors and miners who had visited the region.

GEOGRAPHY.

TOPOGRAPHIC PROVINCES.

The Yentna district, bounded by Susitna and Yentna rivers and the crest of the Alaska Range, may be roughly divided into three provinces, each having distinctive topography. The first of these includes the lowlands of Yentna, Susitna, and Tokichitna rivers. This area extends westward from the base of the Talkeetna Mountains, on the east side of the Susitna, to the foothills of the Yentna district, a distance of nearly 50 miles, and has irregular projections which occupy the valleys of Yentna, Kahiltna, and Tokichitna rivers. It lies for the most part within 600 feet of sea level, and is characterized by broad, almost flat stretches along the main streams, and by slightly rolling interstream areas. The lowlands are nearly everywhere covered by a good growth of spruce or cottonwood timber, and between the trees willow, alder, and other brush plants grow profusely. The larger streams that cross the lowlands flow in well-defined valleys and most of them are swift, but many of the smaller streams are sluggish and meandering, and the interstream areas contain many small lakes.

The second topographic province includes the foothills belt which lies between the lowland and the rugged mountains to the northwest. In this belt are the Dutch, Peters, and Yenlo hills, and the hills at

¹ Eldridge, G. H., A reconnaissance in the Susitna basin and adjacent territory, Alaska: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900.

² Brooks, A. H., and Prindle, L. M., The Mount McKinley region, Alaska: Prof. Paper U. S. Geol. Survey No. 70, 1911.

the head of Twin and Camp creeks. In general, all of these hills are smooth in outline and their summits reach elevations of 3,000 and 4,000 feet, although at the north end of the Dutch Hills somewhat rougher peaks rise to a height of 5,000 feet. Between the hill ranges and around their margins is a high upland plain, cut transversely by the Kahiltna Valley and sharply trenched by many of the streams which cross it but still retaining enough of its old surface to be recognizable. Between Yentna and Kahiltna rivers this plain lies at an elevation of between 800 and 1,600 feet, and in the basin of Cache Creek it rises to a height of about 2,000 feet. Very little of this high plain is heavily timbered. Scattered groves of spruce occur in favorable localities, but most of the vegetation consists of low bushes, grasses, and sphagnum mosses.

The third region, of a very different character from the others, comprises the rugged, alpine portion of the Alaska Range. The dividing line between it and the foothills belt extends from the lower end of the Tokichitna Glacier southwestward to Yentna River, a few miles above the forks of the stream. The mountains of the lower, southeast portion of the alpine belt have elevations of about 4,000 feet, but the height and ruggedness of the range increase abruptly to the northwest, culminating in Mount Foraker, 17,000 feet high, and Mount McKinley, 20,300 feet high, the loftiest peak of the continent. From the foothills to the crest of the range is a belt averaging about 25 miles in width and including an area of many thousand square miles of territory which is almost unexplored, and which, owing to the sharp, toothlike character of its ridges and to its glacier-filled valleys, is most difficult of access.

DRAINAGE.

The drainage throughout the Yentna region is tributary to Susitna River, most of it flowing to this stream by way of Yentna River, but a small area being drained by the Tokichitna, which joins the Chulitna. Within the Yentna district three great valley troughs transect both the mountain and the foothills belts at right angles to the trend of the range. The Tokichitna Valley, which is the shortest of these, is filled with a great glacier to within about 12 miles of the Susitna lowland. Below the glacier the river has the character of most glacial streams, being heavily charged with gravel and silt and spreading with a multitude of channels across its wide valley floor. Kahiltna River also heads in a great glacier, the upper portion of which lies in an unexplored region, but which probably receives the ice from the slopes of Mount Foraker. The glacier extends downward beyond the confines of the higher mountains and at its lower end is nearly 4 miles wide. Below the glacier the stream is turbid and spreads with many channels and sloughs across a broad flat which lies at an

elevation of less than 600 feet above tide. This flat narrows noticeably about 15 miles below the glacial source of the stream, and for much of the remainder of its course to the Yentna the river flows as a single stream through a narrow canyon-like valley. Lake Creek, which lies between Kahiltna and Yentna rivers, heads in a lake in the higher mountains and flows for about 20 miles across the high upland plain in a valley cut but little below the level of the surrounding country. East of Yenlo Hills it has, like the Kahiltna, intrenched itself deeply and flows through a narrow valley having steep walls, which in places rise 300 feet above the stream. The valley broadens out and the banks become lower as the stream approaches its place of junction with the Yentna.

The third great transverse trough across the mountains and foothills is occupied by Yentna River. It heads far back in the range in glaciers which receive ice from the slopes of Mounts Russell and Dall. As this portion of the range is lower than that farther north, the glaciers are smaller, and the valley is free from ice much farther into the mountains than its neighbors to the north. Above the junction of the two main branches which form this river both streams have the characteristics of other glacial streams, with their many branching channels and wide expanses of bare gravel and sand bars. Below the junction the river maintains a much more definite channel, contains few islands, and is easily navigable by light-draft launches. The smaller creeks of the district are all tributary to one or the other of the above-mentioned streams.

ROUTES OF TRAVEL.

The only practicable route to the Yentna district is by way of Susitna and Yentna rivers. In the summer months the Alaskan Northern Railway may be used from Seward to the head of Turnagain Arm, a distance of 71 miles. From the terminus of the railroad, as well as from Seldovia and other points on Cook Inlet, launches carry both passengers and freight up Susitna River to Susitna station, which is the center of supplies for the Yentna country. Launches make occasional trips during the summer from Susitna station up the Yentna, which is navigable for light-draft boats almost to the forks of the river. The route most followed to the placer camps in the neighborhood of Cache Creek leaves the Yentna at McDougall, a small village at the mouth of Lake Creek. From McDougall a wagon road has been built which follows the east bank of Lake Creek upstream for about 15 miles and swings across to Kahiltna River. A bridge which was built across the Kahiltna in the winter of 1910-11 was washed out in the spring of 1911, so that it is necessary to swim horses at this point, travelers

crossing in rowboats. Beyond the Kahiltna the trail follows the high ground along the west slope of the Peters Hills and crosses several miles of marshy ground which in midsummer is difficult to pass by horses. The Cache Creek valley is reached at the mouth of Spruce Creek and followed upward from this point.

As supplies can be transported overland much more cheaply by sled in winter than by any means in summer, almost all of the freighting is done in winter, either from Susitna station or from McDougall. From the former point the sled route follows Susitna and Yentna rivers to either the mouth of Kahiltna River or to McDougall, the route selected depending on the part of the country to be reached. Much of the freight for Peters Creek and its tributaries has been taken up Kahiltna River and Peters Creek. Practically all the freighting for Cache Creek is done by way of McDougall and the wagon road to the Kahiltna. From the trail crossing at Kahiltna River the sled route most used follows up the Kahiltna Valley for several miles and then swings up the slope to meet the summer trail a few miles south of Cache Creek.

Until 1907 this region was supplied in the summer by a pack train which used a trail from a point on Yentna River near the forks, and, following a course parallel with the base of the mountains, crossed the Kahiltna just below the glacier. It then lay along the northwest edge of the Cache Creek basin and terminated at Home Lake, in the Tokichitna Valley. This trail is now little used and, though portions of it can still be distinguished, it is for most of its length overgrown by brush and grass, so that one not familiar with its course would have difficulty in following it.

The diggings in the basin of Twin Creek are usually reached by way of the Yentna to McDougall. From McDougall supplies are sledged up the wagon road to a point more than halfway to the Kahiltna, where a winter trail branches to the west and follows up Lake and Twin creeks. In leaving the country in the fall the miners from Twin Creek usually build boats or rafts and float down the Yentna. From Cache Creek the trail and road are used to McDougall and launches taken from that point to Susitna station. From the headwaters of Peters Creek the trail to Tokichitna River is often followed and boats are built to descend this stream and the Chulitna to Susitna River.

VEGETATION.

One of the serious problems which confronts the miners in the various camps is the difficulty of obtaining timber suitable for sawing into lumber for sluice boxes and other mining uses, as most of the mines are located above timber line. Cache Creek valley and its branches had formerly some timber up to a point a mile or so above

the mouth of Thunder Creek where a sawmill was built. Spruce trees 2 feet in diameter at the base were not uncommon. The heavy demand for logs for the sawmill has now caused the cutting away of all the best trees as far downstream as the mouth of Spruce Creek, so that a haul of at least 7 miles to the sawmill is necessary. A toll for sawing of half the logs brought in is charged the miners at this mill. Peters Creek is timbered below the lower canyon, and logs are brought from it to the diggings on upper Peters Creek and its affluents, both for lumber and for fuel. Some logs for these camps are procured also from the Tokichitna Valley. Lumber and fuel for the mines on Mills and Twin creeks are obtained from the lower reaches of these streams, a few miles below the camps.

Between June 1 and 10, grass sufficient to supply forage for horses appears at McDougall, but in the higher basins, such as that at the head of Cache Creek, the snow does not always disappear until early in July, and horse feed is not abundant until that time. From the beginning of July until the middle of September, the grasses flourish with exceptional luxuriance, and good grazing may be found almost anywhere that horses can be taken.

GEOLOGY.

As the region here considered lies apart from areas which have already been studied, and as the hard rocks have failed to yield fossils, the age of the older formations represented is still uncertain. The areal distribution of the several formations is shown in Plate IX. The oldest rocks of the district consist of a series of slates and graywackes, which form the cores of all of the foothill ranges and are an important element of the Alaska Range, especially along its southeastern flank. The slates and graywackes are interbedded, in some places in about equal amounts, in other places with one or the other phase predominating. The slates range from fissile, thin cleaving rocks to more massive argillites, and the strong development of the lines of schistosity in many localities makes it difficult to distinguish the original bedding of the sediments. The graywacke beds are commonly hard and massive, and are with difficulty distinguishable from fine-grained dike rocks, for which they are often mistaken by the miners. This slate-graywacke series forms the hard bedrock of the placer camps in the Cache Creek basin.

Next younger in age than the slates are the diorites and granites and associated dikes of the high range. These cut the slates, and so are younger. The slates have undergone contact metamorphism near the large intrusive masses, and the abundant veins and stringers of quartz which are present for several miles from these bodies are probably the source from which the gold of the placer districts is derived.

Tertiary (Eocene) sediments of little-consolidated sands, shales, gravels, and some lignitic coal overlie the slates in the more favorably situated depressions between the foothill ranges and extend eastward from these hills, the beds forming the so-called "soft bedrock" of the miners. They disappear beneath the later deposits of the Susitna basin, but their structure along the slopes of the Yenlo and Peters hills and their presence in the deep canyons of Kahiltna River and Lake Creek indicate that they probably underlie much of the broad Susitna basin. Coal, which is probably from this formation, has been mined on the south bank of Yentna River, some 7 miles above its mouth. In the area near the head of Twin and Camp creeks, the coal-bearing series is overlain by a heavy deposit of stream-washed Tertiary gravel, much coarser than anything seen in the coal-bearing series itself. Exposures of this gravel are found also on the west side of Treasure Creek. The gravels are many hundred feet thick, and seem to be structurally conformable upon the coal-bearing beds. Elsewhere the coal-bearing series is overlain by the widespread blanket of glacial material which masks the older formations throughout a great part of the area outside of the high mountains. The glacial beds consist of morainic materials deposited directly by glacial ice and of gravels laid down by glacial streams. The morainic material commonly consists of tough blue clay in which gravels, boulders, and angular pieces of rock are embedded, and in which the assortment of materials found in water-laid beds is completely lacking. Glacial striations are particularly abundant on the rocks in the glacial till of this region. The glacial gravels are most often seen as benches along the sides of the stream valleys. The glacial deposits shown on the map (Pl. IX) vary greatly in thickness, but over the area shown they are sufficiently thick to conceal the underlying formations. The latest deposits considered are the gravels of the present streams. These form narrow strips along most of the creeks of the area and in the valleys of the more important rivers cover large areas.

MINERAL RESOURCES.

GOLD PLACERS.

GENERAL FEATURES.

Placer gold is of widespread occurrence throughout the Yentna district. Fine colors of gold may be found almost anywhere along Yentna River, and some gold has been recovered along the bars of the lower Kahiltna and Lake Creek, many miles from the mountains from which it must originally have come. Gold in sufficient concentration to encourage continuous mining has, however, been discovered

only in certain rather well-defined areas. The most important of these is the broad basin drained by Cache Creek and the headward tributaries of Peters Creek. The only other important producing camp is in the upper basin of Twin Creek. A study of the map will show that both of these areas lie between the troughs of the main river valleys. The factors which bear on the distribution of placer gold in paying quantities can not be adequately discussed for this region without first considering in some detail the former extent of the glaciers which reached so great a development along the Alaska Range, and such a study is beyond the scope of this paper. It will be undertaken later in the more complete report which is to follow. It may be said, however, that the present glaciers are only remnants of a vast ice sheet which once filled the Susitna basin and extended far down Cook Inlet. This great glacier was several thousand feet thick in the lower parts of the Yentna region, perhaps completely covering the Yenlo Hills, and leaving only the upper portions of the Peters and Dutch hills exposed, if indeed these two ranges were not also covered by the ice. At the time of the greatest glaciers an ice tongue moved southward through the broad valley of Cache Creek and a portion of this glacier pushed across the Peters Hills along the valley now occupied by Peters Creek, greatly eroding and deepening this valley, which may indeed owe its existence to erosion by glacial ice. Later, when the thickness of the vast glacial sheet had somewhat diminished, each of the many valleys of the foothill ranges was occupied by a vigorous valley glacier. The erosive action of these great slow-moving ice tongues was enormous, especially along the larger valleys, which head in the high mountains, and any placer gold that may have been concentrated in the valleys was scattered and mixed up with glacial deposits that are now spread over the lowlands. Only in places that were by their topographic positions protected from great ice erosion could the preglacial placers survive; and only in such places or in places where an unusual amount of postglacial erosion has permitted the reconcentration of the glacially scattered gold, or where erosion since the ice retreated has effected a new concentration, is gold now found in quantities sufficient to justify mining. So little is known of the more rugged portions of the Alaska Range that nothing can be said of the possibility that lodes which existed there might have supplied gold to the stream gravels. In the district around Cache Creek, where the geologic conditions are known, the heads of all the streams that carry placer gold are in valleys eroded in the slate-graywacke series. The rocks of this series contain many quartz veins and stringers, and although these have not yet been found to contain gold, it should be noted that only a small amount of prospecting for gold lodes has been done in them. Some pieces of quartz float containing free gold have been

found in this region and the sluice boxes have yielded much gold to which quartz was attached, and even small pieces of quartz stringers with free gold and with fragments of the slate that formed the walls of the quartz vein. As almost all of the streams that cut the slates contain some gold, it appears highly probable that the placer gold has been derived from quartz veins in the slate-graywacke series.

In the basin of Twin Creek the conditions are different, for the gulches which have yielded the placer gold are cut into the gravels, sands, and slates of the coal-bearing series. It seems certain that the placer gold on these streams has been derived by reconcentration from the gravels of the upper part of the series. Whether or not those gravels originally received their gold from the slates is still a matter of conjecture.

Gold was first discovered in the Yentna district in 1905, and all the streams of the region on which mining is now being done have been worked steadily or intermittently for several years, no important new locations having been made. The most important development of the last year was the discovery of rich ground in an old pre-glacial channel on Dollar Creek, a discovery suggesting the possible existence of similar old channels in benches of near-by streams. During the summer of 1911 mining was done on Cache Creek and its tributaries, Dollar, Falls, Thunder, Rambler, Nugget, and Gold creeks; Peters Creek and its tributaries, Bird, Willow, and Poorman creeks; and Mills and Twin creeks and the small gulches which they drain.

CACHE CREEK BASIN.

FEATURES OF THE STREAMS.

Cache Creek is a rather large stream which joins Kahiltna River about 13 miles below Kahiltna Glacier. It and its larger tributaries head in Peters and Dutch hills, and its course lies through a broad, elevated trough, which runs between these ranges and is continuous from the Tokichitna to the Kahiltna, sloping gently toward the latter. Cache Creek drains the southwestern part of this trough. The many tributaries head in glaciated valleys in the hills; but on entering the broad interhill trough they pass from the slate-graywacke formation, or hard bedrock, out onto the loosely consolidated beds of the coal-bearing series which form the so-called soft bedrock. As Cache Creek in the upper part of its broad basin has an elevation of about 2,000 feet, and its junction with Kahiltna River is less than 600 feet above sea level, it falls 1,400 feet in 18 miles. It has therefore been able to intrench itself into the soft underlying formation and flows through a gorge whose walls in places rise 300 feet above the creek. Its tributaries also have made deep cuts where

they cross the basin. The largest tributaries enter the stream from the northwest, and mining has been confined altogether to these streams and to the main creek.

CACHE CREEK.

CHARACTER AND EXPLOITATION OF THE DEPOSITS.

Cache Creek heads in a small glacial valley in the Dutch Hills, through which it flows for only 2 miles before it emerges into the broad and wide valley which it follows to Kahiltna River. In the hills its valley is cut in the slate-graywacke series, and the stream gravels lie upon hard bedrock. Near its head the stream has eroded its valley but little in postglacial times, but for a short distance back from the base of the hills it has cut a sharp canyon into the slates. This canyon ends abruptly at the contact between the slate series and the sands and shales of the coal-bearing formation, and from this point downstream the creek, though intrenched below the level of the broad plateau, has a wider valley floor. The valley walls, or benches, are about 50 feet high at the mouth of the canyon. At the mouth of Nugget Creek the stream bed is about 250 feet below the level of the surrounding deposits, and the depth increases to nearly 300 feet between Nugget and Spruce creeks. Below Spruce Creek the stream has a steep gradient through a boulder-filled canyon, below which it reaches the Kahiltna Flats.

Gold was first discovered on Cache Creek in 1906, the year after the first discoveries in this region were made on the headwaters of Peters Creek. The first ground mined was at the canyon near the head of the stream on Discovery claim, which has been worked every year since. During the summer of 1911 two men were mining a short distance below the mouth of the canyon. The ground worked was that of the present stream flat and the gravels moved range from 4 to 7 feet in depth and lie upon slate bedrock. There are some large boulders present, but most of them can be handled by one man. A short distance below the canyon the slate bedrock gives place to the coal-bearing series, which changes character within short distances, ranging from a fairly firm, gritty sandstone to soft clay shales. The pay streak is said to be rather well defined in the canyon and for a short distance below it, but spreads out in the wider valley below and is difficult to trace. The gold is rather unevenly distributed, for though most of it is found on bedrock the degree of its concentration depends somewhat on the character of the bedrock, the harder strata having retained it better than the softer. No records have been kept which would show the gold content of the gravels to the cubic yard or to the square yard of bedrock, but it is reported that the returns have averaged about \$10 a day for each man employed. The sluice boxes, 14 inches wide, are set on a grade of 5 inches to the

box length. The gravels are groundsluiced by the aid of canvas hose and water under pressure from the bench to the southwest to within a foot or so of bedrock and the rest of the gravel is shoveled in and bedrock cleaned by hand. The stream at "Discovery" claim can be depended upon to run a sluice head of water for the boxes used throughout the season and most of the time flows two sluice heads. The gold is coarse and bright and somewhat worn, though many pieces are rough and some cubes of crystalline gold have been found. Pieces worth \$20 have been taken from this claim, and only about one-third of the gold recovered will pass through a 16-mesh screen.

The coarseness of the gold and the roughness of some of it indicate that it has traveled no great distance from its bedrock source and it must originally have come from the quartz veinlets of the slate-graywacke series in the upper part of the Cache Creek valley. The upper valley at one time contained a vigorous glacier and ice also came into it from the head of Bird Creek, across a low divide. This glacier eroded its basin and doubtless scattered and removed any preglacial gold which may have been concentrated in its upper portion. No ground carrying commercial values in gold has been found above the canyon of Cache Creek. Toward the mouth of the slate valley the ice scour was less severe, as the glacier joined a large, sluggish ice sheet in the broad basin between Dutch and Peters hills. Here the valley deepening was not pronounced and a part of the material picked up by the ice in the upper valley was dropped. It may be that the glacial deposits here covered up portions of the preglacial channel of Cache Creek without disturbing them. With the melting away of the glacier the stream cut through the glacial deposits and at and below the canyon intrenched itself into the slates and the softer beds to the eastward. In the rehandling of the glacial material any of the gold which it contained was concentrated in the stream bed, and if the valley was cut through any undisturbed portions of the old preglacial channel, this, too, would have contributed to the richness of the present placer deposits.

The possibility that remnants of the old channel still exist in the benches is suggested by several facts which have been learned during the years that mining has been carried on here. It is said that the pay streak terminates rather abruptly at its upstream end in the canyon, although some gold has been found farther upstream. In the spring of 1911 a cut was run into the high bench at the point where the pay streak failed. The bench consists of gravels lying on decayed rocks of the slate series and overlain by 15 to 20 feet of glacial till. In groundsluicing the upper portion of this cut some gold was recovered, but most of it lay on or in bedrock. The gold was coarse, the largest nugget being worth \$9. It may be that at this place there is a portion of a preglacial stream channel which con-

tained workable placer. At the time visited the development work on the bench was insufficient to show definitely the presence of such an old channel or to give any definite clue as to its length or direction.

In 1911 two men were mining on Cache Creek about a mile above the mouth of Nugget Creek. The ground worked was on the present stream flat and ranged in depth from 4 to 7 feet. The usual number of coarse boulders were encountered, but most of them could be readily thrown from the pit. The gravels lie on "soft bedrock," composed of the clay, sand, and soft conglomerates of the coal-bearing series. At one place the creek is crossed by a bed of lignite, which held the gold and yielded good returns. The gold in the gravels is mostly found on bedrock, the richness of the ground depending to an important degree upon the character of the beds crossed. Where the bedrock is clay, little gold is found, but the sandy and gravelly beds have retained the gold much better. A grade of 5 inches to the box length is maintained, this being less than the fall of the creek. The sluice boxes in use are 20 inches wide, and the creek at this point supplies enough water for them throughout the summer. Water under pressure is obtained from Columbia Gulch, a small tributary of Cache Creek from the north, and is carried by ditch over the bench to a point opposite the pit, to which it is conducted through 6-inch canvas hose. A working head of about 75 feet is thus obtained and a 2½-inch nozzle is used in piping the gravel into the boxes. It is reported that the returns from the season's work on this ground were not large.

In the main valley of Cache Creek mining was done at a number of points between the mouths of Nugget and Spruce creeks from 1906 to 1908. In some places the ground worked was in the present stream flat; in others the gravels on benches along the valley sides were mined. In 1908 the Cache Creek Mining Co. was organized and purchased all of the main creek valley from a point 2½ miles below Spruce Creek to the mouth of Gold Creek, a distance of more than 12 miles, as well as a number of claims on the more important tributaries. The total holdings of the company embrace more than 3,000 acres, and extensive preparations have been made for developing the ground. A sawmill has been built on the main creek one-half mile above the mouth of Thunder Creek, which furnishes lumber for buildings, penstocks, flumes, and sluice boxes; and several thousand feet of hydraulic pipe, some as large as 34 inches in diameter, has been placed on the ground. During the season of 1910 and 1911 the energies of the company were in large part directed to procuring an adequate supply of water under pressure, so that their ground could be mined by hydraulic methods. A ditch, originally designed to carry 1,500 miner's inches of water, was surveyed to tap Nugget Creek on claim "No. 7 above," but was only partly completed. Its

connection with Nugget Creek was never made, but during the period of the spring run-off it receives a considerable volume of water from the melting snows on the Dutch Hills and on the broad high bench which it traverses. A second ditch, to carry 2,300 miner's inches of water, was almost completed in 1910. This ditch was to draw its water from Cache Creek a short distance below the mouth of Nugget and carry it for nearly 2 miles to a penstock, from which it was to be taken through a 34-inch steel pipe to the point where needed. The working head at the penstock was 120 feet, and this would be increased to 180 feet at the sawmill. In building this ditch some slumping ground was encountered, and during the summer of 1911 the lower portion of the ditch was abandoned, and the water was carried from the completed portion to the so-called Pineo Bar through steel pipe.

In 1910 mining was carried on at two localities by this company. The upper one of these, on Pineo Bar, lies about halfway between the mouths of Nugget and Thunder creeks. The ground worked is a few feet above the present level of Cache Creek, and the gravels lie upon the sands, clays, and conglomerates of the coal-bearing series. In the bluffs on either side of Cache Creek the beds are seen to lie with only a slight inclination from the horizontal, but on the northwest side of the stream there has been extensive slumping, and the strata shown in the exposures of bedrock in the cut stand nearly vertical. The bench gravels here are certainly deposited upon a slumped portion of the valley wall. In 1911 work was continued at this place, but nothing was learned in regard to the gold recovered per cubic yard of gravel moved.

In 1910 a portion of the bed of Cache Creek was worked at a point near the mouth of Rambler Gulch. The creek was here flowing close to bedrock, and by diverting the stream from its channel during low water bedrock could be cleaned by removing only a thin layer of gravel. Gold was recovered here in considerable amounts, but its distribution was irregular, depending upon the character of the bedrock. Wherever the stream crossed a sandy or conglomeratic bed the gold had lodged, but the clayey beds were almost bare, the gold having passed on over them to find a more favorable resting place on the rougher bedrock. It is said that one working upstream could predict when a clayey bed was to be crossed by the exceptional richness of the sandy or gravelly portion of the bedrock just below. In 1911 a cut was run from the mouth of Rambler Creek up that stream for about 700 feet. A portion of the ground at the mouth of the creek was mined by pick and shovel, but that farther up was piped in by means of hydraulic giants. The depth of gravel was irregular, ranging from 18 inches to 10 or 12 feet, and the surface of the soft bedrock was uneven. At the stream mouth the gold was recov-

ered from a bedrock of rather firm conglomerate, called cement rock by the miners, but farther upstream the beds of the coal-bearing series were encountered, the clayey shales predominating, with some sandy and gravelly beds and a little lignitic coal. These beds are tilted at various angles, and have evidently been affected by slumping. For the lower end of the cut water was supplied to the 3-inch nozzles from Rambler Creek, with a head of about 60 feet. Later in the season water was secured from the upper end of Lucky Gulch, with a head of 230 feet at Cache Creek. The dirt was piped into 24-inch boxes, set on a grade of 6 inches to the box length. At the upper end of the cut the values are reported to have decreased and work was discontinued, the plant being shifted to a bench on Cache Creek about 400 feet above the mouth of Rambler Creek. Here the surface of the gravels lay about 10 feet above the level of Cache Creek and the depth to bedrock averaged about 6 feet. Large boulders were not common in this cut, and those encountered all lay upon bedrock. The value of the gold recovered is said to have averaged approximately \$1.50 to the cubic yard of dirt moved.

GOLD CREEK.

Gold Creek is the uppermost tributary of Cache Creek from the north, and lies between the head of Cache Creek and Nugget Creek. It is a small stream, its total length being only $1\frac{1}{4}$ miles, its upper end heading in the slate hills and its lower portion flowing through a valley cut in the coal-bearing series. Gold was first discovered on it in 1909 near the point at which it passes from the slate onto the softer deposits. At this point the valley is narrow and V-shaped, the gravels to be mined rarely having a width of more than 20 feet. The depth to bedrock ranges from 2 to 6 feet, the gold being found on bedrock or in the crevices of the slates, which are here standing on edge. The gold is coarse and shotty, pieces up to \$14 in value having been found. Its assay value is \$17.81 per ounce, of which \$0.06 is in silver. No mining was being done on this ground in 1911.

NUGGET CREEK.

Nugget Creek is the uppermost large tributary of Cache Creek, joining it a few miles below its head. Its source is in the Dutch Hills, through which it flows in a wide, straight, U-shaped valley, which shows strongly the erosive action of the great glacier that once occupied it. In the hills the basin of Nugget Creek is composed of the rocks of the slate-graywacke series, and the stream flows in a postglacial canyon which is shallow toward the valley head but which becomes narrower and deeper downstream. At the point where it leaves the slate hills the creek occupies a canyon cut 200 feet into the rocks, but at the base of the hills the slates give place

to the softer rocks of the coal-bearing series, and through these the stream has widened its gorge, though the valley walls are high and steep throughout the remainder of its course to Cache Creek.

Gold was first discovered on Nugget Creek in 1905 and the ground first worked was in the lower portion of the rock canyon. Since that year mining has been carried on in the valley each summer. The claims lying immediately above the mouth of the canyon, known as Nos. 1, 2, and 3 below, have yielded the greatest part of the production and are now practically worked out, but a considerable area of ground which is known to contain paying quantities of gold remains unworked.

During the summer of 1911 mining was done on this creek by four parties. The largest camp, consisting of 10 men, was on No. 4 below, the ground worked lying a short distance below the mouth of the slate canyon. The stream gravels are from 6 to 8 feet thick, and lie upon the soft bedrock of the coal-bearing series. The gold is recovered principally from the gravel within a foot of bedrock and on the bedrock itself, which is of sandy or clayey material or loose conglomerate. The gold is very coarse, somewhat rusty, and moderately worn and smoothed. Nuggets worth \$16 have been found below the canyon, and in the canyon one worth \$60 was recovered. Simple mining methods are used, the upper portion of the gravels being groundsluiced off by means of water under pressure, delivered through canvas hose, with a head of 70 feet. The gravel immediately above bedrock and a part of the bedrock itself are shoveled by hand into 14-inch sluice boxes.

Above the present stream flat, at the mouth of the canyon, portions of the former valley floor of Nugget Creek appear as terraces or benches, seven of which can be distinguished. Workable placer has been found on a number of these benches, and one bench, 170 feet above the stream, was being mined at the time of visit. The gravel here, which was from 1 to 6 feet deep, lay on slate bedrock and is said to have yielded much gold. None of the benches, however, is large and the amount of paying ground on them is small.

Three men were engaged in mining at the junction of claims Nos. 1 and 2 above, at which place Nugget Creek lies in a slate canyon about 70 feet deep. The stream is crooked and its flat narrow, only small patches of gravel appearing between the creek bed and the base of the canyon walls. The ground worked ranged from 5 to 6 feet in depth and contained a good many boulders, most of which, however, could be moved by hand. Hydraulic methods were employed for stripping away the upper portion of the gravels, and the water was obtained from a small tributary on the northeast side of the creek and conducted through a ditch over a thousand feet long to a point above the cut, where it was delivered through canvas hose with a head

of 70 feet. Bedrock here consists of slates and graywackes, which stand at high angles and strike in the general direction of the course of the creek. The gold is coarse and somewhat worn, and is unevenly distributed over the bedrock. Where the bedrock is rough, much gold is found, but where it is smooth the gold recovered is not sufficient to pay for the handling of the ground.

On claim No. 3 above two men were mining on a bench which lies some 10 feet above the level of the stream. Pick-and-shovel methods were used for getting the lower part of the gravels into the sluice boxes, after the upper portion had been removed by groundsluicing. Sluice boxes 12 inches in width were set on a grade of 8 inches to the box length, and sufficient water was to be had during the entire season. Most of the gold recovered was found on bedrock, which is here slate or graywacke. The gold is coarse, nuggets ranging in value from \$1 to \$6 being common. It is planned to build a ditch in 1912 to bring water under 70 feet pressure to the cut, and to install 24-inch boxes, so that a larger quantity of ground may be handled.

Claim No. 4 above was purchased by a party of three men who commenced mining in the spring of 1911. A wing dam was constructed which diverted Nugget Creek for about 300 feet, and the bed of the creek was mined by shoveling the gravel into the sluice boxes. The ground ranges in depth from 2 to 9 feet, and most of the gold was found on or near bedrock, which is here composed of the uptilted beds of the slate-graywacke series. Much of the gold is coarse, somewhat rusty and worn, and although some fine gold was recovered the greater part occurred in pieces worth from 10 cents to \$3.50. The result of the season's work on this claim are reported to have been fairly satisfactory, and it is the intention of the owners to obtain water under pressure by building a ditch, and to enlarge their sluice boxes next summer.

Two parties were mining during the summer of 1911 on the Jumping Jack claim, in the valley of Nugget Creek close to its junction with Cache Creek. Two men were working on the south side of the creek and one man on the north side. The gravels here range from 3 to 5 feet in depth, lie on soft bedrock, and are comparatively free from large boulders. The bedrock surface is irregular, being cut by shallow grooves which diverge like the rays of a fan, showing the old channels which Nugget Creek once followed as it left its own valley to join Cache Creek. The gold is irregularly distributed over bedrock, the ground being "spotted," as the miners say. The gold is brighter and finer than that found in upper Nugget Creek. The season's work showed the gold tenor of the gravels in lower Nugget Creek to be too low to warrant working by pick-and-shovel methods.

LUCKY GULCH.

About $1\frac{1}{2}$ miles below the mouth of Nugget Creek a small valley known as Lucky Gulch joins the Cache Creek valley from the northwest. This valley is sharply V-shaped and has a steep gradient. It heads on the broad bench in which Cache Creek has intrenched itself and is scarcely more than a mile long. Lucky Gulch lies exclusively within the area of the coal-bearing series, and throughout its length the stream flows over "soft bedrock," which is covered by only a shallow filling of stream gravels. At times mining has been done in this gulch in a small way, but its total production has not greatly exceeded \$1,000. No work was being done at the time it was visited in 1911.

RAMBLER GULCH.

Rambler Gulch joins the Cache Creek Valley three-fourths mile below Lucky Gulch, from the same side, and, like it, is short and steep and lies altogether in the coal-bearing sediments. In its upper portion the ground was shallow and easily worked, and the creek bed was worked out in the early years of the camp, a few thousand dollars in gold being obtained. In 1911 mining was resumed on the lower portion of the creek, under conditions that have already been described (pp. 186-187).

THUNDER CREEK.

Thunder Creek heads in the slates and graywackes of the Dutch Hills near Nugget Creek. On leaving the hills it bends to the south, following the general direction of the Cache Creek valley, and joins Cache Creek $3\frac{1}{2}$ miles below the mouth of Nugget Creek. In its course below the hills it is intrenched below the level of the surrounding plateau, its valley lying for the most part in the beds of the coal-bearing series. For a portion of its length, however, it has cut through the softer sediments into a ridge of underlying slates. The bedrock conditions, therefore, vary in different portions of the stream's course. During the summer of 1911 one man was mining on claim No. 3 below. The gravels, which are from 2 to 3 feet deep, were groundsluiced and the lower portion was shoveled into the boxes. Bedrock here consists of the soft materials of the coal-bearing series. Some lignite outcrops in the high bluffs of the stream. The gold is bright and fairly coarse, but the pay streak is irregular and the gold content varies greatly from place to place, so that the returns are uncertain. The lower mile of Thunder Creek has been staked as an association claim, and four men were mining on the upper half of it. The gravels average about 5 feet in depth and contain few boulders which a man can not roll from the pit. The bedrock is of varying character, at places being of the soft coal-bearing beds, and at other places appearing to be a much-weathered and decayed phase of the

slate series. Sluice boxes 22 inches in width, set on a grade of 6 inches to the box length, were in use, and a 1,200-foot ditch supplied water from Thunder Creek with a head of 35 feet at the cut. Canvas hose and a nozzle were used for piping off the upper portion of the gravels, and the ground near bedrock was shoveled in by hand. The gold is bright and rough, many pieces having quartz attached to them, and seems to have traveled no great distance from its source. It assays \$17.80 to the ounce, and the ground worked ran from \$2 to \$2.50 per cubic yard. Toward the end of the season the work was retarded by a shortage of water.

FALLS CREEK.

Falls Creek is the next important tributary of Cache Creek south of Thunder Creek. It heads in the slates and graywackes of the Dutch Hills, flows in a course roughly parallel to that of Thunder Creek, and joins Cache Creek about three-fourths of a mile south of it. At the point where it passes from the slates onto the beds of the coal-bearing series it has formed a narrow canyon and a waterfall, which suggested its name. Gold was first mined on Falls Creek in 1905, in the canyon cut through the slates, and the stream afforded considerable production for a few years. In the narrower portion of the canyon the difficulties of diverting the creek prevented mining during the season, except for a short time in the spring, when the volume of the stream was small. At the time this creek was visited in 1911 two men were preparing to sluice ground on a high bench on the northeast wall of the valley, on claim No. 3 above. A ditch 2,000 feet long to supply water under pressure was almost completed, but aside from a few small prospect pits no mining had yet been done.

DOLLAR CREEK.

Dollar Creek, the lowest large tributary of Cache Creek from the west, joins Cache Creek 2 miles below the mouth of Falls Creek. The geologic and topographic conditions in its basin are much like those on Thunder and Falls creeks. Dollar Creek flows from the slate hills at its head out onto the Cache Creek plateau in a sharply incised valley, which gradually becomes deeper downstream, until at the mouth of the creek the valley bottom lies over 300 feet below the general level of the surrounding country. Even below the border of the Dutch Hills the slate bedrock is exposed by the stream cut for some distance out onto the plateau, showing that the old slate surface upon which the soft bedrock sediments were laid down was uneven. Since 1905 placer gold has been known to be present in this stream and a few thousand dollars have been recovered from the stream gravels in the slate canyon since that time. In previous years, however, the gravels have yielded only moderate

returns for the expense and labor required to work them. During the spring of 1911 two men began mining on claim No. 2 above, but finding that the pay streak in the creek ended abruptly upstream they ran a cut into the high bench on the northeast side in the hope of finding the source of the gold. In working up the valley side the miners found that slates and graywackes extended to an elevation of about 70 feet above the creek. In the creek channel the beds of the slate series are hard and firm, but toward the top they are weathered and appear as fairly soft sandstones and shales. The beds of the coal-bearing series, which are only a few feet thick, appear above the slates. Some pieces of lignite were found in the cut. Above the soft bedrock lay a bed of stream-washed gravels, from which rich pans were obtained, as much as \$2.50 being taken from a single pan. Above the stream gravels the exposure showed 20 feet of typical boulder-studded glacial clay. At the time the place was visited too little work had been done to determine exactly the conditions at this place, but the facts gathered seem to show that the stream gravels were laid down in an old channel—perhaps a former channel of Dollar Creek—before the great glacial advance, as is shown by the overlying layer of glacial boulder clay. It is also of interest to note that there was a good concentration of placer gold in pre-glacial times. The gravels in the old channel are of the same materials as are now found in the stream bed, the largest boulders being 18 inches in diameter. The material is oxidized to a yellow color, and the pebbles are somewhat decomposed, the whole being cemented into a loose conglomerate which yields with difficulty to hydraulic methods of mining. The gold is coarse, rusty, and very angular. Some pieces, which seemed to be small nuggets, were found on close examination to consist of a large number of small grains cemented together by iron oxide. It is reported that the developments later in the summer showed that the gravels occupy a distinct channel, which diverges upstream from the present valley of Dollar Creek, although it was traced for only a short distance. It is also reported that two distinct pay streaks were found in the gravels, one a few feet above the other, and that the gold was associated with much broken, angular quartz, indicating the possibility that it came from a vein at no great distance. The season's output from this mine is said to have been highly satisfactory, and preparations were being made to install a hydraulic plant so that operations could be conducted on a larger scale.

PETERS CREEK BASIN.

PETERS CREEK.

Peters Creek occupies a valley intermediate between Kahiltna and Tokichitna rivers and in its upper portion is roughly parallel to these two streams. It heads in a broad, severely glaciated, U-shaped

valley in the Dutch Hills, emerges from them to cross the Cache Creek Plateau at a right angle, crosses the Peters Hills through a deep, transverse trough, and enters the broad lowland of the Susitna Valley, the west edge of which it follows to its junction with Kahiltna River. Its total length is more than 35 miles. In its course through the higher parts of the Dutch Hills it flows in the bottom of the glacial trough in a channel which has been notched little or not at all into the slates and graywackes of these hills. In the more easily eroded coal-bearing beds of the Cache Creek plateau it has intrenched itself deeply in a canyon-like valley that extends headward into the slates for some distance above the mouth of Bird Creek, and a similar canyon extends for more than a mile up Bird Creek. As the Cache Creek plateau slopes downward toward Peters Hills, the stream valley becomes shallower and wider in that direction, but on entering the valley through these hills the creek again flows through a rock canyon. This second slate canyon terminates at the east border of the Peters Hills, the stream once more flowing between valley walls of the coal-bearing series, the banks gradually becoming lower downstream through the little known area of the Susitna lowland to the south and east.

Gold was discovered at a number of places on Peters Creek and its affluents in 1905, and mining has been done on that creek each summer since that time. In 1911 work was in progress at two places on the main stream. At the mouth of the canyon through Peters Hills, a short distance above the point at which the stream passes from the slates onto the soft bedrock, two men were mining on a bench about 30 feet above the stream level, where a few feet of gravel lies upon a slate bedrock. Water under a pressure of 70 feet, brought by ditch and canvas hose, was used for piping the gravels into the sluice boxes. The gravels contain rather abundant bowlders, and at the time the place was visited some of the ground was still frozen. The gold, which is for the most part concentrated on bedrock, is coarse, flat, worn, and somewhat rusty, and gives evidence of having traveled some distance from its source. The largest nugget found weighed 9 pennyweights, and the gold assayed about \$17.75 to the ounce. The ground worked in 1910 was a short distance downstream from that worked in 1911, on a bench only a few feet above the stream. The bedrock at this place is a hard, rusty dike intruded into the slate. Prospect holes in the creek gravels below the canyon show placer gold on soft bedrock, but the gradient of the creek is too low and the ground too deep to permit mining by pick and shovel.

The bedrock source of the gold in lower Peters Creek is still open to question, but this gold, like that in the other parts of this district, was doubtless derived from the quartz stringers in the slates and graywackes. In lower Peters Creek some of the gold may have come

directly from the rocks of Peters Hills through which the valley is cut, but as gold is found in the stream gravels above the Peters Hills and up to the head of the stream it seems probable that the present placers are in large part the product of reconcentration of gold that was scoured from the upper tributaries of the stream by glacial ice, scattered throughout the valley, and again reconcentrated by post-glacial erosion.

About three-fourths mile below the mouth of Bird Creek, at the lower end of the upper rock canyon of Peters Creek, two men were mining near the contact of the slates with the soft bedrock. A dike of a crystalline intrusive rock crosses Peters Creek at this place. The creek gravels average about 6 feet in depth, and the gold is concentrated on or near bedrock. At the time the creek was visited in 1911 little ground had been mined, but the claims between the mouth of the canyon and Bird Creek are said to have produced a few thousand dollars altogether.

BIRD CREEK.

The valley of Bird Creek, a tributary of Peters Creek, lies altogether in the slates of Dutch Hills and is but little more than 2 miles long. Its head is a broad cirque, which was once occupied by a glacier that evidently joined the valley of upper Cache Creek. Bird Creek, however, turns northward from this broad valley, and in the last mile of its course flows through a narrow postglacial canyon. The canyon walls show excellent exposures of the slate and gray-wacke series, which at several places are cut by light-colored dikes. Gold is being mined at three places in the canyon. At the upper place, on the fourth claim above the mouth of the creek, the stream flows in a narrow gorge, which is 80 feet deep. The gravel benches are from 1 to 3 feet deep and are of small area, as in many places the stream fills the canyon bottom. Most of the gold mined has been recovered by diverting the stream with wing dams and cleaning the bedrock in the stream channel, much gold having penetrated a foot or two into the crevices of the slates. The gold is coarse and rough, and assays about \$17.90 an ounce. One man was working on this ground in 1911. The gold is irregularly distributed, rich spots being succeeded upstream or down by barren ground, so that the returns are uncertain.

One man was mining on claim No. 3 above, and one on No. 2 above, under conditions much like those described for claim No. 4 above. The ground is 4 to 5 feet deep and is worked by groundsluicing and shoveling in. The slates are very irregularly bedded and great care must be exercised in cleaning bedrock, as the gold penetrates deeply into the cracks. At one place where a dike crosses the creek gold was found in crevices 5 feet below the stream bed. The gold is

bright and coarse, and although many pieces are worn smooth much of it is rough and angular. The great drawbacks to mining are the irregular distribution of the gold and the large percentage of bowlders in the stream gravels.

The rock walls of the canyon of Bird Creek are in many places capped by a heavy layer of glacial clay from which some gold has been recovered, but not enough to encourage its further exploitation.

COTTONWOOD CREEK.

The only important tributary of Peters Creek from the north is Cottonwood Creek, which flows close to the west base of the Peters Hills and which itself has two western tributaries of economic importance.

Willow Creek.—The lower tributary of Cottonwood Creek is Willow Creek, which heads on the southeast flank of Dutch Hills and flows for about a mile through a slate valley, below which it is intrenched in the coal-bearing beds to its mouth. Gold was first found on Willow Creek in 1906, near the contact between the slates and the soft bedrock, and mining has been in progress on this stream each season since. In 1911 claim No. 1 below was being worked by five men. As the volume of the stream diminishes greatly toward the end of the summer it is the practice to groundsluice off as great an area in the period of early spring flood waters as can be mined during the remainder of the season and to clean up bedrock later, when the water is low. Water from a high ditch that gave 30 feet pressure at the cut was used in stripping off the upper gravels. The gravels mined are from 6 to 8 feet deep, and the gold is recovered from a soft, sandy bedrock. It is coarse, rusty, and somewhat worn, and assays \$17.85 an ounce.

On Discovery claim 11 men, working in two shifts of 10 hours each, were mining by pick and shovel methods on ground a short distance below the mouth of the slate canyon. The ground was from 6 to 8 feet deep, and most of the gold was concentrated on soft, sandy, or gravelly bedrock. The work at the cut was hampered by the low grade at which the boxes had to be set, as it had been necessary to build a wall at the lower end of the claim and to pile tailings in order to keep from covering the ground on claim No. 1 below. The gold is bright, somewhat worn, and very coarse, nuggets having a value of \$30 having been found and pieces weighing one-half ounce being common. The operations on this claim in both 1910 and 1911 were very successful, although a shortage of water in the fall of 1911 reduced the output below what it otherwise would have been.

A number of small tributary streams of Willow Creek, known as Rocky, Snow, Slate, and Falls gulches, all in the slates of the upper portion of the basin, have at times been mined in a small way. The

total production of all four, from 1906 to 1911, inclusive, is estimated at between \$7,000 and \$8,000.

Poorman Creek.—Poorman Creek lies northeast of Willow Creek and is roughly parallel to it, joining Cottonwood Creek about 2 miles above the mouth of that stream. The gulches at its head have cut down into the rocks of the slate and graywacke series, but for most of its length it crosses the soft coal-bearing beds and is intrenched into them. Discovery claim lies across the contact between the slates and the soft bedrock. It was staked in 1906 and has been mined every year since that time. The greatest production was in 1907, when six men working for only a short season and with a very small supply of water, recovered 1,329 ounces of gold. The gravels mined that year lay on slate bedrock, and the ground was very shallow, so that it was quickly worked out. Since that year most of the work has been done on the lower portion of the claim, where the gravels are in places 11 feet deep and lie on soft bedrock. Some mining has been done on the benches above the present stream flat, and paying ground has been found on them. The creek gold is coarse and much of it is dark colored and rusty. Pieces valued at \$33 have been found. The bench gold is brighter and not so coarse as that in the stream bed.

Claim No. 1 below and a fractional claim between No. 1 below and No. 2 below have been mined by the owner since 1906, but at the time the place was visited he and another man were working on the upper end of No. 2 below, by groundsluicing and shoveling in. The gravels are from 8 to 11 feet deep and lie on a loose conglomerate of the coal-bearing series. A bed of lignite, which crosses the creek on claim No. 1 below, has furnished some fuel for the camp. The gravels are nowhere exceptionally rich, but the gold is said to be evenly distributed in them across the whole width of the flat, a distance of 150 feet in places, and might be profitably recovered if some more economical method of mining could be employed. The gold, most of which occurs in the lower 3 feet of gravels, is coarse, rusty, and worn smooth. The largest nugget found had a value of \$28. The small flow of Poorman Creek has always hindered mining during the later half of the season.

TOKICHITNA BASIN.

A tributary of the Tokichitna, known as Long or Dog Creek, heads in the broad plateau near the head of Cottonwood Creek. In 1908 three men mined successfully on this stream, the gold being found on slate bedrock. In 1910 an attempt was made to continue mining here, but the depth of gravels increased abruptly in the stream bed, and a deep excavation made by groundsluicing with an automatic dam failed to reach bedrock. The production in 1911 was therefore light.

LAKE CREEK BASIN

LAKE CREEK.

Lake Creek is a large stream, 40 miles long, which heads in a lake in the high mountains between Yentna and Kahiltna rivers and flows over a high plateau in the upper half of its course. Throughout the lower half of its course it is intrenched in glacial materials and beds of the coal-bearing series, flowing in a canyon which in places has a depth of 300 feet. In the headward portions of its basin gold has been found in many places, but in sufficient quantities to mine only in the basin of Mills Creek. In the lower intrenched portion of the valley some gold was recovered from the stream bars several years ago, but no permanent camps were established. It is reported that in 1911 one man was mining gravels on a bench 50 feet above the stream, about 12 miles from its junction with Yentna River. All the gold taken from lower Lake Creek is fine and has evidently traveled far from its source. Much of it was probably taken up by the glacial ice from the higher mountains and deposited in the glacial clays and was reconcentrated by the stream.

MILLS CREEK BASIN.

Mills Creek is a tributary of Camp Creek from the west. Camp Creek, which empties into Lake Creek, drains a portion of the foothills and of the high plateau between that stream and Yentna River. In the upper portion of Mills Creek basin only the soft beds of the coal-bearing series and their associated gravels are exposed, the rocks of the slate and graywacke series which are seen in the basins of the streams of the Cache Creek region not appearing at the surface. Gold in paying quantities has been found only in the gulches of the hills that surround the two main forks of the stream. These hills were formerly covered and smoothed by the great glacier which mantled the region, but since its retreat the streams have cut considerable valleys in the easily eroded materials of which the hills are composed.

Gold was first discovered in this basin in 1906 in Wagner Gulch, a small tributary of Mills Creek, near its head. The gulch is steep and narrow and contains only a small stream. The ground to be mined averaged only 20 to 30 feet wide in the valley bottom and was from 3 to 10 feet deep. The gold was found on a somewhat consolidated bed of gravels in the stream bed or on the sands and clays of the coal-bearing series. It is bright in color and is flat and much worn, showing evidence that it has been transported some distance from its bedrock source. This gulch is about mined out, as the pay streak terminated rather abruptly upstream. No work was done on it in 1911.

In Chicago Gulch, another tributary of upper Mills Creek, the conditions for mining are much like those on Wagner Gulch, except that the valley is smaller and steeper. The fall of the creek is about 1 foot in 6, and the stream gravels average about 20 feet in width from one valley wall to the other. Boulders are numerous, but few are too large for one man to handle. The flow of the stream becomes small during the later part of the summer and sluice boxes 12, 10, or 8 inches wide are used, according to the supply of water. The gold is coarse, but is flat and flaky, and few large nuggets have been found. The pay streak in this gulch, like that on Wagner Creek, played out abruptly upstream. One man was mining on Chicago Gulch in 1911.

Little work has been done in the main valley of Mills Creek, as prospectors there have always had difficulty in reaching bedrock. The dryness of the season of 1911 put an end to mining on the smaller gulches at an earlier date than usual, and a number of men thus found opportunity to sink a bedrock drain in the main creek valley a short distance above the mouth of Chicago Gulch. Bedrock was reached at a depth of 12 feet, and it was reported that sufficient gold to warrant mining was found.

Twin Creek forms one of the headward forks of Mills Creek and, like it, lies in a basin composed solely of the gravels, sands, and clays of the coal-bearing series. Gold has been mined on three small tributaries known as Big Boulder, Little Boulder, and Johns creeks. They are small, steep-sided gulches cut into the soft bedrock, with steep gradients and narrow valley floors. The conditions in these gulches are like those in Wagner and Chicago gulches, already described. The stream gravels have been mined for the last six years by various people and the production, though never large, has been fairly steady.

The bedrock in the basins of Mills and Twin creeks is quite different from that in the heads of the streams in the Cache Creek region, and the same explanation of the origin and distribution of the placer gold can not be applied to both areas. In the Cache Creek district all the producing creeks head in the slates and graywackes of the foothills ranges or flow through materials which have come from these hills, and the gold was certainly derived from the slates. The basins of Mills and Twin creeks lie altogether in the sands and shales of the coal-bearing series and the associated gravels, and the present valleys of the streams have been eroded in postglacial time. It seems certain, therefore, that the placer gold of the creeks was scattered through the deposits in which the streams are eroding and has been concentrated by them to form workable placer. Sufficient prospecting of the materials of which the hills are composed has not been done to determine their gold content, but the manner in which the pay streaks terminate rather abruptly upstream in the several gulches

suggests that most of the gold is derived from certain well-defined strata in the hills and is found in the creeks only below the point at which these strata are crossed by the streams. The gold is flat and worn, having been rehandled by the streams. Its original source may have been the slates in the mountains to the northwest, but of this there is no definite evidence.

PROSPECTS.

In addition to the producing creeks already described, prospecting has been done on many streams in the Yentna district, some of which give considerable promise and may soon support a mining population. Kichatna River, and its tributary, the Nakochna, which lie southwest of Yentna River, above the Skwentna, have been prospected by a number of men, and have yielded some fine gold. It is reported that these streams afford extensive areas of gold-bearing gravels suitable for dredging. Independence Creek, a small tributary of the Yentna below its forks, contains some gold and has been prospected for several seasons.

The streams between Mills Creek and Kahiltna River, including Camp, Sunflower, and Lake Creek basins, have been prospected, and though gold is present in all of them, no paying ground has so far been found. Unsatisfactory prospects have also been found on the streams between Dutch Hills and the main mountain range.

On the east side of Peters Hills, on the headward tributaries of Martin Creek, coarse gold has been found, although this drainage basin has received little attention from prospectors. The geologic conditions are somewhat similar to those on the producing tributaries of Cache Creek, and from this it would appear that this neglected area is at least worthy of more thorough prospecting.

The recovery of considerable fine gold from the bars of Lake Creek and Kahiltna River and reports that encouraging amounts of gold in the wide flats on the lower courses of these streams give hope that at some future time these streams may support a dredging industry.

SUMMARY OF PLACER MINING.

Placer gold has been mined in the Cache Creek district since 1905 and in the basin of Mills Creek since 1906. Though the region has at no time been the scene of great activity or of large production, its output has been steady and the interest in it has steadily grown greater. The population has increased from a few men in the early years to more than 100 men in 1911, most of whom were actively engaged in mining or in development work. In the Cache Creek district the gold assays from \$17.70 to \$18.10 per ounce, and in the Mills Creek camps it averages about \$17.65 an ounce. The total out-

put up to the present time is estimated at \$383,000, of which about \$63,000 was produced in 1911. These figures should be encouraging if the lack of transportation and the freight charge of 10 to 15 cents a pound for all supplies and equipment brought to the mines are considered. Should a railroad penetrate the Susitna Valley and reduce the time and expense of landing supplies at the camps, much ground which is not now worked could be mined at a profit and the gold output of the region would be greatly increased.

COAL.

The accompanying map (Pl. IX) shows the areas over which the beds of the coal-bearing series of rocks outcrop at the surface, but it by no means indicates all the area underlain by this series, which in many places is covered by glacial materials and stream gravels. It should not be understood that all the area so mapped contains workable coal beds, for in most places the exposures are imperfect, and only a portion of the series can be seen. At many localities in the Yentna district, however, there are outcrops of lignitic coal of varying thickness. All the coal examined was of low grade and was light and woody in texture, with a black to brownish color, and would be classed as medium to low grade lignite. No coal has been mined commercially and no extensive openings have been made which show it in an unweathered state. The best natural exposures of coal are on Cottonwood Creek, a small stream near the Mills Creek mining camps; on Short Creek, a small tributary of Cache Creek; and on Peters Creek below the lower canyon. At these localities coal beds ranging in thickness from 3 to 12 feet are exposed. Coal taken from them has been used for fuel by miners in places where timber is scarce, but has no other present commercial value.