THE UPPER SUSITNA AND CHISTOCHINA DISTRICTS.[1]

By FRED H. MOFFIT.

INTRODUCTION.

A topographic reconnaissance survey of that part of the south slope of the Alaska Range and the adjacent lowlands between the latitudes of Delta River and a point a few miles west of Mentasta Pass was made by T. G. Gerdine in 1902. At the same time the geology of this region, which includes the placer gold deposits of Chistochina River, was studied by Mendenhall.[2] This paper describes the continuation of that work in 1910. An account of the field work on which it is based is given on page 10.

The descriptions that follow deal principally with the two placer gold fields commonly known in the Copper River region by the names of their most important gold-producing creeks—Valdez Creek and Slate Creek. These two fields lie in the foothills on the south side of the Alaska Range. They are about 75 miles apart and are associated here because of their geographic position and the fact that they were visited in the course of the same summer's work rather than because of similarity or relationship between them. The two districts are represented in Plate VII (p. 114).

Valdez Creek is a tributary of Susitna River from the east and joins it a little more than 15 miles south of the nearest of the several glaciers from which the Susitna rises. Slate Creek, on the other hand, is a tributary of Chistochina River, which in turn is a northern branch of Copper River and is one of the three largest streams draining that part of the Alaska Range included within the Copper River basin. Both districts lie within the foothills of the Alaska Range, and their principal gold-producing streams are just above timber line—that is, between 2,500 and 3,000 feet above sea level. Fortunately, however, they are so near timber that the supply needed for fuel and for mining is procured with little difficulty.

[1] This paper is a preliminary statement of the results of a geologic reconnaissance by the writer and B. L. Johnson in the upper Susitna and Chistochina districts in 1910; it will be followed at a later date by a more extended account of the upper Susitna district.

[2] Mendenhall, W. C., Geology of the central Copper River region, Alaska: Prof. Paper U. S. Geol. Survey No. 41, 1905.

The nearest shipping point on the coast is the town of Valdez, which is about 130 miles almost directly south of a point midway between Valdez and Slate creeks. Since the discovery of gold in these two districts all supplies required by the miners have been brought in over the military trail from Valdez in winter. Freight for both districts passes over the same route from Valdez to Gulkana, but at that point the winter trails separate. Supplies for Valdez Creek are taken up Gulkana River and one of its western branches to a low divide leading to Maclaren River. Thence they are carried down the Maclaren to the Susitna and up the Susitna to Valdez Creek. These trails will be described in more detail in the account of Valdez Creek.

From Gulkana supplies for Slate Creek are taken up the Copper and the Chistochina to the camps at the head of the latter stream. These two winter trails will be better understood by referring to the map (Pl. VII).

The military trail, which for 12 years has been the route of entrance to the Copper River valley, has been turned into a road, and it was possible at the end of the summer (1910) to take wagons all the way through to Fairbanks from Valdez. This improvement is a great benefit to all the region in touch with the road, and the members of the Alaska Road Commission and those working with them deserve much credit for what they have accomplished. There still remains a great deal to be done in the matter of bridges and ditching, but those who have traveled over the old trail and the new road can not fail to appreciate the progress that has been made. A road also has been cut through from Willow Creek, between Tonsina and Copper Center on the military road, to connect with the Copper River & Northwestern Railway at the mouth of Chitina River, and when the bridge over Tonsina River is constructed communication between the coast and the upper Copper River valley will be far easier than it has been. This road will undoubtedly draw considerable traffic away from Valdez but will avoid the delays and difficulties that are presented by Thompson Pass in the winter and spring.

In the matter of mail communication with the outside, the Chistochina region is more fortunate than Valdez Creek. Gulkana is the last post office south of the Alaska Range on the military road out of Valdez, but a second mail route between Gulkana and Dempsey (near the mouth of Chisna River) by way of Chistochina was in operation in the summer of 1910 and a regular bimonthly service had been established. There was no mail service between Gulkana and Valdez Creek. The miners on Valdez Creek, however, received letters and a limited number of papers from Gulkana by an Indian messenger who was paid by private subscription. It would seem as

if a summer service, which would benefit a greater number of people, could be established by carrying the mail from the coast to some point like Paxsons or Yosts on the Valdez-Fairbanks road, from which branch routes would connect with Slate Creek, 25 miles to the east, or with Valdez Creek, 65 miles to the west. Such an arrangement would make the most of the advantages offered by the military road, but these more northern branch trails, especially that to Valdez Creek, would hardly be practicable in winter, as both are above timber line and afford no wood for fuel.

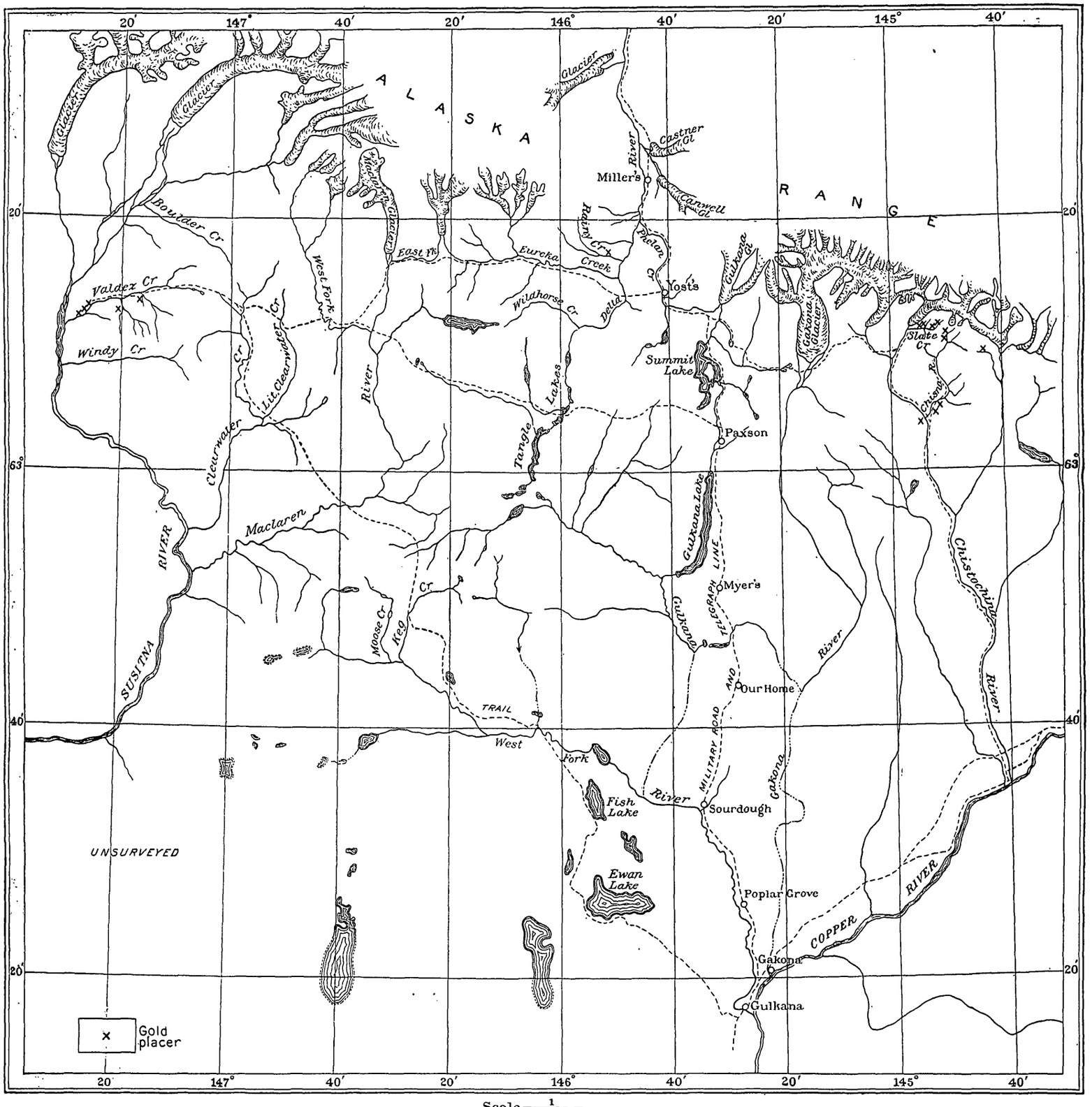
Although, with our present knowledge of the facts, it is too much to say that the gold occurrences of Slate Creek and Valdez Creek are exactly alike, there are, nevertheless, many points of similarity between them. The source of the gold in both localities is in slates that have been intruded by diorite and related granular rocks. It has not been shown that the slates of the two localities are of the same age, and in fact it appears more probable that they are not, but the intrusions of the slate by the diorite are believed to be approximately contemporaneous, whatever their geologic age may be.

No well-defined and persistent auriferous veins have yet been found in the slates, although small gold-bearing quartz stringers and lenses are present. Nearly all the streams heading in the Alaska Range between Slate Creek and Valdez Creek have shown the presence of gold in their gravels, but in most places the amount has not proved sufficient to make mining profitable. The one possible exception is Rainy Creek, a tributary of Delta River below Eureka Creek, on the west side. Five men were at work there in 1910 and in the early part of the summer had some promising prospects but were hardly making wages at that time. Prospecting on Delta River above Eureka Creek and on Little Clearwater Creek has not been successful, yet gold is present in the gravels. Although gold is widely distributed in this part of the Alaska Range, deposits of commercial importance are localized and few in number. It would seem that the best places for prospecting are in the slate areas, for there is no reason to believe that gold is present in the basaltic rocks and the diorite areas do not yield gold, notwithstanding the fact that the diorite intrusives were most probably connected with the origin of the gold.

VALDEZ CREEK.

GENERAL STATEMENT.

Valdez Creek has been a producer of placer gold since 1903, but it was not visited by any member of the United States Geological Survey previous to the summer of 1910. For that reason and because the published descriptions of the stream are few and incomplete, it is desirable to make the present paper somewhat more com-



SKETCH MAP OF UPPER SUSITNA AND CHISTOCHINA RIVER BASINS.

prehensive than would be necessary if the district had been fully described before.

Valdez Creek is approximately 14 miles long, but only a short stretch at its lower end yields placer gold at present (1910). Some of its tributaries, however, produce gold and others probably will do so in the near future. This creek, as previously stated, is a tributary of Susitna River. It rises in the mountain complex flanking the main Alaska Range and flows westward to the Susitna (Pl. VII). Its principal branch, Roosevelt Creek, heads in two small lakes that occupy the pass leading from Valdez Creek to Big Clearwater Creek and contributes nearly as much water to the main stream as does the upper part of Valdez Creek above the mouth of Roosevelt Creek. The two next largest feeders are Timberline and White creeks. Rusty Creek and Lucky Gulch are tributaries of White Creek and Roosevelt Creek, respectively. All these tributary streams are on the south side of Valdez Creek proper.

Valdez Creek flows through a strongly glaciated valley. South of it and around its headwaters are high, rugged mountains, but the mountains north of the lower or western end of the creek present smooth, rounded contours when viewed from the southern side, although the north slopes are precipitous. The valley is wider than most of the smaller stream valleys in the region to the east, especially at its lower end, where the valley of Valdez Creek joins that of Susitna River. This difference is pronounced, yet less so than that shown by the tributaries of Susitna River on the west side opposite Valdez Creek and to the northwest in the direction of Broad Pass. All the northern tributaries of Valdez Creek are comparatively unimportant, as regards both their present economic value as gold producers and the quantity of water they contribute to the main stream. They drain the smooth north slope of the valley and have cut deep gulches and canyonlike channels in its surface. The larger southern tributaries, on the other hand, occupy steep, strongly glaciated valleys and head in cirques that either contain the dwindling heads of old glaciers or were but recently vacated by them.

Valdez Creek has an abundant supply of water which is available for mines on the lower 4 miles of the stream and which can be secured with little difficulty and at small expense, considering the very high cost of supplies and equipment in this region. A rough measurement was made a short distance above the canyon for the purpose of obtaining data on which to base an estimate of the amount of water available for use below. This measurement, made at the end of August, showed from 3,000 to 5,000 miner's inches. These figures are, however, only a very rough approximation, and a long series of careful measurements should be made before installing any expensive plant to use this water.

TRAILS AND TRANSPORTATION.

The first miners on Valdez Creek came from Valdez by way of Valdez Glacier and the upper Klutina Valley. They crossed Klutina Lake on the ice, and after ascending St. Ann River to Hudson Lake they traveled north to the Susitna Lakes by way of Tazlina Lake, and then descended Tyone Creek to Susitna River, where they established a base camp and began their prospecting. During the first year or two of work on Valdez Creek supplies were brought from Valdez by this route, but it was then abandoned in favor of the better route by way of Gulkana, already described. All freighting is now done over the Gulkana trail. The smooth ice of Gulkana, Maclaren, and Susitna rivers gives a low-water grade for hauling that is practically continuous from Gulkana to Valdez Creek, for the divide between the Gulkana and Maclaren drainage, where crossed by the trail, is too low to be noticeable. The distance from Valdez to Gulkana is 128 miles and from Gulkana to Valdez Creek is approximately 125 miles. The cost of freighting from Valdez over this trail averages nearly 30 cents a pound (1910).

An attempt to establish a new winter route to the coast by way of Susitna River was not considered successful and has not been renewed. A few supplies, however, are brought in from Fairbanks each year by way of Nenana River and Broad Pass.

There is a choice of several routes for summer travel between Valdez Creek and the military road. The one usually followed is an old Indian trail from Bear Creek near the mouth of Gulkana River directly northwest to Valdez Creek, a distance of 105 miles. This trail is in timber all the way and has the disadvantage of being exceedingly wet in the open season. Another route, used only a few times, is from Paxsons to the west fork of Maclaren River and thence to Valdez Creek by way of the Roosevelt Lakes. This trail is about 65 miles long, but it is above timber line after it leaves Paxsons except in the vicinity of the Tangle Lakes and has another disadvantage in that it crosses a number of ridges, ranging in height from 500 to 1,000 feet above the valleys. The shortest and easiest trail is from Yosts, or some near-by point on the military trail, to Maclaren River by way of Eureka Creek, and thence to Valdez Creek by way of the Roosevelt Lakes. This trail is above timber except at Delta River. The only ridges of consequence which it crosses are between the forks of Maclaren River and between Maclaren River and Little Clearwater Creek, both of which can be avoided by a little labor in brushing out a trail. This northern trail, however, is very little shorter than that from Paxsons.

GENERAL GEOLOGY.

The statements that follow regarding the geology of Valdez Creek apply to the immediate vicinity of the creek (see fig. 15), yet the same geologic formations are widely distributed in the region both to the east and west.

Slate forms the bedrock of Valdez Creek throughout its length except for a short distance at the upper or east end. Locally the slate has been changed into schist. This change was brought about

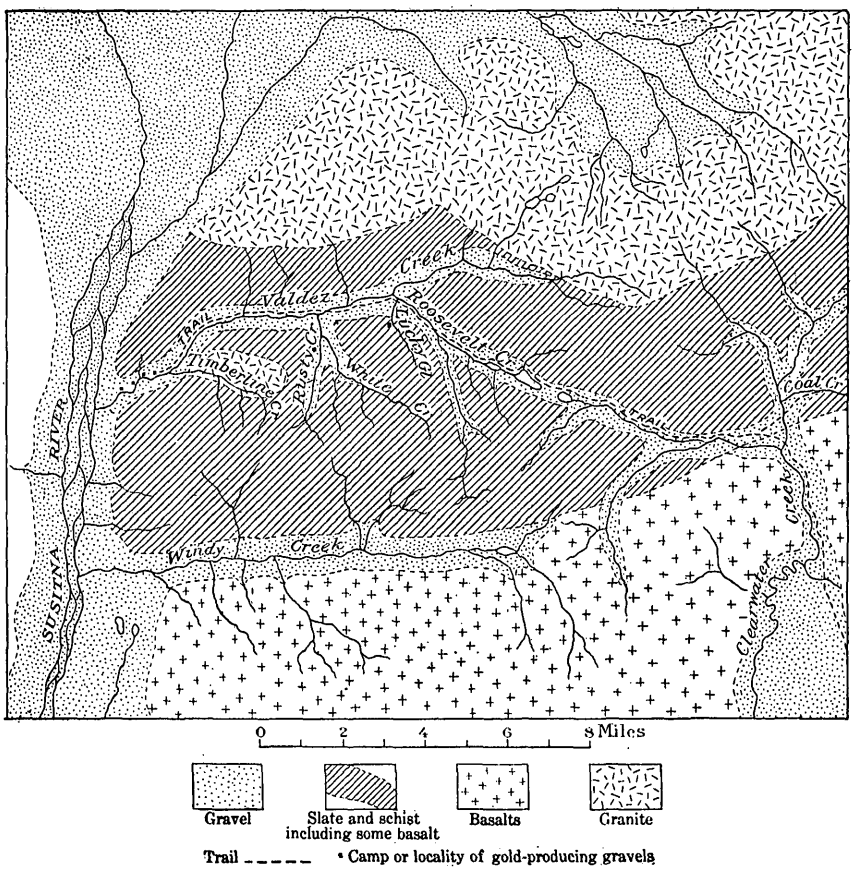


FIGURE 15.—Geologic sketch map of the vicinity of Valdez Creek.

by the intrusion of granite and related light-colored granitic and porphyritic rocks into the slates and by moderate folding, which probably took place during and after the time of granite intrusion. The slates are associated with limestone and shale beds that contain Upper Triassic fossils, but convincing evidence of their Mesozoic age is still lacking.

South of the slate area is a belt of dark basaltic rocks whose stratigraphic relation to the slates has not yet been determined

beyond question. The basalts have a bedded appearance and have undergone deformation that is shown by folding. They are best developed on Windy Creek.

The slate area is bounded on the north by diorite, which is exposed over a large area that includes the head of Valdez Creek and most of the ridge north of it. The diorite intrusions are younger than the slates but may possibly differ much in age among themselves, since there is a wide variation in the amount of metamorphism that has taken place in them. At the head of Valdez Creek part of the diorite appears to be fairly fresh and little altered, but in the ridge north of Valdez Creek the changes are great. The rock has a gneissoid structure and a pronounced cleavage, whose production was accompanied by the formation of such minerals as cyanite and garnet in the adjacent schistose sediments. Great alteration has taken place in the sedimentary rocks adjacent to the granite intrusions north of Valdez Creek, and the schistose character is highly developed there. Schistosity decreases as distance from the granite intrusion increases till it practically disappears in the slates south of Valdez Creek, although the regularity of the decrease is affected in some degree by smaller intrusive masses such as that on Timberline Creek.

The principal rock formations of the Valdez Creek vicinity, then, are the dark basaltic rocks of Windy Creek, the slates and schists into which the slates that occupy most of the Valdez Creek valley have been changed, and the granite that was intruded into the slates and is most widely exposed north of Valdez Creek.

The unconsolidated deposits of Valdez Creek consist chiefly of talus material that mantles the mountain slopes and the gravels that cover the valley floor. The gravel deposits include, of course, the present stream wash, but they are made up chiefly of bench deposits and are intimately associated in their origin with the glaciation of the valley. The rock fragments are chiefly slate and schist, with much associated igneous material. The gravels contain an uncommon proportion of large granite bowlders. During the period of maximum glaciation Valdez Creek valley and the adjacent Susitna Valley were filled with ice, but the Susitna ice stream was able to contribute to the gravels of lower Valdez Creek some rock foreign to the valley. A very important feature of Valdez Creek, in connection with the distribution of its gravel deposits, is the fact that the present stream channel is not the original channel. Before the present canyon was developed the creek had cut an earlier but shallower canyon in bedrock. This was overridden by ice from the north and east and filled with gravel, and when at last the ice disappeared and the creek established a new channel for itself, its new course did not coincide with its old one. The present canyon is cut into the slates 60 feet deeper than the old canyon at the place of their intersection on claim "No. 2

above" and is now 170 feet below the top of the benches on either side of the creek at that locality.

ECONOMIC GEOLOGY.

The placer gold of Valdez Creek has its chief source in the slate area south of the creek. This is fully proved by the results of prospecting on the tributary streams. The tributaries that flow into the main stream from the north have been found to carry only a small quantity of gold, not enough to encourage prospecting. On the other hand, all the gulches and creeks that cut the slates to the south carry gold, and in many places even the loose slide rock on the slopes yields a good string of colors on panning.

Among these southern tributaries Lucky Gulch has been a gold producer for several years and Rusty and White creeks give promise for the near future. There appears to be little doubt that the hill between Valdez Creek and White Creek extending east to Roosevelt Creek is one of the principal areas of mineralization, although it is not the only one. The slates are cut by light-colored igneous intrusives and by small quartz veins. Many of these quartz veins carry gold in sufficient quantity to encourage careful examination, yet little attention has been given to prospecting for lode deposits of gold in the district.

The total production of the Valdez Creek district is about $260,000. Mining operations in this district in 1910 were restricted to a few creek claims on Valdez Creek, to the Monahan tunnel, Lucky Gulch, and Rusty Creek. Assessment work was done on many other claims, but this was only to hold the property for future development.

The creek claims on Valdez Creek that have received most attention are "Discovery claim," "No. 1 below," "No. 2 below," "No. 2 above," and "No. 3 above." (See fig. 16.) "No. 1 above" includes a deep rock-walled canyon too narrow to permit mining. The richest of the productive claims were "Discovery claim," "No. 1 below," and the lower half of "No. 2 above." There is little variation in the character of the gravel on the creek claims. It ranges from 3 to 8 feet in thickness and consists of slate, schist, and granite, together with a small proportion of light-colored porphyritic intrusives and dark basaltic and tuffaceous material. An important characteristic of the gravel deposits is the great proportion of large granite bowlders. Such bowlders are difficult to handle in the cuts and add much to the cost of mining. Many of the larger ones are too heavy to lift with the ordinary means at hand and are moved only by undermining them on one side and causing them to roll over.

The gold in the creek claims shows considerable variation in its appearance. Part of it is flat and smooth, but another part is rough and little worn. Gold from the claims above the Monahan tunnel

shows less wear than that below. A large amount of "ruby sand" or garnet is associated with the gold, yet less "black sand" is present than might be expected from the quantity of igneous material contained in the gravel. A little more than one-third of the total gold production of Valdez Creek from 1903 to 1910 has come from these creek claims, but it is expected that their yield will be considerably less from now on, because so far as known most of their richest gravel has been mined out.

The Monahan tunnel is of particular interest, both geologically and because it has yielded more gold than any other single property in the district and nearly as much as all the others together. This tunnel follows the bottom of an old filled-in canyon in the slates, which

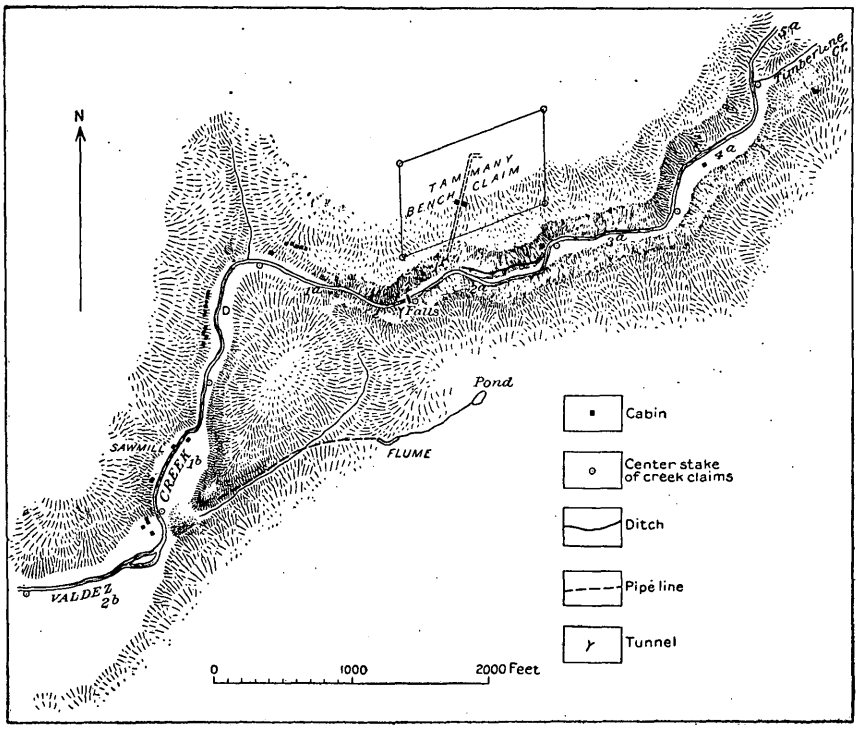


FIGURE 16.—Sketch map of part of Valdez Creek, showing placer-mining camps. D, Discovery claim 1*a*, claim "No. 1 above," etc.

makes an angle of about 45° with the present course of Valdez Creek at their point of intersection. It starts on claim "No. 2 above" at an elevation of approximately 60 feet above the present creek bed and is driven across the north half of the creek claim into the adjoining Tammany bench claim. (See figs. 16 and 17.) Its position south of Valdez Creek has not been determined. Its present length is about 700 feet. The course of Valdez Creek at the tunnel's mouth is east-northeast; that of the tunnel itself is north-northeast. The distance from the tunnel floor to the surface of the bench above is 110 feet,

which represents the depth of gravel filling in the old canyon, for on either side of the tunnel slate bedrock is seen outcropping within a few feet of the surface of the bench. The canyon is not straight, yet the variations in its course so far discovered are not important, unless the last abrupt turn to the east near the end of the present workings marks the beginning of a new course.

Bedrock in the tunnel is slate or schist. It is not fractured enough to permit gold to penetrate it far. Crosscuts from the tunnel, one about 100 feet to the west and one 60 feet east, show that the bedrock rises steeply on either side and that the walls are waterworn. The measurements in these crosscuts, however, do not indicate the general width of the canyon, for the tunnel in most places is at or near the canyon wall and the measurement of 100 feet is probably a maximum. In many places the width is much less than that.

There is no difference between the kind of rock material making up the gravel in the old canyon and that in the creek, but there are variations in its character. The lower 50 feet of gravel in the canyon contains flat granite bowlders with rounded edges, rounded slate and schist fragments, and fine black clay. Above this the canyon filling shows more of the large granite bowlders, but they are round rather than flat, the gravel is not so clean as below, and the whole deposit has an appearance of greater disorder.

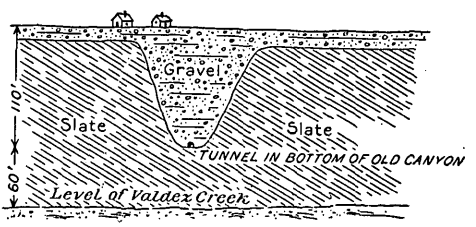


FIGURE 17.—Diagrammatic section showing relation of the Monahan tunnel to Valdez Creek. The old canyon intersects the present channel at an angle of 45° and is 60 feet above it.

Gold is found chiefly in the lower 5 feet of gravel, although there is fine gold in the upper part also. Most of it is contained in the hard black clay and fine rounded slate gravel. The gold is coarse, flattened, and smooth for the most part, yet a few rough nuggets, some of them containing quartz, are present. Although heavier, it much resembles the gold of the creek claims below.

If it should become desirable to apply hydraulic methods in the mining of these bench gravels, the favorable conditions for obtaining a good water supply and a dump for tailings are to be noted.

Aside from the Monahan tunnel, mining operations were conducted in the bench gravels of this creek at one other locality. A small tributary joins Valdez Creek at the upper end of claim "No. 2 below." It drains a slight depression southeast of the main creek and at its upper end is probably not over 175 feet above the creek. At its lower end it drops over the high rock wall of the main stream, where an excellent dump for tailings is thus provided. Water was brought

from Timberline Creek, a distance of 1½ miles, by a ditch and a short line of pipe for the purpose of moving gravel on the bench at the mouth of the little stream, and mining operations were carried on in 1909 but were not continued in 1910. The gravel resembles that of the creek except that it is cleaner and contains more sand. The same trouble from bowlders was experienced here as on all other parts of Valdez Creek.

Lucky Gulch is a small gulch tributary to Roosevelt Creek near the junction of Roosevelt and Valdez creeks and is about 6 miles from the main camp on Valdez Creek. It is a steep, narrow gulch, little more than a mile long, and draws most of its water from melting snow. Since the gulch is on the north slope of the mountain, the snow that drifts in and fills it in winter melts slowly in summer, thus both preventing work in the early part of the open season and providing the only source of water for mining later in the summer. The slate bedrock of Lucky Gulch dips about 20° N., so that the dip of the slate and the fall of the creek are about the same in many paces. On account of the narrowness and steepness of the channel there is no opportunity for the accumulation of any considerable body of gravel, and such as does accumulate consists of angular fragments and slabs of slate. Well washed and rounded gravel is present only in small amount.

The gold from Lucky Gulch is coarser than that from any other part of the Valdez Creek district. In general it is rough, with spines and protuberances, yet some of the large pieces are flattened and smooth. Large nuggets form a very considerable part of the product of the creek. One was found in 1910 that weighed 32 ounces. The largest ever found weighed 52 ounces. Many of the nuggets contain sugary quartz, and it is evident that the gold is of local origin and has traveled only a short distance.

A short season and small supply of water counterbalance in large measure the advantage due to the freedom from granite bowlders that Lucky Gulch enjoys over Valdez Creek. Large slabs of slate are common in the gulch, but most of these can be broken with a sledge, or, if this fails, with a small charge of powder, and thus removed. The gravel deposits are worked by booming or sometimes with a small nozzle and hydraulic hose. Part of the gulch has been worked out, but there still remains a large amount of ground to be exploited.

Rusty Creek is 4½ miles east of the Valdez Creek camp and is the principal tributary of White Creek. The valleys of these two streams, White and Rusty creeks, are the largest that have been cut into the mineralized slate mass south of Valdez Creek. They head in the complex of slates, tuffs, and basalts of the ridge north of Windy Creek, and run north through the slates to Valdez Creek. Both of these streams offer promising ground to the prospector. Such pros-

pecting as has been done on White Creek has not resulted in any definite results and was carried on under much difficulty and expense, due in part to the high cost of supplies and lumber but principally to troubles that arose from depth of gravel and much water. Such results as were obtained did not appear to the miners to warrant the heavy expense required for thorough prospecting at that time.

Prospecting on Rusty Creek has been conducted for three years in the face of many difficulties and much expense without any returns, and it was not till the end of the 1910 season that results of much promise were obtained. During the three years preceding, a large cut several hundred feet long and over 25 feet deep in places was made in the creek channel just at the place where the White and Rusty Creek valleys join Valdez Creek valley. This was accomplished by booming—that is, by the use of a dam with an automatic gate which opens periodically and releases a large volume of water. The water rushes through the cut, tearing up the gravel and washing it away. By this method a deep, narrow cut, begun in the expectation of reaching bedrock at no considerable depth, was made in the gravel deposits. The cut follows the east wall of an old gulch or canyon and exposes the northward-dipping slates on that side, but the bottom of the canyon was not reached at the end of the working season of 1910.

The gravels filling the old gulch include an upper deposit of unsorted glacial débris from 10 to 20 feet thick, made up of slate and basalt. Below this is another deposit of fairly well sorted gravel and coarse sand with a distinct cross-bedding. There are many large bowlders in the cut, derived chiefly from the upper glacial deposit. Most of them are basaltic in character and come from the head of Rusty Creek. There are also a few granite bowlders.

Encouraging gold prospects have been secured from the projections or benches of the rock wall on the east side of the cut and especially from the bottom of the cut, where work ended in 1910. The gold is very rough and bright. Few pieces of greater value than 20 cents were found during any of the mining until the end of last season, but there was a noticeable increase in coarseness in the last gold taken out that lends encouragement to the belief that the bottom of the cut is now near bedrock.

Rusty Creek and White Creek give greater promise for extension of the gold-producing ground of the district than any of the other streams, and it is believed that they should be thoroughly prospected. It is impossible to predict whether the concentration of gold in their gravels will be found sufficient to yield rich placer deposits, but the streams cut mineralized slates that are known to be gold bearing and there has undoubtedly been some concentration of gold during the time that erosion of the slates has gone on.

Timberline Creek also is another possible source of placer gold, as it heads in the mineralized slate area. A little prospecting has been carried on, but without particularly encouraging results. The discovery of other gold-producing gravels in the Valdez Creek district is highly desirable, because it is evident that most of the rich channel gravel of the original creek claims is worked out.

CHISTOCHINA GOLD FIELD.

All the gold-producing ground of the Chistochina district lies between the west and middle forks of Chistochina River. It includes Slate Creek and Miller Gulch, Chisna River, its tributary Ruby Creek, and the tributary of the Middle Fork called Lake Creek on the older maps but now known to the miners as Lime Creek. To complete the list of localities where mining operations are conducted in this district, there should be added that on the west side of Chistochina River, near the mouth of Chisna River, where the post office, Dempsey, is situated.

The geology of this small area was described by Mendenhall[1] and may be stated briefly as follows: South of the depression formed by the valleys of Slate Creek and the upper part of Chisna River is a series of tuffs, quartzites, and conglomerates with associated igneous rock, called the Chisna formation. This formation is conspicuous because of its red color, due to the oxidation of pyrite in the rocks that form it. North of the depression is the Mankomen formation, which in this vicinity is made up of limestone and shale, locally metamorphosed to slate. These two formations are separated by a fault of unknown displacement by which the Chisna formation is raised relatively to the Mankomen. The Mankomen formation is of late Carboniferous age. The Chisna formation is older, but probably Carboniferous also. Patches of coal-bearing Tertiary shale have been exposed in the channel of Slate Creek by mining operations.

During the last 11 years, since the discovery of gold in 1899, most of the rich creek gravels of Slate Creek and Miller Gulch have been worked out, yet there still remain creek claims of lower grade and bench gravels that have not been touched. The total production of Slate Creek and Miller Gulch is about $1,500,000.

There are about 20 creek claims on the channel of Slate Creek and 7 on Miller Gulch. Between 40 and 50 men were employed in the Chistochina district in 1910, most of whom were on Slate Creek. They were scattered along at several camps, from "No. 3 below" to the lower end of the creek.

[1] Mendenhall, W. C., Geology of the central Copper River district: Prof. Paper U. S. Geol. Survey No. 41, 1905, pp. 24 et seq.

The first three claims above the mouth of Slate Creek are virgin ground but are difficult to work because of the depth of the gravel and the large amount of water. A hole 21 feet deep near the south side of the gravel bar did not reach bedrock. Tailings from the claims above are another source of trouble. A dam was built on the lowest claim in 1910 to furnish water for booming a low bench on the north side of the creek. This was not completed in July, 1910, when the creek was visited.

On the fourth, eighth, and ninth claims above the mouth of Slate Creek mining was confined to the bank on the south side of the stream. A heavy deposit of glacial material, consisting of blue clay or glacier mud and large bowlders, is exposed on that side. It is overlain by a deposit of frozen yellow talus material or shale rock from the mountain side on the south, ranging from 5 to 25 feet in thickness. The glacial material contains gold and is exploited by undermining and caving. Bowlders are piled back from the cut to form a channel along the foot of the bank and then the water is turned in to cut the bank, and wash away the fine gravel. Afterward the remaining gravel and gold is shoveled into the sluice boxes. This work is slow and very dangerous, because the high bank of frozen gravel above sloughs off continually as it thaws and at times breaks down in large masses, so that men must be constantly on the alert and ready to jump to a place of safety.

The largest force of men on the creek was at work near the mouth of Miller Gulch on ground that has been the richest of the district and is still producing gold. This Tacoma claim, as it is called, together with the lower part of Miller Gulch, has yielded much more gold than all the other claims together. The gravels of Slate Creek above Miller Gulch are of lower grade than those below, and fewer men have been employed there, yet their contribution to the gold production of the creek is important.

There was less mining on Miller Gulch in 1910 than in previous years. This was not due to the exhaustion of gold-bearing gravels. Work was partly suspended in order to avoid covering unworked gravels in Slate Creek with tailings and will be resumed another year. The water supply of Miller Gulch available for mining operations is small, so that it has been the custom of the two principal claim owners to use it in alternate years. In this way all the bed of the gulch has been worked out, but there still remain bench gravels that will be exploited as soon as the ground below can be used for dumping.

The most important gold-producing creek in this district, after Slate Creek and Miller Gulch, is Ruby Creek, which lies just east of Slate Creek across a low, flat divide. Ruby Creek has thrown out a broad fan of gravel extending outward in a semicircle from the point

where the creek leaves the narrow gulch in the mountains at the head of Chisna River, thus forming a smooth slope to the west, south, and east. The creek has cut a channel ranging from 15 to 20 feet in depth in this gravel fan. The gravels are gold bearing and mining is carried on in them, and also in a short bend of filled and abandoned channel at the head of the fan just within the gulch. From some cause the creek cut a new rock-walled channel within a few feet of its former channel at the point where it leaves the mountain. The gold content of the gravels that filled the old channel is low but still great enough to encourage prospecting and pay the bare expense of doing it. Work is greatly hindered by snow and ice, which in some summers do not melt, so that even the water for sluicing is brought through a tunnel in the ice. Bedrock has not been exposed in the channel of Ruby Creek where it crosses the gravel fan. The false bedrock which holds the gold is a gravelly clay bed but a few inches in thickness. Ruby Creek, in cutting its present channel, has concentrated the gold contained in the gravel removed and has left it on these clay beds. Only a few feet of gravel is shoveled into the sluice boxes and care is used not to go below the false bedrock into the barren gravel beneath.

Mining operations on Lime Creek at the head of the middle fork of Chistochina River are on a bench well above the creek and about 1½ or 2 miles east of the divide between the heads of Lime Creek and Chisna River. The section exposed in mining shows about 6 feet of heavy bowlder wash resting on blue glacier clay containing small angular fragments, which is overlain in turn by more of the heavy bowlder wash, the whole section having a thickness of 30 to 40 feet. A large amount of greenstone is present in the deposit and is associated with slate, limestone, conglomerate, and granite. The richest deposit of gold is found in a rusty gravel seam on the blue-clay bedrock. Copper nuggets ranging in size from shot to pieces of several pounds are caught in the sluice boxes. They resemble those of Chititu and Dan creeks, in the Nizina district, and like them are probably derived from copper deposits in basalts or greenstones. Greenstone that resembles the Nikolai greenstone [1] is exposed in the mountain northwest of Lime Creek.

Work on Chisna River was in the nature of assessment work and prospecting. Considerable ground is held there by different persons awaiting the time when the introduction of hydraulic machinery or other economical mining methods shall make mining more profitable. At present the cost of labor and supplies prevents development of much of the gold-bearing gravels. Wages are $10 a day without board, and freight costs from 20 to 25 cents a pound.

[1] Schrader, F. C., and Spencer, A. C., The geology and mineral resources of a portion of the Copper River district, Alaska, a special publication of the U. S. Geol. Survey, 1901, p. 40. Moffit, F. H., and Maddren, A. G., Mineral resources of the Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909, p. 23.

Work at Dempsey is also in the nature of prospecting. Considerable time has been expended in driving a tunnel into the bench gravels west of Chistochina River in the belief that an old channel would be discovered. The gravels yield some fine gold.

Mendenhall regarded the slates of the Mankomen formation as the source from which the placer gold was derived. This conclusion appears justified by the distribution of gold in the gravels, the character of the gold itself, and a study of the geology of the region. It seems evident, for instance, that the richness of Miller Gulch was due to local mineralization of the slates and concentration of gold in the gravels formed during erosion and weathering of the rocks containing it. Failure to find important lode deposits can not be considered as evidence against this source of the gold any more than the failure to find large nuggets in a gravel deposit is evidence that no gold is present. The presence of bowlders of granite, hornblende porphyry, and other rocks from the main range north of Slate Creek is one of the results of former glacial activity but is not in itself proof that the gold of Slate Creek was introduced in the same way.

If the principal source of gold in this district is in the Mankomen formation and the gold of Chisna River is derived from that source, as is indicated by the fact that so far as the writer knows these streams cutting the Chisna formation are not gold bearing except where they have received some contribution of foreign gravels from the north, it is probable that rich pay streaks with coarse gold should not be expected on the lower Chisna and Chistochina. The hope of prospectors there should be for the discovery of large supplies of low-grade gravels that may be exploited in an extensive way by economical means. This statement is believed to be valid unless it shall be shown that there is some other source of the gold than that referred to previously.