

# MINING IN THE CHITINA DISTRICT.

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By FRED H. MOFFIT.

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## INTRODUCTION.

The year of 1909 was one of expectation and preparation in the Chitina district. The subject of greatest interest to those concerned with the copper resources there was progress in the construction of the new railroad up Copper River from Cordova, and all work on the copper prospects, as well as all plans for future work, were influenced by the hope of railroad communication with the coast and a consequent great saving of time and expense in freighting within the next year and a half. As was indicated by the quantity of supplies sent in over the trail from Valdez in the early part of the year, the number of men employed in the copper belt was smaller than in several previous years. On the other hand, operations on the gold-bearing gravels of Chititu and Dan creeks in the eastern part of the district were carried on in about the same manner as in the two years immediately preceding. The execution of one or two projects requiring the use of heavy machinery was postponed till the time when the cost of installation shall be less, and development work in general was interrupted in some degree or was pushed less vigorously than in previous years. This lessening of activity was not wholly and perhaps not even principally due to the cause mentioned, for both development work and prospecting were greatly influenced by the uncertainty of the copper market and the difficulty of obtaining money for developing copper mines while this condition continues.

Construction work on the Copper River and Northwestern Railway was stopped during the winter of 1908-9, but was begun again in the spring as soon as weather permitted. The steel work of the lower bridge over Copper River was completed early in the summer and work on the piers of the next bridge between Childs Glacier and the foot of Miles Glacier Lake was started. These piers and the abutments are now completed and ready for the steel structure, which was to be put in place in the spring of 1910. While the piers and bridge are under construction supplies and material for the work above Abercrombie Rapids are ferried across the lower end of the lake on a barge. Ferry slips connected with the railroad were

built and a small steamboat was launched on the lake to tow a barge on which two cars were carried. During most of the summer a passenger train was run from Cordova to Miles Lake each day, and "camp 55," at the head of Abercrombie Rapids, could then be reached by the ferry and construction trains. At the end of September the track had been laid to "mile 72," but no attempt was made to carry either passengers or freight, except workmen and needed supplies, beyond the rapids. At that time engineering and construction parties were stationed along Copper River from the rapids to the mouth of the Chitina, and the engineers in charge expected to have the rails laid as far as Tiekel River, about 100 miles from Cordova, before work was interrupted by winter weather. Soundings were made for the piers of the third bridge over Copper River just below the mouth of Kotsina River, but between the mouths of the Chitina and the Kennicott grading was not commenced, although the right of way is cleared and ready for the work. It is reported that early in November the track had been pushed forward to "mile 89." Three small steamboats were built for distributing supplies to the men at work above the rapids and for operating the ferry over Miles Glacier Lake, thus making four boats now in use on the river. These boats have difficulty in navigating certain stretches of Copper River in times of high water, particularly when a strong wind is blowing, and although they are of light draft do not attempt to go up Chitina River after the water begins to fall in the latter part of August or early in September.

There can be no question that the building of this railroad is the most important undertaking now being carried on in the Copper River region, and that its completion means more for the future of the district than can be estimated. Development of the copper prospects is impossible until a means of handling the ore and procuring supplies is provided. Another most desirable result to be brought about by the railroad is that the various prospects will shortly be compelled to stand on their individual merits as producers of copper, and the investing public will be able to learn which have value and which have not, and further what place this district is to take among copper-producing camps.

### COPPER.

The following descriptions are not presented as a complete report of copper-mining operations in the Chitina Valley in 1909. During the summer a detailed geologic study was made of the area represented on the Nizina special map (see p. 15), an area that includes the Bonanza mine and the gold placers of Chititu and Dan creeks. The properties within the limits of this area were examined, but none of those west of Kennicott River were visited, and such facts

as are given concerning them were obtained either from the owners or from others who had been on the prospects. Most of the claims and the occurrence of the copper have been described in a recent Survey publication,<sup>a</sup> and it is not desirable to repeat that description here.

The Bonanza mine, on the east side of Kennicott Glacier, is in every way the most important copper deposit yet discovered in the Chitina Valley. When the property was visited in 1907 the development work consisted of two tunnels crosscutting the ore body, a winze in the ore in the longer tunnel, and a drift from the bottom of the winze along the ore body. The total length of the tunnels and drift was 340 feet. The winze was 33 feet deep. Since that time a second tunnel has been started 78 feet lower than the longer tunnel and an upraise made connecting with the winze. A body of glance was exposed in the raise and the ore taken out was sacked for shipment. The tramway for carrying ore from the mine to the ore bunkers at the mouth of National Creek, which was begun in 1908, was completed in 1909 and put into operation about the end of August. It is approximately 3 miles long and is divided by an angle station, at a point a little less than halfway down from the loading station, into what are virtually two independent tramways, but, of course, there is no interruption in the descent of the buckets. The difference in elevation of the loading and delivery stations is 4,000 feet and the carrying capacity is 100 tons a day. At the close of the season the buckets were all removed from the cables after 130 tons of ore had been sent down to furnish power for bringing up provisions and fuel for use during the winter. There still remains some construction work to be done, such as the building of ore bunkers and quarters for men, but the completion of the tramway puts the Bonanza mine into a position to produce and ship ore as soon as railroad communication with the coast is established.

About half a mile northeast of the Bonanza mine and across the ridge separating Bonanza Creek from one of the small western tributaries of McCarthy Creek are the claims of the Houghton Alaska Exploration Company and of the Mother Lode Company. These claims are on a fault zone that was traced in a direction N. 30° E. from the Bonanza mine for a distance of 1 mile. The copper minerals exposed here are high in the Chitistone limestone, at least 1,000 feet above the top of the greenstone. Chalcocite is the prevailing copper mineral and is associated with considerable azurite, an oxidation product of the chalcocite. The claims of the Houghton company have gone to patent, but the others had not at the time they were visited in 1909. The development work on these various claims con-

<sup>a</sup> Moffit, F. H., and Mäddren, A. G., Mineral resources of the Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909.

sists of several short tunnels and a number of open cuts. Considerable importance, aside from the value of the copper they may produce, attaches to the deposits here, because they are the first proof that the copper-bearing solutions reached so high a stratigraphic position above their source in the greenstone.

Other development work done within the area of the Nizina special map was that of the United Alaska Copper Exploration Company on property, including the Westover claim, situated on Dan Creek and on Chitistone River, and that done along the limestone-greenstone contact from McCarthy Creek to Nizina River on a series of claims held under private ownership.

Prospecting and development operations were carried on in the Chitina Valley in a number of places outside of the Nizina district. Among such operations was the work of the Alaska-Kotsina Copper Company on Kotsina River, of the Great Northern Development Company on Kotsina River and at Iron Mountain and Copper Mountain, of the Hubbard Elliott Copper Mines Development Company on Elliott Creek, and of the Alaska Consolidated Copper Company on Nugget Creek. Work was done also on Kluvesna Creek, Kuskulana, Chokosna, and Lakina rivers and Hidden Creek. Most of this was for the purpose of testing ground or was done as assessment work and did not have for its object the exploitation of an ore body. It is therefore of a more or less temporary character.

The Alaska-Kotsina Copper Company devoted a considerable part of the summer to the development of the claims known as the Hubbard group. The ore was deposited along a well-marked fault plane and has been exposed in several open cuts made in previous years. This year a tunnel was started to cut the lode at quarter depth, but had not been completed when the season closed.

The operations of the Great Northern Development Company were largely of a prospecting character. This company owns a large number of claims scattered along the copper belt as far east as Kenicott Glacier and has expended much money in testing its ground. Among the claims on which work has been done those of Copper Mountain are regarded as most promising.

The work of the Alaska Consolidated Copper Company on Nugget Creek resembles that of the Alaska-Kotsina Copper Company at the head of Kotsina River. In order to determine whether the vein exposed in the tunnel and shaft of the Valdez claim continued down along the fault in which it is found, a second tunnel was started below the old one, but it was not completed at the end of the season.

### GOLD.

Placer mining on Chititu and Dan creeks was seriously interrupted by unusual weather conditions, and in consequence the gold production fell below that of last year. The winter of 1908-9 was characterized by extraordinary cold and a small snowfall. Overflows took place frequently on the streams and ice formed to a greater thickness than had ever been known there before. In places the ice did not melt till early in July, and sluicing, therefore, could not begin till much later than is customary. Furthermore, twice during the summer high water destroyed the dams and filled in the pits and sluice boxes, so that in all about twenty-six days of the working season were lost.

The hydraulic plant of the Nizina Mines Company was moved in the spring from the place where work was stopped the previous year to a claim higher on the creek, because ice filled the old pit and the whole width of the creek bottom besides, and it was certain that the gravels would not be exposed till late in the season. Yet in spite of unusual difficulties a creditable showing was made in the amount of gravel handled and encouragement was afforded by the proof that the value of the gold in the gravel had not been overestimated.

The hydraulic plant at the mouth of Rex Gulch belonging to Frank Kernan continued operations from the point where work had ceased the previous fall. This plant also was delayed in its earlier work by lateness of the season, but perhaps suffered less from high water during the summer than the property below it.

The placer-mining operations on Dan Creek and the tributary Copper Creek differed little from those of the last two or three years. Preparations were begun by the Dan Creek Mining Company in 1908 for the installation of a hydraulic plant on the lower part of Dan Creek, but it was finally decided to postpone the erection of this plant for a year or two till the completion of the railroad shall make it possible to decrease the very large part of first cost that results from the expense of freighting. There was therefore no attempt to do much more than the work necessary to hold the ground.

Placer mining was carried on in the Copper Creek valley chiefly at or just below the mouth of Rader Gulch, yet some mining was done on Idaho Gulch and on the head of Copper Creek near the mouth of Seattle Gulch. The work was all done with pick and shovel. Twelve or fourteen men were employed on Copper Creek during the summer, but owing to the cost of mining and the fact that the richest of the known gold-bearing gravels had already been sluiced the profits were not great. Experience has not shown the gravels of Copper Creek to equal in value the part of Dan Creek below the canyon, though it is hard to explain why there should be this difference and also why little or no fine gold is found on Dan Creek.

## GEOLOGIC INVESTIGATIONS.

Detailed mapping of the geologic formations of the Nizina district was begun in July, 1909, and completed early in September. For this survey the topographic map made by D. C. Witherspoon in 1908 was used as a base in the field work. This map represents an area of about 300 square miles and includes most of the Nizina River drainage basin below Chitistone River. Inasmuch as reconnaissance geologic maps of the region had been made in previous years and the principal formations and their distribution were already known in a general way, the work of mapping the boundaries was less difficult than it otherwise would have been.

The more careful study of the summer of 1909 showed the necessity of changing some of the ideas formerly held concerning the thickness and distribution of the Jurassic conglomerate, sandstone, and shale known as the Kennicott formation. It was found that both thickness and areal distribution were greater than had been supposed and that part of the shale areas which until this time have been thought to be Triassic are in fact Jurassic. The economic importance of the Jurassic rocks—the Kennicott formation—lies in the fact that they are the source from which the placer gold of Chititu and Dan creeks was derived. Numerous veinlets of gold-bearing quartz are found in fractures and joint planes of the shales and there is little doubt that they are an adequate source of supply for the gold now concentrated in the creeks, for an enormous quantity of the shales has been removed by erosion. Few of the veinlets exceed an inch or two in thickness, and many of them are no thicker than a sheet of paper or cardboard. Another discovery of interest is that the native copper of Chititu Creek and with little doubt the silver also are derived in part from a source in the Nikolai greenstone, either about the head of Young Creek or higher in the Chitina Valley, and in part from the greenstone of Dan Creek and the upper Nizina, and that it has been transported to its present location by glacial ice. Most of the placer copper of Dan Creek is unquestionably derived from rocks within the greenstone area of the Dan and Copper Creek valleys, but a small proportion of it may have come from a source to the north in the Nizina Valley. The facts concerning the copper in Chititu Creek suggest the desirability of prospecting for copper in the region about the head of Young Creek and eastward in the valley of Chitina River. Some prospecting has been done there, but the region is harder to reach than most of the rest of Chitina Valley and the search for copper has not been thorough.

# MINING AND PROSPECTING ON PRINCE WILLIAM SOUND IN 1909.<sup>a</sup>

By U. S. GRANT.

The year 1909 showed less activity in mining and prospecting on Prince William Sound than the previous year. On many of the unpatented properties little was accomplished in addition to the necessary assessment work, although active prospecting was carried on in a few localities. Little ore was shipped from the district until August, but in that and later months there was more activity in mining, so that the total copper production from Prince William Sound for the year 1909 is approximately equal to the production for 1908:

At the Ellamar mine, at the town of Ellamar, most of the work in 1909 was devoted to the construction of a dam to exclude the sea from the ore body, which outcrops at and below the level of high tide. It is expected that with the protection afforded by this dam most of the ore between the surface and the 100-foot level can be removed.

At the Bonanza mine, on Latouche Island, the first half of the year was devoted to further exploration in the lower level, which resulted in the discovery of more ore, and to the removal of part of the mine dump, so that the ore between the quarry floor and the upper level could be economically mined. Later in the year a considerable quantity of ore so situated was mined and shipped.

The Galena Bay Mining Company continued its tunnel on the north slope of Copper Mountain to a total length of about 1,800 feet, and then did some diamond drilling near the breast of the tunnel. The drills penetrated a body of ore about 30 feet in thickness some 200 feet from the breast of the tunnel. Further drilling was done on the Sunnyside claim, about 3,000 feet from the mouth of the Galena tunnel, on the west side of Vesuvius Valley.<sup>b</sup>

<sup>a</sup> In the progress report for 1908 (Bulletin 379, pp. 87-96) is a summary statement concerning recent mining and prospecting on Prince William Sound, accompanied by a map (Pl. IV) showing the locations of the various properties. In that paper is also a list of Survey publications dealing with this district. A more detailed report, entitled "Geology and mineral resources of Prince William Sound, Alaska," is in preparation to be issued as a bulletin of the Survey.

<sup>b</sup> Information from R. C. Bogue.

At Landlocked Bay the Standard Copper Mines Company and the Three Man Mining Company did considerable development work, and the latter company constructed an ore bunker at the beach and mined a few hundred tons of ore.

Near Cordova and Orca prospecting was done on several claims, and especially at the Head-of-the-Bay mine, owned by the Cordova-Tacoma Copper Company. This prospect is 2 miles east of the head of Cordova Bay and the ore lies close to the contact of a diorite mass with the country rock, graywacke, and slate. The Cordova Copper Company exhibited at the Alaska-Yukon exposition some large pieces of native copper from its Fleming Spit prospect.

On Knight Island there was much less prospecting than in 1907 and 1908, though work was done on several properties, especially those owned by Bettels and by Rua (Copper Bullion claims).

On Latouche Island not much work was done outside of the Bonanza mine, but the Latouche Copper Mining Company added a steam boiler and an air compressor to its equipment.

The Cliff Gold Mining Company erected a 5-stamp mill on the north shore of Port Valdez just east of Shoup Bay, where some gold-bearing quartz veins have been discovered in the slates and graywackes of the Valdez group. This ore is reported to be free milling and some of it to be very rich.

Prospecting for gold was carried on just northwest of McKinley Lake, which is about 20 miles east of Cordova, and some encouraging finds have been reported. On one of these prospects a 2-stamp mill was erected in 1909.<sup>a</sup>

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<sup>a</sup> Communication from W. N. Armstrong.



# PRELIMINARY REPORT ON THE MINERAL RESOURCES OF THE SOUTHERN PART OF KENAI PENINSULA.

By U. S. GRANT and D. F. HIGGINS.

## INTRODUCTION.

During the summer of 1909 the authors were commissioned to carry on a general geologic reconnaissance of the southern part of Kenai Peninsula. About two months were devoted to a study of the shore line between Seward and Seldovia. (See p. 13.) All mineral prospects of which knowledge was obtained were visited and a few trips were made back from the coast, including one to Moose Pass and False Creek, north of Seward.

Contributions to the geology of Kenai Peninsula have been made by Mendenhall;<sup>a</sup> by Gilbert;<sup>b</sup> by Emerson, Palache, and Ulrich;<sup>c</sup> by Stanton and Martin;<sup>d</sup> by Brooks;<sup>e</sup> by Moffit;<sup>f</sup> by Stone;<sup>g</sup> by Grant and Higgins;<sup>h</sup> and by Atwood.<sup>i</sup> A more extended report than the present is in course of preparation.

## GEOLOGY.

The rocks of the coast of the southern part of Kenai Peninsula from Prince William Sound westward to Kachemak Bay may be separated into four divisions, as follows: (1) A division of highly folded slates to which the name Sunrise "series" has been applied; (2) a division of cherts, tuffs, and greenstones, with graywackes, slates, and limestones; (3) a division of stratified tuffs, with cherts, slates, limestones, and basic igneous rocks; (4) a division of sandstones, shales, and lignite. These are named in order from east to

<sup>a</sup> Mendenhall, W. C., A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 265-340.

<sup>b</sup> Gilbert, G. K., Harriman Alaska Expedition, vol. 3, 1904.

<sup>c</sup> Emerson, B. K., Palache, Charles, and Ulrich, E. O., *Idem*, vol. 4, 1904.

<sup>d</sup> Stanton, T. W., and Martin, G. C., Mesozoic section on Cook Inlet and Alaskan Peninsula: Bull. Geol. Soc. America, vol. 16, 1905, pp. 391-410.

<sup>e</sup> Brooks, A. H., The geography and geology of Alaska: Prof. Paper U. S. Geol. Survey No. 45, 1906.

<sup>f</sup> Moffit, F. H., Gold fields of the Turnagain Arm region: Bull. U. S. Geol. Survey No. 277, 1906, pp. 7-52.

<sup>g</sup> Stone, R. W., Coal fields of the Kachemak Bay region: *Idem*, pp. 53-73.

<sup>h</sup> Grant, U. S., and Higgins, D. F., Notes on the geology and mineral prospects in the vicinity of Seward, Kenai Peninsula: Bull. U. S. Geol. Survey No. 379, 1909, pp. 98-107.

<sup>i</sup> Atwood, W. W., Mineral resources of southwestern Alaska: *Idem*, pp. 108-152.

west, and this order is also probably the order of age, the oldest being on the east.

The Sunrise "series" occupies the coast from Prince William Sound westward to the west side of Nuka Island Passage. Smaller areas perhaps occur farther west. The rocks are essentially slates and graywackes, with minor amounts of quartzites and conglomerates. In only one place—between Resurrection Bay and Day Harbor—are there surface igneous rocks and here are the ellipsoidal greenstones so characteristic of the Orca group on Prince William Sound. The slates and graywackes of the Sunrise "series" probably include at least two unconformable formations of very similar lithology. On Nuka Bay an apparent unconformity with a basal conglomerate has been observed in this "series." The age of the Sunrise "series" is not known with certainty. The only fossils found in these rocks in the southern part of Kenai Peninsula were obtained at Nuka Bay. These fossils were worm tubes (*Terebellina palachei* Ulrich)<sup>a</sup> similar to those found on Yakutat Bay, on Prince William Sound, and on Kodiak Island. At the last-named locality other fossils also occur and Ulrich<sup>b</sup> refers them most probably to the Lower Jurassic.

The Sunrise "series" is intruded by several masses of granite, which is usually a coarse-grained biotite granite. A large mass of granite extends from Hive and Rugged islands, in Resurrection Bay, westward to and beyond Aialik Bay and makes up much of the headlands on both sides of the southern half of this bay and all the adjacent islands. Another large granite mass makes up Pye Islands and the adjacent mainland.

The next group of rocks consists essentially of cherts, tuffs, and greenstones (locally ellipsoidal in structure), with less amounts of graywackes, slates, and limestones. These rocks extend, with the exception of possible areas of Sunrise "series," from Nuka Island Passage westward to and beyond Port Chatham. The Chugach Islands are made up of these rocks, whose western border passes through Port Graham and Seldovia Bay, and they occur on the southeast side of Kachemak Bay. These cherts and tuffs are much folded, are abundantly intruded by dikes of fine-grained granitic rocks, and, where they are in close proximity to the next group of rocks on Port Graham and Port Chatham, are highly metamorphosed. The relation of these cherts and tuffs to the Sunrise "series" is not definitely known, but they are clearly older than the next series of stratified tuffs. Stanton and Martin<sup>c</sup> and Moffit<sup>d</sup> refer these cherts

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<sup>a</sup> Determined by T. W. Stanton.

<sup>b</sup> Ulrich, E. O., Harriman Alaska Expedition, vol. 4, 1904, p. 132.

<sup>c</sup> Stanton, T. W., and Martin, G. C., Bull. Geol. Soc. America, vol. 16, 1905, p. 393.

<sup>d</sup> Moffit, F. H., Bull. U. S. Geol. Survey No. 277, 1906, p. 20.

and tuffs most probably to the Triassic, which seems to be the youngest age possible for them.

The group of stratified tuffs, with which are cherts, slates, limestones, and basic surface igneous rocks, forms the coast line from Dogsalmon Bay (near Port Chatham) northward to Seldovia Bay, except for small areas of the Kenai formation. The general dip of these rocks is westward and they are much less folded and much less intruded by acidic dikes than the rocks last described. These tuffs contain a considerable fauna which has been referred to the Lower Jurassic. The field work of the present season disclosed a series of cherts and black limestones near the base of this tuff formation. In the limestones are pelecypods of the genus *Halobia* (*H. sp.* related to *H. superba* Mojsisovics), a genus which is characteristic of the Triassic.<sup>a</sup>

The uppermost series of rocks, known as the Kenai formation (Eocene series of the Tertiary), is little altered and little folded. It consists of sandstones, shales, and coal (lignite) beds, occupies isolated areas along the coast line from Port Graham northward to and beyond Seldovia Bay, and is extensively developed on the northwest side of Kachemak Bay and to the west and north on the west shore of Cook Inlet.

## MINERAL PROSPECTS.

### IRON.

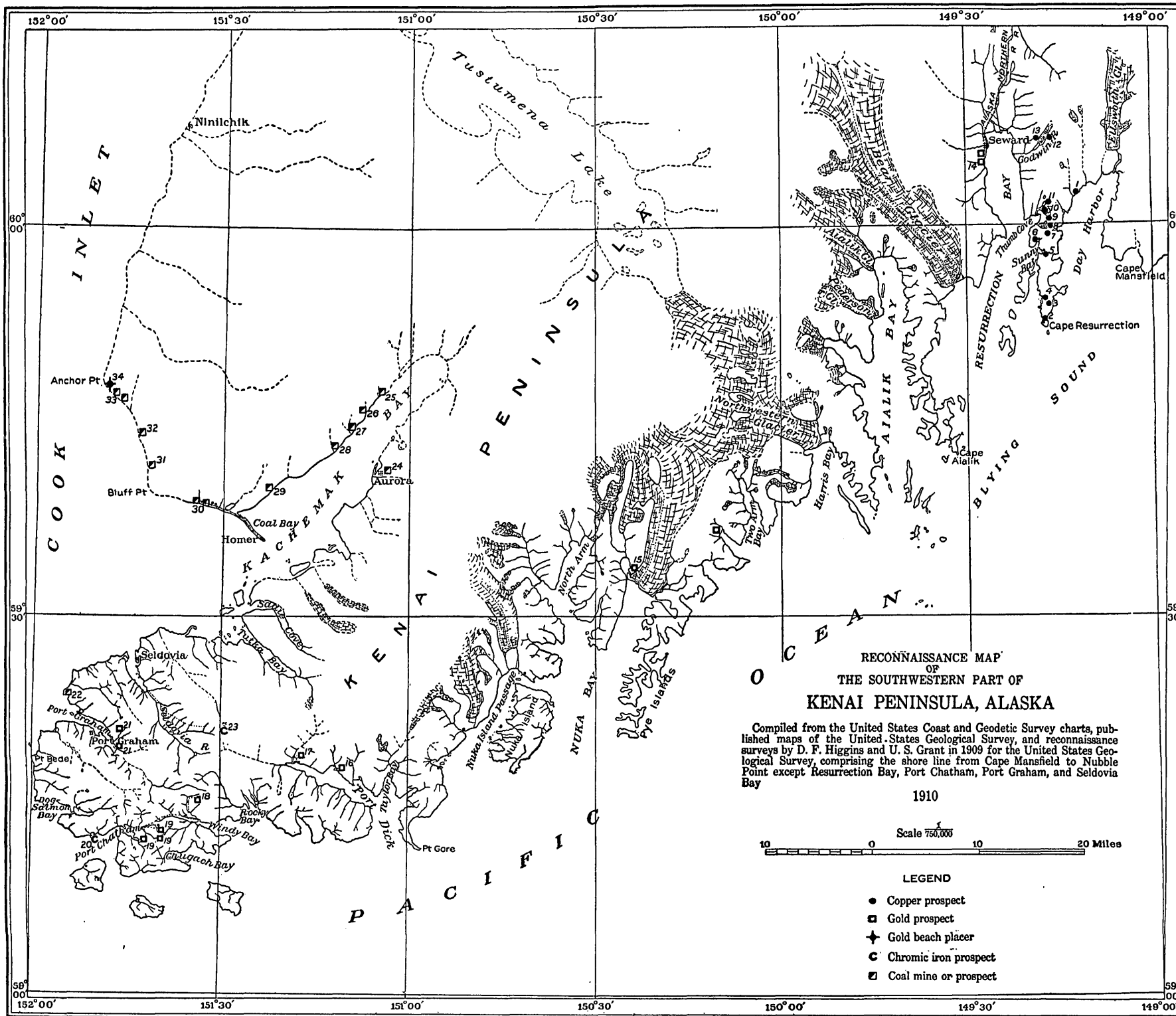
The similarity in lithology of much of Kenai Peninsula and the Lake Superior iron district is marked. In both places there are great thicknesses of graywackes and slates, as well as cherts and greenstones. The greenstones are to a considerable extent ellipsoidal in structure and are closely associated with the cherts. The cherts on Kenai Peninsula are usually gray to black in color and only here and there reddish. On a small island near the west end of Port Dick a small amount of reddish jasperoidal material and some hematite in veinlets were found in connection with these ellipsoidal greenstones. This is the only occurrence of iron ore noted in the district, with the exception of chromic iron ore, which is found at Red Mountain, southeast of Seldovia, and at Port Chatham. These occurrences are described below.

### RED MOUNTAIN.

James Linder, J. T. Ballan, and Bruce Markle have staked a number of chromic-iron claims (No. 23 on Pl. III) on Red Mountain, which is a prominent peak, probably over 3,000 feet in altitude, lying about 7 miles southeast of the town of Seldovia. This moun-

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<sup>a</sup> Determined by T. W. Stanton.



## MINES AND PROSPECTS

1. Lietzke
2. Pitman and Gould
3. Ellsworth
4. Peterson
5. Pitman and Gould
6. Likes and Frazer
7. Redman and Guyot
8. Shaw, Deubruel, and Bouchaert
9. Kusturin and Johanson
10. Morris, Sheridan, Kuppler, and Lee
11. Alaska Commercial Co.
12. Port Dick Mining and Power Co.
13. Mills and Trimble
14. Thomas Rock
15. Anderson
16. Alley
17. Whorf
18. Linder and Ballan
19. Markle
20. Reynolds-Alaska Development Co.
21. Falls Creek
22. Eastland Creek
23. Cottonwood Creek
24. Curtis
25. Bradley
26. Cook Inlet Coal Field Co.
27. Bluff Point
28. Diamond Creek
29. Troublesome Gulch
30. Anchor Point

tain is noticeable from several positions along the coast because of its light terra-cotta color and the scarcity of vegetation on its upper slopes. The country rocks are the cherts and tuffs of possibly Triassic age, while the mountain itself is composed of a mass of fine-grained peridotite of the variety dunite, a basic igneous rock composed essentially of olivine. This igneous rock occupies an approximately circular area about 2 miles in diameter. In certain places the dunite carries narrow bands of a coarser-grained rock composed of augite and olivine in varying proportions. The dunite itself contains small grains of chromite, and in places these are abundant and are segregated into bands, some of which are made up practically of chromite alone. These chromite bands are of varying thickness, from a fraction of an inch to a foot. Usually they are 1 to 3 inches thick. In one place a zone of 20 feet of country rock was so well supplied with these chromite bands that about one-fifth of this thickness of 20 feet was chromite. Exposures were not sufficient to allow this zone to be traced more than a few rods. An analysis of this chromic iron ore is reported as follows:

*Analysis of chromic iron ore.*

[By C. E. Bogardus.]

Iron protoxide (FeO).....	22. 20
Chromium sesquioxide (Cr <sub>2</sub> O <sub>3</sub> ).....	57. 00
Silica (SiO <sub>2</sub> ).....	5. 16
Lime (CaO).....	. 85
Magnesia (MgO).....	11. 23
Sulphur (S).....	. 13
Phosphorus (P).....	None.
Alumina (Al <sub>2</sub> O <sub>3</sub> ).....	3. 10
	<hr/>
	99. 72
Metallic iron.....	17. 27
Chromium.....	39. 03

PORT CHATHAM.

The peninsula called Claim Point, on the north side of the entrance to Port Chatham, is composed of peridotite, and the same rock occurs on the mainland just north of this peninsula. On this point William and Charles Anderson have staked chromic-iron claims. The mineral chromite occurs in small amounts in the peridotite and in one place on the east shore of Claim Point fairly pure chromite occurs in bands and veinlike forms in the peridotite. The veins have a general northwesterly strike and dip 50° SW. There is 3 to 10 feet of peridotite well seamed by chromite bands, so that about a quarter of this thickness is chromite. The largest single band noted was 10 inches thick.

## COPPER.

The copper prospects near Seward are on the east side of Resurrection Bay; they were visited in 1908, and descriptions of them have been published.<sup>a</sup> As little work has been done on these prospects since the summer of 1908, they were not visited in 1909. It is reported that the tunnel on the Fairview claims (No. 3 on Pl. III) has been extended to a length of 25 feet, cutting 6 feet of ore, and that the breast of the tunnel is still in ore. Work is progressing on the Feather Bed claims (No. 8 on Pl. III) about 2,000 feet above sea level, and a trail has been constructed from Safety Cove, on Day Harbor, to these claims.

At the water's edge on the northwest side of Day Harbor, about 4 miles southwest of the head of this bay, a small amount of work has been done on a prospect (No. 1 on Pl. III) which is along a shear zone between gabbro and peridotite. This zone is 4 feet thick and contains some gabbro-pegmatite (a coarse-grained aggregate of plagioclase feldspar and augite), which carries pyrrhotite, pyrite, and possibly a small amount of chalcopyrite.

## GOLD.

## INTRODUCTION.

The gold prospects of the northern part of Kenai Peninsula have been described by Moffit.<sup>b</sup> The work of the summer of 1909 did not include the district investigated by him except for certain points about Kenai Lake and Moose Pass, where there was considerable activity in prospecting for gold. These localities are described below, and descriptions are also given of gold prospects near the southern coast of Kenai Peninsula, especially at Port Dick, Windy Bay, and Port Chatham.

The gold prospects (No. 13 on Pl. III) just south of the Seward town site<sup>c</sup> were not worked during the summer, and it is stated that no work was done on the gold prospects at Aurora (No. 24 on Pl. III), on the southeast side of Kachemak Bay.

F. P. Skee and John Lechner, of Seward, report a gold prospect, on which little work has been done, about 5 miles west of Resurrection Bay, on the creek whose mouth is at Lowell Point.

Mining and prospecting for placer gold have been carried on at many points in the northern part of Kenai Peninsula,<sup>d</sup> more or less work has been done about Tustumena and Kenai lakes, and sporadic

<sup>a</sup> Grant, U. S., and Higgins, D. F., Notes on the geology and mineral prospects in the vicinity of Seward, Kenai Peninsula: Bull. U. S. Geol. Survey No. 379, 1909, pp. 98-107.

<sup>b</sup> Moffit, F. H., Gold fields of the Turnagain Arm region: Bull. U. S. Geol. Survey No. 277, 1906, pp. 5-72.

<sup>c</sup> Grant, U. S., and Higgins, D. F., Notes on the geology and mineral prospects in the vicinity of Seward, Kenai Peninsula: Bull. U. S. Geol. Survey No. 379, 1909, p. 107.

<sup>d</sup> Moffit, F. H., loc. cit.

prospecting has been carried on south of these lakes. Lately, however, no serious prospecting for placer gold has been reported south of latitude  $60^{\circ}$  except at Anchor Point, on the west side of Cook Inlet, of which Atwood<sup>a</sup> reports as follows:

During the summer of 1906 a few miners were at work on the Anchor Point beach placers, using rockers or small sluice boxes, and they reported that they were making "fair wages." The gold which they obtained was very fine and the deposit exceedingly shallow, making it necessary to move frequently to different parts of the beach.

#### MOOSE PASS.

The present center of interest in the Moose Pass gold district lies on the headwaters of Quartz Creek, about 10 miles northwest of Upper Trail Lake. (See Pl. IV.) Leaving the Alaska Central Railway at mile 29, at the lower end of Upper Trail Lake, the traveler to the district goes along the lake to its west end and up Moose Creek through Moose Pass. Thence the route leads over a low divide by Fairman Lake to Quartz Creek, and up Quartz Creek to Slate and Summit creeks. The district might more fitly be termed the Summit Creek district, in view of its nearness to this stream.

Along this route, over which a government road is now being constructed, there is a singular absence of rock exposures. Outcrops are plentiful only on the higher and more rugged mountain slopes. However, such information as could be gained shows that all the territory from Upper Trail Lake to Summit Creek is underlain by closely folded and sheared slates and graywackes. The strike of these rocks is about N.  $10^{\circ}$  E., or about parallel to the axis of the Quartz Creek valley. The dips are high. The whole district, with the possible exception of the highest peaks, has been glaciated.

At the time this region was visited (July, 1909) the property of Gilpatrick, Sprague, and Byers, locally known as the John C. Gilpatrick claims, was the most extensively developed in the district. Upon this property are five cuts or test pits, the principal one of which is a shallow cut across the main lead on the south side of the crest of the divide between Slate and Summit creeks. This opening shows 6 feet of auriferous quartz west of  $10\frac{1}{2}$  feet of fine-grained greenish-gray rock. The country rock is slate and graywacke. The quartz is iron stained and shows small quantities of native gold, galena, pyrite, and arsenopyrite. A gold telluride (sylvanite or calaverite) is probably also present, but no decisive test for tellurium could be made. Mr. Gilpatrick, however, has roasted some of this quartz and says that there is good evidence of the presence of a telluride.

The greenish-tinted rock noted above is a dike along which is the quartz vein. At this cut the dike rock is in direct contact with the

<sup>a</sup> Atwood, W. W., Mineral resources of southwestern Alaska: Bull. U. S. Geol. Survey No. 379, 1909, pp. 147-148.

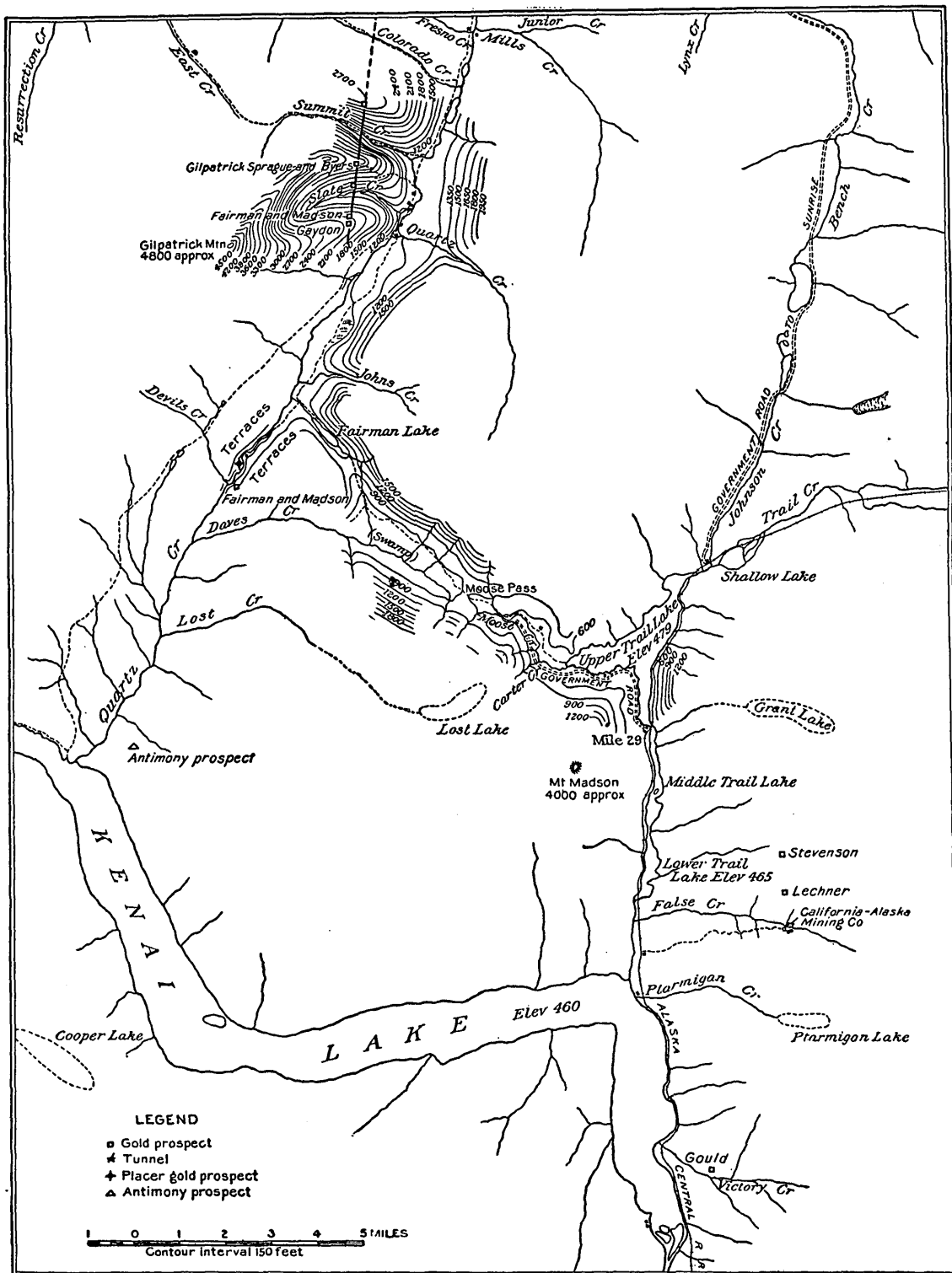
graywacke on the east side, but no metamorphic action on the sediments was noticeable. A microscopic examination of this dike rock shows that it is a fine-grained aggregate of plagioclase, quartz, mica, and probably orthoclase, with scattered crystals of arsenopyrite. The mica is the result of the alteration of the feldspars and is of a very light-green color, which gives this tint to the rock. Veinlets of coarser-grained fresher acidic plagioclase (soda-lime feldspar) traverse the rock in irregular directions.

Two other openings on this vein and dike are to the south of this one, toward Slate Creek. Lining up these cuts gives the strike of the vein and dike as N. 15° W. magnetic, or N. 10° E. true. On the nose and about 150 feet below the top of the ridge between Slate and Summit creeks Mr. Gilpatrick has uncovered a 16-inch vein of quartz in slate which pans free gold in considerable amount. Just over the crest of the ridge on the north side, a short distance east of the line of strike of the main vein, is another cut on a quartz vein. This vein is 40 inches wide in sheared graywacke and strikes N. 60° W., magnetic, dipping about vertically. The quartz of this vein shows free gold very plainly to the eye, also galena and arsenopyrite. Mr. Gilpatrick thinks that these two quartz exposures are on the same vein, which is an offshoot from the main lead. The smaller vein is about on the strike of the larger one.

South of the property across Slate Creek and on the strike of the main vein William Fairman and John C. Madsen have staked several claims and opened two cuts on the vein. David Gaydon has done some work on the same vein on claims adjoining Fairman and Madsen's on the south. Specimens from these two properties shown by Gaydon and Madsen are of the light grayish green dike rock and quartz containing galena, arsenopyrite, and possibly a telluride. A small cut has been opened on the vein near the crest of the first mountain north of Summit Creek. Mr. Gilpatrick reported that native gold was found at that place. Mr. Gaydon and Bert Higgins reported that this vein had been traced north across the mountains on approximately the same strike to Pass Creek, distant about 6 miles from Summit Creek.

About 1½ miles down Quartz Creek from the Moose Pass trail Fairman and Madsen have opened a considerable placer prospect in the gravels of the flood plain of Quartz Creek. Hand sluicing little more than "makes wages," they say, but the ground might pay well with proper machinery for washing the gravel and for handling the boulders. The many terraces in this district have never been prospected. At two or three points below the prospect these men have discovered small quartz veins which carry gold in graywacke and slate. No assays of these veins are at hand.





MOOSE PASS AND FALSE CREEK GOLD DISTRICT, KENAI PENINSULA.

## KENAI LAKE.

The California-Alaska Mining Company is developing a gold property, known locally as the Skee and Lechner claims, on False Creek, 4 miles east of the south end of the southernmost of the Trail Lakes. (See Pl. IV.) The country rock here is slate and graywacke, highly folded. The vein which is being worked is 1 to 4 feet thick, strikes N. 57° E., and is vertical. The vein material is white quartz, carrying a little arsenopyrite, galena, native gold, and minute quantities of other metallic minerals. Telluride of gold has been reported from this vein, but tests made on the material collected here failed to show any telluride. The vein is crossed by a 12-foot zone of rusty rock in which is arsenopyrite, and the same mineral occurs in small crystals in the country rock immediately adjoining the vein. This locality is about 1,600 feet above sea level. The development work consists of a tunnel 75 feet in length, with two winzes 12 and 40 feet in depth and several strippings. Two arrastres, each 12 feet in diameter, are being installed and were nearly finished at the time of visit, July 16. A Ford rock crusher and an air compressor are also in course of transit from the railroad to the camp. The machinery is to be run by water power from False Creek, which flows past the mouth of the tunnel. It is said that 40 tons of ore, running about \$35 a ton in gold, has been shipped from this place.

Just north of the property of the California-Alaska Mining Company and about 1,100 feet higher, John Lechner has a prospect which, as far as uncovered, shows a quartz vein 1 to 4 feet in width, striking N. 48° W. and dipping 65° NE. This vein contains a little arsenopyrite, galena, and native gold.

About a mile still farther north, on the northern slope of the same mountain, C. E. and J. W. Stephenson have some claims. About a mile east of Kenai Lake and near Victory Creek some claims have been staked by A. C. Gould. Both of these groups of claims are reported to be on quartz veins, similar to those described above, cutting slates and graywackes.

## TWO ARM BAY.

On the east side of the east arm of Two Arm Bay there are a few small quartz veins in the graywacke and slate, and in one place there is a zone 4 to 8 feet wide of fractured rock, the fractures being filled by quartz. J. J. Bettels reports that an assay from one of these veins showed no gold. Near the head of this arm of the bay are a few granite dikes cutting the graywacke and slate, and Mr. Bettels reports that an assay across one of these dikes gave \$1.80 in gold.

On the mountain at the head of the west arm of Two Arm Bay John Kusturin and Gus Johanson have staked nine claims on three

quartz veins which are reported to be similar veins from 2 to 6 feet in thickness. One of these (No. 14 on Pl. III), on the southern flank of the mountain, was examined. The vein strikes N.  $27^{\circ}$  E. and dips  $40^{\circ}$  W. This vein is 71 inches thick, the upper 27 inches being quartz and rock, while the rest of the vein is practically all quartz carrying small quantities of pyrite, chalcopyrite, and graphite. Little work, except for some small strippings, has been done on these prospects.

#### NUKA BAY.

On Nuka Bay Daniel Morris, James Sheridan, George W. Kuppler, and John H. Lee have staked claims at three points. One is on the flat at the west side of the front of McCarty Glacier (No. 15 on Pl. III), at the head of the eastern arm of Nuka Bay. Here are a number of pieces, the largest 5 feet in diameter, of "float" quartz carrying chalcopyrite, but no vein has been found in place. Another point is near the center of the west side of the central or northern arm of Nuka Bay. Here the slates and graywackes are cut by three dikes of very fine-grained granite. The dikes strike N.  $35^{\circ}$  W. and dip  $80^{\circ}$  S. They are, from north to south, 8, 25, and 35 feet in width. The granite is rusty weathering and contains disseminated pyrrhotite and pyrite.

A broken quartz vein in slates has been uncovered by the men named above near the south point of the first ridge west of the west side of McCarty Glacier. The prospect is about 300 yards from the ice as it was in July, 1909. The vein is 4 to 5 feet wide, striking with the schistosity of the surrounding rock, about north and south, and dipping steeply west. Numerous bands of shattered quartz and partings of slaty and chloritic material are in the vein, indicating deformation of the rock since the vein was formed. Small amounts of pyrite and considerable rusty stain may be seen at the surface, but the vein was opened for only 2 or 3 feet.

#### PORT DICK.

North of the head of the western arm of Port Dick there has been considerable prospecting for gold in the last few years. Much of this work was undertaken by the Alaska Commercial Company and later by the Port Dick Mining and Power Company. The former company did most of its work in 1899 and the latter from 1904 to 1907. The work done is about three-fourths of a mile north of tide water and from 200 to 1,200 feet above the sea (No. 17 on Pl. III). Five mules, left here in the fall of 1907, have passed two winters without care or protection, except for the shelter of a barn, and were in good condition in August, 1909.

The country rocks about the head of the west arm of Port Dick are slates, graywackes, flints, tuffs, and greenstones. Acidic dikes,

mainly of fine-grained biotite granite, are common, especially on the north side of the arm, where the country rock is largely graywacke, considerably recrystallized. The veins prospected are in the main nearly vertical quartz veins, which cut both the granite and the graywacke. The prospects examined are described below.

Some 200 feet above tide, on the east side of the stream which flows southwestward and enters the west end of the west arm of Port Dick, is a tunnel 140 feet in length. This is along a vein which strikes N.  $54^{\circ}$  W. and dips  $75^{\circ}$  to  $85^{\circ}$  N. The wall rock is hardened graywacke. The vein is 6 to 20 inches in width and has veinlets parallel to the main vein, so that there is a maximum thickness of 24 inches of quartz, the average being about 15 inches. In the quartz of the vein is a large amount of arsenopyrite and small amounts of chalcopyrite and pyrite. The arsenopyrite and quartz are arranged so as to give the vein a distinctly banded structure, and in places there are thicknesses of 1 to 3 inches of this sulphide.

Some 300 feet higher than the last and about 500 feet to the south is another tunnel 310 feet long. This is along a quartz vein which varies in direction, but has a general strike of N.  $64^{\circ}$  W. and a dip of  $75^{\circ}$  N. to  $80^{\circ}$  S. This vein branches a little, but in general is a well-defined vein 12 to 40 inches thick, averaging 24 inches. It is very similar to the one described above, but has a little less arsenopyrite, carries a little pyrrhotite and sphalerite, and has small fractures filled by calcite. The wall rock is a fine-grained biotite granite.

One-third of a mile farther south and 300 feet still higher is another vein, 6 to 12 inches thick, carrying pyrrhotite and chalcopyrite. The strike is N.  $69^{\circ}$  W. and the dip  $83^{\circ}$  S. The wall rock is fine-grained biotite granite.

Farther south and about 1,200 feet above tide is a tunnel 240 feet in length, running N.  $61^{\circ}$  E. The rock cut is granite and hardened graywacke. At 25 feet from the breast this tunnel cuts a quartz vein 6 to 12 inches thick. This vein strikes N.  $59^{\circ}$  W. and dips  $80^{\circ}$  N. and has been followed 65 feet in a branch tunnel. Aside from quartz this vein contains arsenopyrite, chalcopyrite, and pyrite.

At the water's edge on the north side of the western arm of Port Dick, near the supply house, the flints have been irregularly fractured and partly impregnated by pyrrhotite and chalcopyrite. A similar phenomenon occurs about 4 miles to the east (No. 16 on Pl. III), also at the water's edge and on the north side of the arm. A small amount of excavation has been done at each of these localities.

#### WINDY BAY.

About  $2\frac{1}{2}$  miles north of the west end of the western arm of Windy Bay Sanford J. Mills and A. J. Trimble have done some prospecting on several quartz veins which contain arsenopyrite, chalcopyrite, and

pyrite (No. 18 on Pl. III). These can frequently be recognized at some distance by the brownish gossan which has developed on their outcrops. These veins are reported to contain gold, silver, copper, and nickel. Those examined by us were about a foot in width and contained the minerals noted above. The country rocks are graywackes, flints, limestones, tuffs, and greenstones cut by acidic dikes. In one place there is a zone 30 to 50 feet in width, made up of reddish decaying acidic dike rock which has been much fractured by recent movements and which contains some quartz veinlets. This zone has a general north-south direction and dips  $60^{\circ}$  to  $70^{\circ}$  W. Along both sides of the zone the rock is decayed to a limonitic clay. Several small openings have been made in this zone, especially on its sides.

#### PORT CHATHAM.

About the head of Port Chatham some prospecting has been done, mainly by Thomas Rock (No. 19 on Pl. III). The country rocks here are flints, tuffs, and graywackes, cut by granitic dikes. About 2 miles east of the head of the northeasterly arm of Port Chatham, on the south side of the main valley and some 450 feet above tide water, the contact between graywacke and a fine-grained biotite granite dike has been uncovered. The dike rock is decayed and has been fractured, the fractures being healed by quartz veinlets. Along the actual contact is a clay selvage one-half inch in thickness. About a fourth of a mile northeast of this prospect and 150 feet higher is an opening, 10 feet long, on a quartz vein which is 22 to 28 inches in width. The vein strikes N.  $19^{\circ}$  W. and dips  $60^{\circ}$  N.; it carries arsenopyrite, chalcopyrite, pyrrhotite, and a little sphalerite. The country rock is a hardened graywacke. Higher up the hill to the south what appears to be the same vein has been uncovered in two places, where the width is 36 and 44 inches. Here the vein cuts a fine-grained granitic dike rock.

About a mile southwest of Cone Mountain, on the west wall of a cirque which contains a small lake, are some rusty zones crossing the tuffs and flints. A little work, at an altitude of about 2,000 feet, has been done on one of these zones which is 5 feet thick. These zones are fractured parts of the rock, the fractures being healed by quartz and calcite and minor quantities of sulphides.

On the coast between Port Chatham and Port Graham, about 3 miles south of Flat Islets, is a marked brown-weathering zone in tuffs, which are impregnated by pyrite. This zone is irregular and in places is 15 feet wide. No work has been done here.

#### PORT GRAHAM.

On Port Graham very little prospecting has been done, though a few claims have been staked. One of these is a few rods south of the steamboat wharf, one is on the north shore of the port near its

east end, and another is in a gulch about 3 miles directly east of the wharf and a mile or more from tide water. The last two claims (No. 21 on Pl. III) are owned by J. W. Alley, and are located on rusty-weathering fractured areas in the country rock (cherts). The fractures are filled by quartz veinlets. An assay from one of these localities is said to have shown \$6 to the ton in gold.

## SUMMARY.

The prospects along the coast of the southern part of Kenai Peninsula are in quartz veins of rather moderate size, so far as known. They contain arsenopyrite and chalcopyrite, locally with small amounts of pyrite, pyrrhotite, and sphalerite. These veins are very similar to a quartz-arsenopyrite vein found on the western part of Prince William Sound, which carries good values in gold.<sup>a</sup> Samples were taken across several of these quartz veins in the southern part of Kenai Peninsula, care being taken to get average samples of the most promising and most typical veins. The results of these assays are given in the accompanying table, Nos. 1 to 4 being from clearly defined quartz veins and Nos. 5 to 8 being from brecciated mineralized zones. The results of these assays, especially when the small size of the veins is taken into consideration, is not encouraging. There is still, however, the possibility that larger and richer veins may occur in this coast district.

The gold prospects in the Moose Pass and Kenai Lake districts are in quartz veins cutting the graywackes and slates of the Sunrise "series" of rocks. At Moose Pass one vein lies between these sediments and a fine-grained acidic dike rock. Average samples across some of the veins in these districts were collected and assays were made from these samples. The results of these assays are shown in Nos. 9 to 12 of the accompanying table. No. 13 is from the acidic dike rock mentioned above.

*Assays of gold-bearing veins in Kenai Peninsula.*

By W. H. Coghill and D. F. Higgins.]

	Ounces of gold per ton.	Ounces of silver per ton.	Value per ton. <sup>b</sup>
1.....	0.04	Trace.	\$0.82
2.....	.06	0.94	1.71
3.....	.12	Trace.	2.48
4.....	.04	.76	1.20
5.....	.02	Trace.	.41
6.....	.08	Trace.	1.65
7.....	.02	Trace.	.41
8.....	.06	1.14	1.84
9.....	.70	1.10	15.02
10.....	2.44	.56	50.71
11.....	2.74	.66	56.97
12.....	.38	.02	8.16
13.....	.02	Trace.	.50

<sup>a</sup> Grant, U. S., Gold on Prince William Sound: Bull. U. S. Geol. Survey No. 379, 1909, p. 97.<sup>b</sup> Gold at \$20.67 per ounce; silver at \$0.50 per ounce.

Assays much higher in gold than those here given have been reported, and many samples show considerable free gold. It should be noted, however, that single assays of samples of free-milling gold ore do not always give accurate information concerning the average gold content of a vein. The average content can be determined by a considerable series of assays of samples taken across the vein at different points. The work thus far done on the prospects in the Moose Pass and Kenai Lake districts and the assays which have been made show the presence of gold ore of sufficient richness for economic mining. The extent of these gold-bearing veins and the tonnage which is available have not been ascertained. Sufficient is known, however, to encourage careful and systematic prospecting of the veins described and also to encourage a search for similar veins in the same general district.

#### SILVER.

No silver prospects have been reported from the southern part of Kenai Peninsula. Such silver as is known is found in connection with gold, and assays from the gold prospects show silver running up to 1.14 ounces to the ton of ore. It is probable that small amounts of silver occur in the copper ores, but no assays of these ores are available.

#### ANTIMONY.

John Lyengholm, Isaac Hargood, and Lars Larson report an antimony prospect near Kenai Lake north of Seward. The prospect is about three-fourths of a mile from that lake and about 1 mile east of Quartz Creek. (See Pl. IV.) The country rock is slate cut by a dike 6 to 8 feet thick. The specimens shown us from this prospect are of a fine-grained sheared gray acidic rock in which are stringers and disseminated particles of stibnite (sulphide of antimony).

#### COAL.

The coal fields of the Kachemak Bay region have been described by Stone <sup>a</sup> and later by Atwood.<sup>b</sup> Little development work has been done on the coal (lignite) of this region, except at Port Graham, since the report by Stone. During the summer of 1909 J. W. Whorf mined coal from the north shore of Port Graham just east of Cape Danger (No. 22 on Pl. III). From this place coal was obtained for local use and for some of the steamboats plying these waters, and shipments were made to Seward and to Prince William Sound ports. The coal was taken from a shallow shaft, from a tunnel, and from cuts made in the beach below the high-tide mark. At the time of visit the shaft and tunnel were closed and little information was obtained additional to that given by Stone.<sup>c</sup> Aside from this work at Port Graham we did not learn of any work having been done on the coals on the east side of Cook Inlet in 1909.

<sup>a</sup> Stone, R. W., Coal fields of the Kachemak Bay region: Bull. U. S. Geol. Survey No. 277, 1906, pp. 53-73.

<sup>b</sup> Atwood, W. W., Bull. U. S. Geol. Survey No. 379, 1909, pp. 121-124.

<sup>c</sup> Op. cit., pp. 66-68.