MINERAL INVESTIGATIONS IN SOUTHEASTERN ALASKA

By A. F. Buddington

FIELD WORK

Since 1921 the writer has been engaged in a study of the geology and mineral deposits of southeastern Alaska. The field work in 1921 and 1922 was devoted chiefly to the Wrangell district. A part of the results have already been published,[1] and a more complete report is in preparation. In 1923 the investigation was given a rather broader scope, and mineral deposits in many widely separated districts were examined. These studies yielded much information, which, it is believed, is of immediate practical value to the mining industry. For this reason it is here presented, even though the mapping of the geology necessary for a full understanding of the occurrence of ores in the district examined is by no means complete. Therefore, the statements here made must be taken as a record of progress rather than of final results. This report will deal chiefly with the gold and silver deposits of the Hyder district and the copper and nickel ores of Chichagof and Baranof islands. The results of examinations of other widely distributed mineral deposits will also be included.

The writer was engaged from May 21 to August 10, 1923, in geologic mapping of the northern portion of Prince of Wales Island, in the Ketchikan district, and of the mainland from Port Houghton to Taku Inlet, in the Juneau district. From August 10 to September 15 he made an examination of mineral developments in the Sitka, Petersburg, Hyder, and Ketchikan mining districts.

The writer is indebted to his assistants, C. M. Deming and George A. Wiggan, for consistent efficient aid, and to Mr. Wiggan for notes on the topography of Texas Creek, the description of the Cripple Creek prospect in the Hyder district, and other data. He is also under obligations to Walter C. Waters, of Wrangell, for very satisfactory services as navigator, and to Government officials in Juneau and many men connected with mineral development in

[1] Buddington, A. F., Mineral resources of the Wrangell district: U. S. Geol. Survey Bull. 739, pp. 51–75, 1923.

southeastern Alaska. He specially acknowledges assistance and information from Messrs. Metzger, of the Alaska Juneau Co.; Cann and White, of the Apex-El Nido Co.; S. H. P. Vevelstad, D. W. Yates, and Gudmund Jensen, of Juneau; and Hardy Haughn, H. Tanner, Jack Littlepage, Daniel Bayne, C. Carlson, and J. H. Hewitt, of Hyder.

RECENT DISCOVERIES OF ORES

Several new discoveries of mineral deposits have been made in southeastern Alaska during the last three years. In the Sitka district veins of high-grade free-milling gold have been discovered and prospected on Lisianski Inlet, Chichagof Island, and a mill for their treatment is now being constructed by the Apex-El Nido Mining Co. Veins of similar type are being prospected by the Pinta Bay Mining Co. near Pinta Bay. Nickeliferous pyrrhotite deposits have been found on Tenakee Inlet and at several places on Yakobi Island.

A nickeliferous pyrrhotite lode has also been found on Snipe Bay, Baranof Island, and barite veins have been located along the southwest side of Saginaw Bay and Keku Straits, on Kuiu Island, all in the Petersburg district. The Helm Bay King Mining Co. is prospecting a newly discovered gold lode in the Ketchikan district.

In the Hyder district the discovery in July, 1923, of a strong quartz vein well mineralized with galena carrying silver on the West Fork of Texas Creek resulted in a stampede of prospectors to this district. About 30 reached this area, and by the middle of September about 100 claims had been recorded, and 11 prospectors were still in the field. Veins containing gold, lead, silver, and copper, medium-grade gold-silver veins, and low-grade silver-lead and copper deposits have been located. Quartz porphyry sills, similar to those in which occur the ores of the famous Premier mine, in British Columbia, have been found on the east side of Salmon River in American territory and are being prospected. In September rich pockets of ore carrying much gold had been found in them, but no commercial ore body.

In the Juneau district, near Hawk Inlet on Admiralty Island, a number of large, strongly defined quartz veins are being prospected on the Charles Williams property. One workable shoot, 18 feet in width, of low-grade gold ore has been proved by the present developments. Numerous other veins show indications that warrant the continuation of prospecting for similar ore shoots. These veins are similar in type to those which are being prospected by the Admiralty-Alaska Co. on Funter Bay and form a southward extension of the belt in which they occur.

HYDER DISTRICT

INTRODUCTION

Many factors have worked together to maintain interest in the possibilities of mining development in the Hyder district. These include the continued success of the Premier mine; the extensive prospecting and development work being carried on along Big Missouri Ridge in the adjoining part of British Columbia; the discovery on the American side of mineralized felsite or porphyry sheets similar to those in which the ores of the Premier mine occur; the maintenance of prospecting, to an extent in excess of that required for assessment work, on many properties along the Salmon River valley; and the new strikes along Texas Creek. In the spring of 1923 the United States Forest Service began the construction of a prospectors' trail from Salmon River near Ninemile to Behm Canal by way of the West Fork of Texas Creek, Chickamin Glacier, and the Chickamin River valley. It was expected that this trail would be completed in 1924 and would have a length of 48½ miles. The Forest Service also expects to have a pack trail for horses completed from the Salmon River bridge near Ninemile to the Chickamin Glacier by the fall of 1924 and proposes in the future to build a trail up the south fork of the Chickamin, running almost east, across the divide at the head of Dolly Varden Creek and down the valley of that creek to Portland Canal. Another trail up the Le Duc River valley is also proposed. These trails will help to open up this area for systematic prospecting.

A preliminary examination of the geology of the Hyder district was made in 1920 by L. G. Westgate.[2] Much light has also been thrown on the geology of the district by the detailed studies made by the Canadian geologists in the adjacent region across the international boundary.[3]

In 1923 the writer spent from September 8 to 15 in a reconnaissance of new ore discoveries along the Salmon River valley, especially those on the West Fork of Texas Creek along the route of the recently constructed Government trail. Between Westgate's examination in 1920 and the time of the writer's visit no very large new body of ore had been found or productive mine developed. New veins of ore have been discovered, however, and the results have been of such a character as to warrant continued work. It is probable that one or more mines will be developed from the prospects in the

[2] Westgate, L. G., Ore deposits of the Salmon River district, Portland Canal region: U. S. Geol. Survey Bull. 722, pp. 117–122, 1922.

[3] Schofield, S. J., and Hanson, G., Geology and ore deposits of Salmon River district: Canada Geol. Survey Mem. 132, Ottawa, 1922.

Hyder district. The location of the prospects on the American side of the boundary and of the more prominent prospects on the Canadian side is shown in Plate I.

TYPES OF MINERAL DEPOSITS

In the following table are grouped the present available data on the mineral veins of the Salmon River and Texas Creek districts in British Columbia and Alaska. The data for the Canadian deposits have been taken from the report by Schofield, and those for the Salmon River district from the report by Westgate and from the writer's own observations, more particularly on Texas Creek. It must be recognized that in view of the slight development of most of the veins and the lack of intensive study, any grouping that may be made is tentative and is offered only for what suggestive value it may have. Several known veins do not conform in detail to all the characters of any one of the groups.

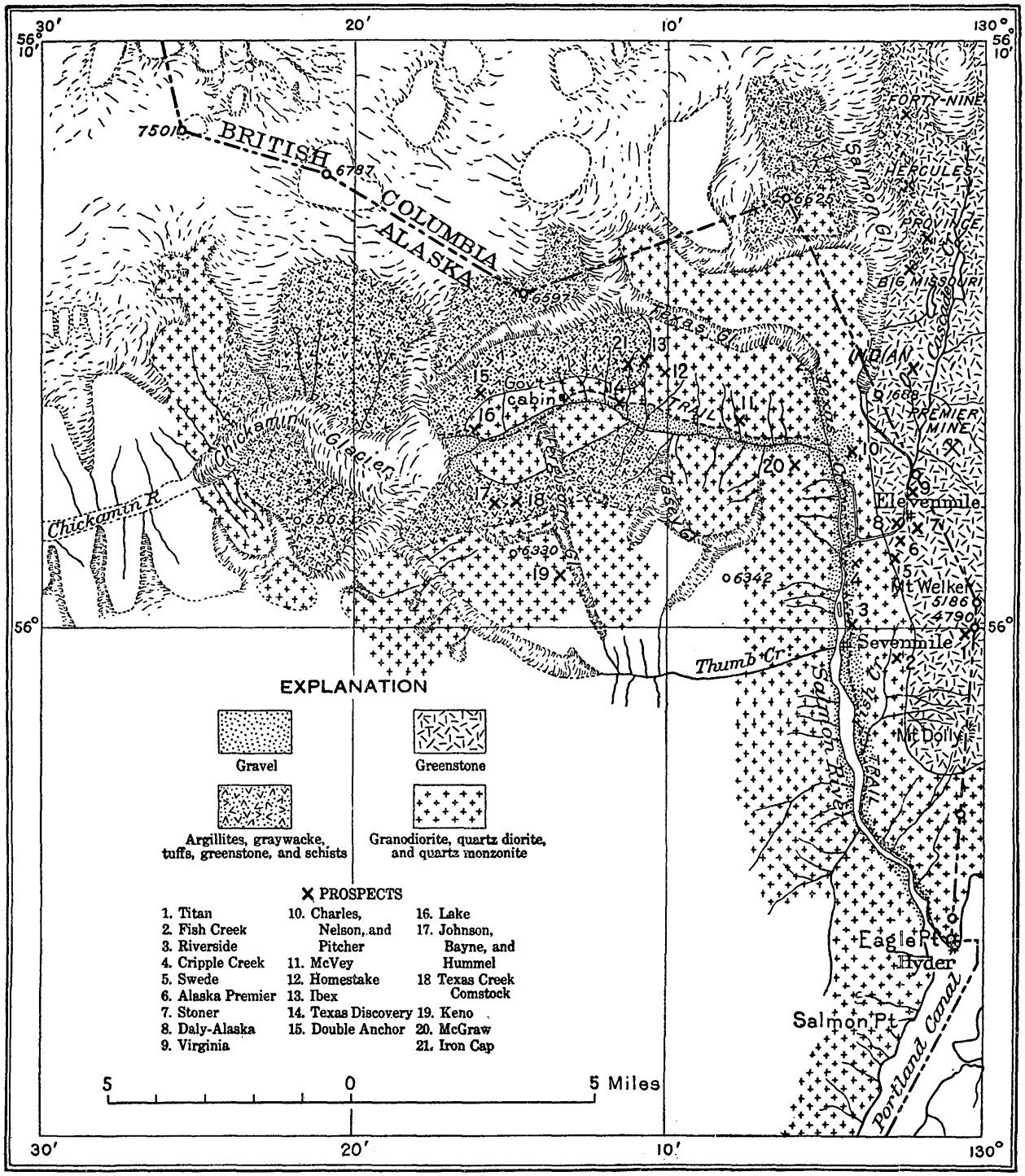
Types of mineral deposits on Texas Creek, Alaska, and in Salmon River district, Alaska and British Columbia

[—, Major mineral, or important ore mineral; +, an important mineral in some veins, in others a minor accessory]

Mode of occurrence	Country rock[a]	Pyrite	Galena	Sphalerite	Chalcopyrite	Tetrahedrite	Rich silver minerals	Pyrrhotite	Examples
Quartz veins and veinlike replacement deposits.	Quartz porphyry sills and their contacts with tuff.	—	—	—	—	—	—	....	Premier, B. C., and certain ore bodies in the Forty-nine, Big Missouri, and Mineral Hill.
	Quartz porphyry (felsite).	—	—	—	+	....	....	+	Alaska-Premier, Titan.
	Quartz porphyry *....	—	....	....	....	....	....	....	An ore body of the Premier, B. C.
Replacement and disseminated deposits.	Schistose tuff and fine tuffaceous conglomerate.*	—	—	—	+	....	....	....	Big Missouri; Hercules, Forty-nine, Province.
	Greenstone....	—	—	—	+	....	....	+	Virginia group, Elevenmile, Stoner, Swede group.
	Greenstone....	+	+	....	+	....	....	—	Certain bodies at Elevenmile, Virginia group, Fish Creek.
Quartz fissure veins	Granodiorite (one prospect in tuffs).	—	—	....	+	....	....	....	Riverside group, Jackson & Hummel, Reno, Cripple Creek, Texas-Discovery, Lake.
	Granodiorite....	+	—	+	+	—	....	....	Fish Creek.

[a] An asterisk (*) indicates types found on Canadian side; after Schofield.

On the American side mineral deposits are found in country rock of four general types—quartz porphyry, greenstone, granodiorite, and sedimentary beds. At the Alaska-Premier and Titan and perhaps at one of the Stoner groups of claims sheets of quartz porphyry (greenish felsite) similar to that at the Premier mine in British Columbia are being prospected. The mineralization in this rock on the Alaskan side differs in that the rich silver minerals, such



GEOLOGIC SKETCH MAP OF HYDER DISTRICT

as argentite, pyrargyrite, stephanite, and native silver, have not been found. High gold returns, however, have been obtained from local pockets, particularly rich in sphalerite, and some bodies with low tenor in gold have been found, but as yet no commercial ore body.

Within the greenstones local pockets giving high-grade gold assays, samples reported to give very high silver assays, and mineralized bands of low to medium grade containing mainly silver, gold, and lead have been found. There are many mineralized streaks in the greenstones, but no extensive prospecting has been done on them and no commercial ore body has yet been developed.

Most of the development work in this region so far has centered on the quartz fissure veins in granitoid rock. The granitoid rocks vary from granodiorite to quartz-hornblende diorite. The term granodiorite will be used as a general descriptive name for them where accurate determination has not been made. The fissure veins occur along the east side of Salmon River and both sides of the West Fork of Texas Creek. Veins of similar character and mineralization are also found in the andesitic tuffs at the Texas Creek Comstock group, on the south side of the West Fork of Texas Creek, and in banded argillite and quartzite at the Ibex prospect, on the north side of the West Fork of Texas Creek.

The available data on the strike and dip of the veins suggest the possibility that there may be two groups—one whose strikes vary between N. 30° W. and N. 60° W., with dips of 45°–70° NE., and another whose strikes vary between N. 15° E. and N. 10° W., with dips of 30°–70° E. The former are the most numerous, and the latter are prominent in the vicinity of the Homestake-Ibex groups on Texas Creek. Faults that offset the veins with small displacements are not uncommon, and at several localities the veins are cut by dikes.

With respect to the sulphide mineralization, most of the veins may be divided into two groups, one of which is characterized by the predominance of galena and pyrite, and the other by galena associated with tetrahedrite, chalcopyrite, and other sulphides. The veins of the second group carry more silver than those of the first. This difference is in accordance with Schofield's statement that wherever tetrahedrite is present the ore carries much silver. Veins of transitional character between the two groups occur, such as the "cross" vein at the Riverside group and some veins on the Texas Creek Comstock claims, where chalcopyrite in considerable quantity is associated with the pyrite and galena. Pyrite and sphalerite occur in practically all the veins in varying amounts, but galena appears to be the predominant sulphide. The sulphides occur concentrated in shoots within or along the vein.

The continuity of the veins and the quality of their mineralization is, of course, a most important consideration. Some of them, as exposed at the surface, are several hundred feet long and pinch abruptly or are displaced by faulting. In some places the fissure persists beyond the vein matter. Other veins have been proved to have a minimum length of 600 or 700 feet, with their total length undetermined. One vein on the Riverside group appears to have been traced for nearly 2,100 feet and to crop out at altitudes from 200 feet up to 900 feet. The tunnels at an altitude of about 250 feet on this vein, so far as explored, show the vein to consist only of stringers of quartz in schistose granodiorite. Developments have not proceeded far enough to give an adequate idea of precisely what may be expected. For this reason the deductions of Knopf[4] from his study of the development of the quartz veins which occur in granite rocks of the Berners Bay region are of interest here and are quoted:

> It has been pointed out in previous pages that the veins were formed by the movements of the walls past each other along gently sinuous fractures. Pinches and swells are therefore encountered on the levels along the strike of the veins. Similar variation is to be expected vertically, also, although development has not yet been sufficiently extensive to demonstrate this as a law.
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> Inasmuch as narrow portions of the fissures are commonly occupied by masses of schistose diorite which are here and there interlaced with quartz stringers, such schistose zones are worth exploring or drifting on in the chance of striking other valuable ore bodies. This possibility was forcibly illustrated at the Jualin mine, where an 18-inch zone of crushed diorite of most unpromising appearance opened out when followed along the strike into a strong and valuable ore body. That this is no infallible rule, however, is clearly demonstrated by certain fruitless attempts that have been made under its guidance. In the most conspicuous example 500 feet of tunnel was drifted along in a schistose zone in the diorite without encountering a ledge. The probability of striking an ore body is apparently strongest in those belts of crushed or sheared diorite that are penetrated by quartz stringers.
>
> On the whole, the downward persistence of fissuring would seem to be proved by the deep-seated origin of the vein-forming solutions, as shown by their mineralization.

Westgate has described five veins at the Fish Creek claims which, to judge from the claim map, constitute a group lying within a radius of 500 feet. Other veins are found on the same group of claims but at greater distances. All the veins show a similar type of mineralization with shoots carrying much silver. At the Riverside property three veins lie within a width of 600 feet and likewise show among themselves a similar type of mineralization but different from that of the Fish Creek group, though the two groups are only a little over a mile apart. The Ibex and Homestake veins, on

[4] Knopf, Adolph, Geology of the Berners Bay region, Alaska: U. S. Geol. Survey Bull. 446, pp. 37–38, 1911.

the north side of Texas Creek, are similar to each other in type of mineralization. The occurrence of several veins in a group at the Fish Creek and Riverside claims suggests that probably new veins with similar mineralization will be found in the vicinity of the Homestake and Ibex veins.

The metallized veins are known to occur throughout a vertical range of nearly a mile, from an altitude of 200 feet at the Riverside group to 5,000 feet on the Texas Creek Comstock claims, on the West Fork of Texas Creek. The sulphides of the veins are believed to be primary, and no evidence of enrichment has been found. From these two facts it is probable that the same general quality of mineralization of the veins persists in depth and that if any change occurs it is one arising from peculiarities of original deposition. The mineralization of the quartz fissure veins agrees essentially with the statement made by Westgate[5] with respect to the mineralization in the Salmon River district in general.

PROSPECTS NEAR SALMON RIVER

TITAN

The writer did not visit the Titan group of claims, and the following data were furnished by S. P. Fitzgerald, one of the stockholders. The property is about 4½ miles by trail from the intersection of the Fish Creek trail and the Salmon River road. It comprises 10 claims located in 1917 and held by the Titan & Salmon River Syndicate. The developments consist of 400 feet of tunnel, started in the fall of 1922 at an altitude of 2,950 feet, and a short crosscut from the tunnel that is reported to have cut 12 feet of quartz running about $4 in gold and 6 ounces of silver to the ton. The quartz is sparsely mineralized with galena, pyrite, and sphalerite. The country rock is quartz porphyry, similar to the type found at the Premier mine and the Alaska-Premier prospect. Rich stringers are reported to have been found in the porphyry, picked specimens of which assayed as much as 4½ ounces in gold to the ton.

FISH CREEK

Developments on the Fish Creek property up to 1920 have been described by Westgate.[6] Since his report was written the main work done has been the prospecting of a new vein on the Olympia Fraction claim. The vein is a metallized quartz fissure vein in quartz-hornblende diorite and has been exposed by a series of trenches along its strike for a length of about 300 feet. At each end it tapers off abruptly, though the fissure continues in each direc-

[5] Op. cit., p. 131.
[6] Op. cit., pp. 134–138.

tion. The vein strikes about N. 60° W. and dips 50° NE. The vein matter breaks freely from the wall rock, and the walls show marked slickensiding. A narrow dike of dense black lamprophyre cuts the vein.

At the longest surface trench the vein is from 4 to 6 feet wide and consists of quartz with 5 per cent or more of disseminated sulphides and with stringers of solid sulphides so localized as to constitute rich ore shoots. The gangue is mostly quartz, with some calcite and brown siderite. The sulphides include galena, tetrahedrite, chalcopyrite, pyrite, sphalerite, and rarely a little arsenopyrite. The tetrahedrite occurs in solid streaks as much as 2 inches wide and is rich in silver. Forty tons of sorted ore taken from the surface trench is reported to have averaged about $90 to the ton.

At an altitude of about 2,800 feet a crosscut tunnel 125 feet long was driven to intersect the vein. Near the end of the crosscut a winze was sunk on the vein for 42 feet and a drift run along the vein to the southeast for 120 feet. In the drift the vein ranges from 2 to 5 feet in width and locally contains inclusions of the wall rock. In the winze the vein is reported to narrow and the tenor to decrease. It is reported that 55 tons of sorted ore was taken from the drift and shipped and that it averaged about $90 to the ton.

About 30 feet below this tunnel another tunnel was started on a fissure and driven for a total length of about 400 feet. The fissure on which the tunnel was started did not lead to the vein sought, but a short crosscut made from the tunnel intersected the vein, and then a drift was run back along the vein for about 50 feet, and from its face a raise was opened to the upper tunnel.

SWEDE

The Swede group is reported to comprise six claims on the mountain side about a mile south of Elevenmile. These claims were not examined by the writer but are reported to be similar in type to the Daly-Alaska prospects.

ALASKA-PREMIER

The Alaska-Premier group (not to be confused with the Premier mine, which is on the Canadian side of the boundary) comprises 25 claims between Elevenmile and Fish Creek. The general country rock is greenstone with intercalated beds of slate and graywacke. Three sheets of felsite (quartz porphyry) cut the greenstone and the sediments. Present developments are being directed toward finding an ore body within two of these sheets. The northern sheet, on the Alaska claim, is about 40 feet thick, strikes about N. 60° W., and dips 50° E. A short prospect tunnel 15 feet long, at an altitude

of 1,400 feet, has been driven on a mineralized streak in the sheared felsite. Veinlets of quartz several inches thick, with pyrite, sphalerite, galena, and a little pyrrhotite and carrying considerable gold, have been found. On the Ready Money claim the second sheet of felsite is being prospected. Open cuts have been made, and a tunnel is being driven. At about 40 feet above the tunnel an open cut was made on a very rich pocket of mineralized, veined, and altered felsite. The rock is shattered, veined with quartz, and much silicified. Veinlets and blebs of sulphides occur throughout the pocket and comprise pyrite, sphalerite, galena, and a little pyrrhotite and chalcopyrite. As much as 35 ounces of gold to the ton is reported to have been obtained on assays of selected specimens. A crosscut tunnel at an altitude of about 1,300 feet is being driven to cut the felsite sheet. On September 9, 1923, the tunnel was in about 200 feet and had cut about 30 feet of felsite. The country rock at the entrance to the tunnel is a dark-gray to brown hornlike stone of uncertain origin. The tunnel passed through about 50 feet of a light-colored diorite porphyry dike which does not show at the surface. The whole zone of felsite is fractured, and the fractures are faced with small pyrite cubes. These small cubes are also disseminated throughout the felsite. Rarely a bleb of pyrrhotite occurs. Such rock is reported to average $2 to $3 in gold and about 1 ounce of silver to the ton.

RIVERSIDE

The Riverside group of claims is on the east side of the Salmon River road a little beyond Sevenmile, at an altitude of about 260 feet. The property consists of ten claims under development by Strong, Barber & Black. The developments consist of about 2,400 feet of underground workings and numerous trenches and strippings at the surface, made since September, 1922. Three quartz fissure veins in grandiorite are being prospected, known as the Ickis vein, Cross vein, and Southeast vein or "main lead."

The Ickis vein has been prospected by three tunnels, the lowest one about 15 feet long, the middle one about 20 feet long and 35 feet higher (now covered by the dump from the upper tunnel), and the upper one about 70 feet above the lowest tunnel and 500 feet long. In the upper tunnel the vein is about 20 inches wide at the face and is reported to be 4 to 5 feet wide in front of the entrance, now covered by the dump. The tunnel was driven on the vein, which narrows to a stringer a fraction of an inch wide at about 200 feet from the entrance and does not thicken again within the length of the tunnel. The vein within the tunnel averages about 8 or 10 inches in width, with local pinches. The country rock is a shattered, slickensided

gneissoid granodioritic rock. The vein occupies a fissure and consists of quartz with local bunches strongly mineralized with pyrite and galena and rarely with sphalerite. The vein has a general northwest strike, though varying considerably, and a steep northeast dip. Assays as high as $20 to the ton in gold, silver, and lead are reported. The vein matter breaks free from the walls. Stringers (droppers) of quartz several feet long offshoot into the wall rock.

The Cross vein was cut in the underground workings when a crosscut was driven from the drift on the Ickis vein with the intention of reaching the Southeast vein. It is intersected about 600 feet from the entrance of the tunnel, and drifts have been driven on it for about 150 feet to the south and for about 60 feet to the north, to a point where it pinches out; from this point the tunnel has been continued northward to the extension of the Southeast vein. The southerly 100 feet of the vein ranges from 8 inches to 3 feet in width, but the southernmost 25 feet is sparsely mineralized and carries only a little gold. In the drift north from the crosscut tunnel the vein is also narrow but is better mineralized with sulphides. The 50 feet of the vein immediately south of the crosscut tunnel ranges from 18 inches to 3 feet in width, is well mineralized with sulphides, and carries gold, reported to average locally $40 to the ton. At 50 feet in from the crosscut tunnel a 20-foot raise and a 40-foot winze have been opened on the vein. The vein maintains a width of about 2 feet in the raise but narrows to 6 or 8 inches in the winze. The vein as thus exposed in the tunnel is about 210 feet long; the northerly three-fourths is well mineralized with sulphides and carries a good metal content, and the other fourth has sparse sulphides and a low metal content, mainly gold. The southern termination of the vein is not shown. About 150 feet of the vein, as developed in the tunnels, is considered workable. The sulphides comprise pyrite, galena, and chalcopyrite, with rare sphalerite. The vein is in part frozen to the walls (granodiorite). It strikes about north and dips 30° E.

By September, 1924, continued prospecting of this vein had developed new ore shoots, and it was planned to install a 50-ton mill using both tables and flotation to treat the ore. Three shoots of ore have been found in drifting on the vein at the level of the crosscut tunnel—a small one north of the crosscut tunnel, the one described above south of the crosscut tunnel, and a new 70-foot shoot 150 feet farther south. About 150 feet of sparsely metallized quartz intervenes between the two main shoots. The southernmost ore shoot in turn gives way to quartz metallized with pyrrhotite and other sulphides but of low tenor. A winze has been sunk on the vein from the tunnel level 140 feet to a lower level, where drifts have been run on the vein for a length of 180 feet, and 110 feet to a still lower

level, where drifting is in progress. On the first level below the tunnel 50 feet of fine ore has been exposed which averages over 3 feet in width, ranging from 2 to 5 feet, and is reported to average $46 a ton in value, ranging from $36 to $100 per ton. The ore averages about $7 or $8 to the ton in gold and 1 ounce of silver to 1 per cent of lead. A sample from the muck pile of both the upper and lower levels, which included some rock, yielded about 25 per cent concentrates. The pyrite concentrate obtained by separation on tables gave 0.56 ounce of gold and 10.40 ounces of silver to the ton, 4.4 per cent of lead, 37.4 per cent of iron, and 0.4 per cent of insoluble matter. The galena concentrate gave 0.40 ounce of gold and 58 ounces of silver to the ton, 74 per cent of lead, 4 per cent of iron, and 1 per cent of insoluble matter.

The Southeast vein or "main lead" has been developed by two adits and a drift over 400 feet long from the crosscut tunnel. The crosscut intersects the vein at about 800 feet from the entrance. The vein here consists of quartz stringers, locally widening to several feet, in a very highly mashed, minutely plicated schistose granodiorite. A 70-foot raise showed similar material. A lens of solid pyrite several inches wide was found. About 60 feet above the main tunnel the vein crops out on the hillside, and an adit about 300 feet long, known as the Lindeborg tunnel, has been driven on it. Some inclusions of schistose granodiorite occur within the vein. In the Lindeborg tunnel the vein averages about 3 feet in width and is reported to average about $14 a ton. The vein is cut by two dikes of dark andesite porphyry, and the tenor is reported to decrease near the dikes. The sulphides are pyrite and galena, usually localized in bands, with here and there a little sphalerite and chalcopyrite. About 90 feet below the Lindeborg tunnel is another adit about 150 feet long driven on the vein. At the portal of the adit is a 2-foot quartz vein, which pinches markedly about 50 feet in. Stringers of quartz occur in the adjacent country rock, and stringers and veins of quartz are found along the remainder of the drift. There is here no well-defined persistent mineralized vein, but sulphides, mainly pyrite and galena, are present locally in considerable quantity. At the surface numerous trenches and strippings have exposed quartz with sulphides for a length of about 1,800 feet up to an altitude of 900 feet. The amount of sulphides varies considerably. Layers of solid galena several inches thick and carrying considerable silver are found here and there. At one cut the quartz vein is 5 feet wide and contains 18 inches of steel galena reported to assay 27 ounces of silver to the ton. The present workings thus show a better-defined vein with higher metal content in the outcrop and the upper (Lindeborg) tunnel than in the lower tunnels. In the lower tunnels the vein has more of the nature of a stringer lead in schist, with thick

bunches of quartz and small local pockets of sulphides. Several dikes of andesite porphyry cut the granodiorite and the vein. The vein matter breaks freely from the walls.

At an altitude of about 550 feet about 40 feet of vein matter is exposed, consisting in part of solid milky-white quartz and in part of a brecciated granodiorite with quartz veinings. A grab sample of this quartz is reported to show a little gold, though it carries practically no sulphides.

CRIPPLE CREEK

The Cripple Creek group of claims is on the south bank of Salmon River just above Texas Creek and just below the bridge across Salmon River at Tenmile. The group comprises four claims. The developments consist of an adit 45 feet long with a 15-foot open cut at the portal, an 8-foot drift to the west from the breast of the adit, four small prospect holes, and strip pits along the projected strike of the vein. An upper vein of quartz has been stripped for 150 feet.

The adit was driven on a vein zone lying along the contact between a sheet of granodiorite and greenstone and consisting of two veins, one on the footwall of the adit and the other on the hanging wall, with a barren zone of fractured greenstone between them. The lower vein is exposed for 65 feet, and the upper vein for 45 feet, pinching out within 20 feet of the breast of the adit. From the breast a drift was driven 8 feet to the west on the lower vein without reaching the end of the vein zone. In the open cut the vein zone is exposed for a width of 13 feet and consists of a massive vein of quartz 4 feet wide with numerous smaller stringers in fractured greenstone. In the drift the strong quartz vein splits into a vein zone of small quartz stringers in brecciated and fractured greenstone. A little pyrite was noted in the drift, scattered through the greenstone in disseminated grains. No sulphides were noted in the massive quartz, though it has iron and copper stains in the open cut.

The upper vein has granodiorite on the hanging wall; all the footwall has been cut away, but to judge from the rock exposed in the breast, it was an altered and brecciated greenstone. The vein consists of quartz bordered by several smaller stringers of quartz in the hanging wall. The main vein ranges from a few inches to 2 feet in width and averages 11 inches. On the footwall side of this vein were noted two small seams of sulphides, one about 2 inches wide exposed for about 6 inches, the other about 1 inch wide and traceable for 5 feet. Both of these stringers carried rather coarsely crystalline galena, with a little pyrite and sphalerite. Scat-

tered through the quartz vein are sparse grains of pyrite, galena, and chalcopyrite. Specimens of solid galena 3 to 4 inches wide are common on the dump.

About 200 feet above the road is a solid mass of quartz which has been exposed by stripping for about 150 feet. The quartz vein is about 4 feet wide and is contained in granitic work, probably the sheet that partly parallels the adit on the lower vein zone. No sulphides were noted in this vein. The lower vein strikes northwest and dips 70° N.; the upper vein strikes northeast and dips 40° E.

STONER

The Stoner group of claims adjoins the Elevenmile group and is held by H. B. Stoner. About 300 feet above the Hoosier tunnel on the Elevenmile claims, at an altitude of 1,360 feet, 15 feet from the boundary line of the Elevenmile group, an open cut was made. This cut is about 40 feet wide and is in either silicified greenstone or a felsite sheet. More careful examination would be necessary to determine which. Dikes of andesite porphyry are found on each side of the open cut. Fine pyrite cubes are disseminated throughout the rock, and locally there are little threads and veinlets of fine granular galena. Calcite veinlets are common. The best assays are reported to be about half an ounce of gold to the ton.

DALY-ALASKA

The Daly-Alaska group of claims is also known as the Elevenmile and as the New Alaska group. The claims are near Elevenmile, on the Salmon River road.

The writer is indebted to B. W. McDougall for information about the property. The group comprises 11 claims and is equipped with a 25-horsepower Fairbanks-Morse oil engine and compressor. An average of about 16 men were employed between March and August, 1923. Since Westgate's report was written about 380 feet of underground workings have been driven. At an altitude of about 150 feet above the camp on Salmon River a 58-foot shaft was started on a mineralized streak in greenstone and sunk vertically. From the bottom of the shaft a 70-foot crosscut was driven; from this crosscut a drift 62 feet long was run on a mineralized streak, and from the end of the drift 44 feet of crosscut. The mineralized zone consists of broken and silicified greenstone, with quartz veinings and streaks of sulphides.

A short distance northeast of the Daly shaft a crosscut was driven for about 150 feet in a southeast direction and intersected some rich but narrow sulphide stringers.

Many small open cuts have been made on mineralized outcrops above the entrance to the Larson tunnel. Near the bed of a creek, at an altitude of about 600 feet, two open cuts have been made on a mineralized shear zone in the greenstones. There is a 3-foot vein here, streaked with stringers of fine granular galena, pyrrhotite, and sphalerite, with some chalcopyrite and pyrite, together with calcite and quartz veinlets and some sulphides. The sulphides may form about 20 per cent of the zone. The vein strikes about N. 80° W. and dips 60° S., and it is reported to average about 30 to 40 ounces of silver to the ton. In another open cut on the same zone, about 10 feet above, the sulphides consist mainly of pyrite with local sphalerite stringers that give high assays in gold.

Samples are reported to have been obtained that yielded assays of silver as high as 500 ounces to the ton. A polished specimen reported to be of the high-grade type was examined under the microscope and found to comprise pyrrhotite, sphalerite, and pyrite, with a little chalcopyrite, galena, and tetrahedrite. The tetrahedrite occurs as small blebs in the sphalerite and as minute veinlike stringers. Its reaction with potassium cyanide suggests that it is the silver-bearing variety, freibergite. Moil samples as much as 30 inches in width are reported to have yielded 20 to 30 ounces of silver to the ton. Work is being continued to prove whether or not a definite ore body exists on the property.

VIRGINIA

The writer did not see the workings at the Virginia group, and William Bunting is authority for the following description. The group comprises six claims staked in 1919 on the Salmon River road near the international boundary. Work was begun in 1920, and the developments consist of 600 to 700 feet of tunnel and crosscuts. In this work a zone 50 feet wide, of which 12 to 16 feet is mineralized with sulphides, was crosscut. The ore is said to average about $4 to $5 a ton, mainly in gold. Selected samples have yielded as high as 4½ ounces of gold to the ton.

TEXAS CREEK BASIN

MINERAL DISCOVERIES

Chapin[7] reported in 1916 that several claims had been staked on Texas Creek and that the ore bodies were said to be quartz veins carrying seams of tetrahedrite penetrating granite and pegmatite but had been only slightly prospected. For a number of years little was done in this part of the district. On June 12, 1923, interest was

[7] Chapin, Theodore, Mining developments in southeastern Alaska: U. S. Geol. Survey Bull. 642, p. 98, 1916.

renewed by the staking of claims along the line of the Government trail in the West Fork of Texas Creek valley by Smith, Davidson, and Ferguson. This interest was intensified by the staking, by J. Neary and J. Jackson, on July 23, of a claim still farther up the valley on a large, well-defined quartz vein carrying galena and some pyrite and chalcopyrite. This find attracted about 30 prospectors into this part of the district, and by the middle of September about a hundred claims were recorded and 11 prospectors were still in the field. As little has been printed about this part of the district, its features will be described in some detail.

TOPOGRAPHY

Texas Creek flows almost due south from its source in Texas Glacier to its junction with Salmon River. The West Fork enters the main creek about 2½ miles above its mouth, after flowing almost due east for about 10 miles from the divide at the Chickamin Glacier. The West Fork is fed mainly by streams originating in two glaciers on the south side—Casey Glacier, about 5 miles from the mouth, and Ferguson Glacier, at 8 miles. Many small tributaries flow into the creek, chiefly from the north side.

The valley of the West Fork is essentially a glacial U-shaped, flat-floored valley, covered with a veneer of coarse gravel. It rises gradually, at a rate of about 200 feet to the mile, from an altitude of about 600 feet at its mouth to about 2,600 feet at its head. At about 3 miles and 6 miles from the mouth postglacial gorges have been cut in the valley floor for about 1,000 yards and 600 yards and to depths of about 350 and 200 feet, respectively.

Casey Glacier occupies a great cirque basin and is highly crevassed and broken up; Ferguson Glacier is a "through" glacier, extending across the divide at the head of the narrow valley which it occupies and into a small tributary valley of Thumb Creek, which empties into Salmon River opposite Sevenmile. Ferguson Glacier is retreating, and the old rough moraines extend in front of the present ice for half a mile or so, forcing the West Fork of Texas Creek to flow against the cliffs on the north side of the valley.

Chickamin Glacier is likewise in retreat, and a conspicuous terminal moraine has been left about three-fifths of a mile below the present ice front. Between the terminal moraine and the ice front is a lake; and a narrow, higher-level lake terrace fringes the basin on either side.

Along the sides of the main valley gravel terraces and alluvial fans occur at considerable altitudes above the present bed of the main creek. Such forms are also characteristic of the valley of Ibex Creek, where along the west side a gravel terrace or bench of hard-

pan, in part roughly stratified and in part of slide material, extends nearly to the head. The terrace is maturely dissected by the many tributary streams, which have cut a succession of gulches. The cutting of postglacial gorges and the lowering of its bed by Texas Creek evidently resulted in a quickening of erosion and marked downcutting by its tributaries all along the line, leaving the old gravel deposits as terraces along the mountain sides. Along the Salmon River road up the hill from the Daly-Alaska camp, near Elevenmile, there are exposed well-stratified clay and sand up to an altitude of about 450 feet. These deposits were probably laid down in marine waters and therefore indicate an uplift of at least 450 feet since the retreat of the glaciers there.

The valley of the West Fork of Texas Creek is bordered on both sides by steep, rugged mountains, ranging in altitude from 4,500 to about 6,400 feet. Up to altitudes of about 3,000 feet the hills are timbered with hemlock and spruce of good grade, in quantity adequate for all mining and building demands. No examination was made as to the possibilities of developing water power, but the two gorges and the gradient of the main stream and tributaries suggest that sufficient for all needs could be developed.

GEOLOGY

On the accompanying map (Pl. I) the areal geology of the region east of Salmon River is taken from the map by Westgate; that shown of the region west of the river was sketched in by the writer from distant views and is therefore only a rough approximation. The fact which it is desired to emphasize is that the contact of the coast-range batholith and the sediments to the west is not "smooth and flowing" but irregular and that belts of metamorphosed andesitic tuff, graywacke, slate, and associated greenstone and argillite are found on the American side of the boundary and afford many contacts near which promising prospects have already been located and near which others may be sought. Many prospects other than those described and located on the map have been staked but are not included here for the reason that in the short time available the writer was unable either to visit them or to get accurate information about them.

The granitoid rock along Texas Creek, as along Salmon River, ranges from a granodiorite to a quartz-hornblende diorite and is intruded by numerous dikes of light-colored rock, including granodiorite porphyry, granite porphyry or granophyre, and aplite, and by dikes of dark-colored rock, including andesite and andesite porphyry. Similar dikes are found in the sedimentary beds.

The rock forming the mountain between the Homestake and Ibex groups of claims is a granodiorite consisting by volume of about 60 per cent of plagioclase, 16 per cent of quartz, 12 per cent of orthoclase, and 12 per cent of hornblende, with accessory magnetite, titanite, and apatite. The hornblende is partly or completely altered to chlorite, biotite, epidote, zoisite, and ilmenite. The plagioclase is flecked with sericite, and the quartz shows strain shadows or is recrystallized under nonuniform pressure. The rock at the Keno group of claims is of similar character, except that the percentage of postassic feldspar (microcline) is less (about 6 per cent). At the Lake claims the rock is a quartz diorite with only a trace of orthoclase. Muscovite in large flakes is present and has resulted from the replacement of some of the ferromagnesian minerals. All the rocks show the effect of strain in the crushing of the quartz, also the effects of alteration whereby the plagioclase has been partly altered to sericite and the hornblende has been altered to chlorite with associated epidote, ilmenite, and magnetite. The potassic feldspars, orthoclase and microcline, are predominantly fresh and unaltered.

At the Ibex claims a light-colored dike of pinkish hue occurs in the argillite. This rock was examined in thin section and is a granite porphyry. It consists of abundant small crystals of quartz, orthoclase, plagioclase, and hornblende, in a granophyric groundmass. Aplite and andesite dikes are common in the tuff beds on the south side of Texas Creek.

PROSPECTS

CHARLES, NELSON & PITCHER

Westgate[8] has described a prospect held by Charles, Nelson & Pitcher 2 miles above Salmon River on the east side of Texas Creek.

SNYDER

Ray Snyder holds claims just off the trail along Texas Creek about halfway between the bridge across Salmon River and the cable crossing on Texas Creek. At an altitude of about 600 feet a small open cut has been made on a vein in granodiorite porphyry. The vein strikes N. 25° W. and dips 40° E. It is about 3 feet thick and consists of a shattered zone in the granodiorite with reticulating veinlets and stringers of quartz aggregating 12 to 14 inches in width. The quartz is in part heavily metallized with galena, pale resin-colored sphalerite, a little chalcopyrite, and sparse tetrahedrite. Several open cuts and strippings have been made in the vicinity on small quartz stringers, but the veins exposed do not appear to be persistent.

[8] Westgate, L. G., op. cit., p. 139.

McVEY

The writer was shown specimens of ore by Daniel McVey, reported to come from a vein not yet recorded but staked in a gulch about 2 miles up the West Fork trail. The vein is reported to be a quartz fissure vein in granodiorite, mineralized with pyrite, galena, and chalcopyrite.

HOMESTAKE AND IBEX

The Homestake and Ibex groups of claims are held by J. H. Hewitt and C. Carlson. A cabin has been built at an altitude of about 2,300 feet, about 8 miles by trail from the bridge over Salmon River at Ninemile. Trails have been cut to both groups of claims, but practically no work has been done on the veins.

The Homestake group comprises six claims. The vein is in the face of a bluff on the east side of a gulch at an altitude of about 3,500 feet. The vein strikes about N. 15° E. and dips 45°–50° E. It has been traced for a length of 250 feet or so. The northern 150 feet is strongly metallized, but the southern 100 feet is milky-white quartz with very sparse metallization. The width of the vein ranges from 4 to 5 feet. The vein pinches abruptly at the north end, and its projected line of extension is covered by snow. At the south end the vein is covered for a short space by débris and does not show in the bluff to the south. This may be due to offsetting by faulting. In the ore shoot bands of solid sulphide (almost wholly steel galena) occur in widths up to a foot.

The sulphides on these claims consist predominantly of dense steel galena with some pyrite and chalcopyrite and locally a trace of sphalerite. The pyrite and chalcopyrite usually occur together as small eyes or streaks within the galena and together with the quartz give a banded character to the vein. Under the metallographic microscope the pyrite appears in part as much fractured granular aggregates in a meshwork of chalcopyrite and in part as cubes and corroded grains disseminated through narrow streaks within the galena. The quartz is in part broken up and veined and corroded by the galena. The galena appears to belong to a later stage of mineralization than the quartz and pyrite-chalcopyrite aggregates.

Through the courtesy of Dr. J. Austen Bancroft, assays on three samples (Nos. 1, 2, and 3 in the following table) from this vein, made for him by the Granby Co., are given below, together with an assay (No. 4) made for the writer by E. T. Erickson in the chemical laboratory of the United States Geological Survey.

Assays of samples from vein on Homestake group

	1	2	3	4
Lead.....per cent..	43.8	5.5	62.0	65.75
Copper.....do....	1.0	.84	.9	1.95
Zinc.....do....		1.2	.0	9.22
Silver.....ounces per ton..	5.8	1.3	13.1	9.22
Gold.....do....	.26	.22	.18	.06

1. 12 feet south of discovery post. Width of 20 inches.
2. About 25 feet south of discovery post. Width of 5 feet.
3, 4. Picked samples of galena.

The Ibex group comprises four claims. The vein is exposed on both faces of a small, deep, steep-sided gulch at an altitude of about 3,700 feet, on Ibex No. 1 claim. The country rock consists of thin-bedded gray to black argillite and quartzite, cut by dikes of granite porphyry and granodiorite. The vein is exposed for about 100 feet in length and 75 feet difference in altitude. It pinches and swells but is 15 inches to 2 feet in width for considerable portions. At the bottom of the gulch about 18 inches of sulphide ore with only a little quartz gangue is exposed. The sulphides here consist almost wholly of interbanded pale-colored sphalerite and coarse-grained galena. The vein is cut by a dike of granite porphyry and is offset along the dike. In the face of the north wall of the gulch the vein is again offset by faulting. The vein is a fissure vein striking about N. 5° E. and crossing the bedding of the banded argillite and quartzite. It dips steeply to the east.

Some of the ore is banded with streaks of galena, pyrite, chalcopyrite, light-colored resinous-lustered sphalerite, and tetrahedrite. Several small specimens were examined with the metallographic microscope. The pyrite is the earliest mineral of crystallization and occurs as grains or aggregates in a meshwork of chalcopyrite. The sphalerite is of later crystallization than the chalcopyrite, and veinlets of sphalerite cross the pyrite-chalcopyrite streaks. All three of the earlier minerals are broken and veined by galena, and some corrosion of the sphalerite by galena has taken place. The relations of the galena and tetrahedrite are somewhat indeterminate, but the tetrahedrite appears, in part, to have finished crystallization later than the galena, and in part it occurs as blebs in the galena and may be of contemporaneous crystallization. The tetrahedrite tends to occur as veinlets in or along the borders of the sphalerite.

A high content of silver, copper, and lead is reported to have been shown by assays of picked specimens from this vein.

SILVER STAR

The Silver Star claim was staked by McVey & Connors. It is about 950 feet in altitude above the Government trail, between the

Texas Discovery and the trail that turns off to the Homestake and Ibex groups. The vein is in a shear zone in granodiorite, striking about N. 10° E. and dipping 55° E. At the surface there is a 2-foot shear zone with abundant stringers of metallized quartz. The quartz is, in general, sparsely to heavily metallized with pyrite and galena. Picked samples from this vein are reported to have yielded an ounce of gold to the ton.

SILVER COIN

The Silver Coin claim was staked by Paul Meagher and Ray Snyder. It is on the east side of the western gulch tributary to that on which the Homestake is located and is about 700 feet in altitude above it. The vein is in granodiorite and is about 50 feet in length. It strikes N. 5° W. and dips 45° E. The northern 25 feet of the vein consists of a shoot of ore which widens abruptly from a few inches at the north to 5 feet on the south. At the south end it passes into practically barren milky-white quartz. The quartz splits into stringers, and an extension to the south can not be traced. The quartz vein zone at the south end has no well-defined hanging wall or footwall and is 10 feet or more thick. The quartz stringers appear to stop abruptly down the dip. It was not ascertained whether this is due to pinching or to a fault. The granodiorite shows many slipping planes, and along the footwall of the ore shoot these are coated with malachite. The metallized shoot of the vein consists of quartz heavily metallized with galena and a little pyrite and chalcopyrite.

EVENING STAR AND MORNING STAR

The Evening Star and Morning Star claims were staked by McVey & Connors on August 20, 1923. The two claims are on the east side of the creek just east of the cabin of Carlson & Hewitt and about 150 feet in altitude above it. Only a small open cut had been made on the vein. This shows a zone of shattered granodiorite with stringers of fine-grained to dense steel galena of the type found in the Homestake vein and stringers of quartz as much as 9 inches in width. The vein is otherwise covered along its strike.

TEXAS DISCOVERY

The Texas Discovery claim was staked June 22, 1923, on the West Fork of Texas Creek at an altitude of about 1,900 feet, about 5 miles by trail from Texas Creek. The vein is a heavily metallized quartz vein in a shear zone in granodiorite. It strikes about N. 30° W. and dips 45°–60° NE. The metallic minerals consist of galena and pyrrhotite; galena and pyrite; or galena, pyrrhotite, pyrite, and sparse chalcopyrite. The vein ranges from 1 to 14 inches in

width and pinches out at the northwest end. An assay of a picked sample is reported to have given 30 per cent of lead and $22 in gold and $6 in silver to the ton.

Another vein is reported to have been found higher up on the slope.

DOUBLE ANCHOR

The Double Anchor group comprises four claims lying on the north side near the head of the West Fork of Texas Creek, recorded July 28, 1923. They are said to be held by Frey, Goldborgh & Davidson. No information regarding the nature and exact location of the prospect was obtained.

LAKE

The Lake claim was located on July 27, 1923, and lies on the trail near the head of the West Fork of Texas Creek at an altitude of 2,500 feet. The vein is a quartz fissure vein in quartz diorite, heavily mineralized along the footwall with galena and pyrite; the galena is predominant. The vein is 11 inches wide, strikes N. 35° W., and dips 60° E. No work has been done on the property.

TEXAS CREEK COMSTOCK

The cabin for the Texas Creek Comstock group of claims lies on the south side of the West Fork trail about 11 miles from the Salmon River bridge. (See fig. 3.) The original claim was located July 15, 1923, and is known as the Joe-Joe claim. It is at an altitude of about 4,700 feet. Subsequently 14 additional claims were staked in the vicinity and were known as the Jackson-Hummel group. Subsequently new claims were staked, and together with a claim held by Johnson, Bryne, and Hummel and those previously staked, comprising 20 in all, were grouped as the Texas Creek Comstock.

Veins are exposed at a number of places on these claims, but they have not been developed, and only further exploration and more intensive study can determine whether they represent faulted portions of a few veins or many different veins. In general character they are alike, being quartz fissure veins mineralized with galena, pyrite, and a little chalcopyrite and having a general northwest strike and steep northeast dip. The veins occur both in granodiorite, which forms the lower slope of the mountain ridge, and in metamorphosed graywacke and tuff, which form the upper half of the ridge. Dikes of andesite porphyry and aplite cut both the granodiorite and the sediments.

On the Joe-Joe claim the mineral deposit is a metallized quartz fissure vein in metamorphosed tuff and graywacke with thin layers of gray slate. The slate strikes N. 85° E. and dips 60° S.; the vein

strikes N. 35° W. and dips steeply northeast. The vein ranges from 6 to 11 feet in width, and the mineralized ore shoot from 5 to 8 feet. Sparsely mineralized white quartz veins, as much as 4 feet in width and with inclusions of country rock, occur in the footwall of the vein. Many narrow gash veins of white quartz are found within a zone several feet wide in both the hanging wall and the footwall of the upper portion of the vein. One quartz vein offshooting from the main vein into the footwall is exposed along the

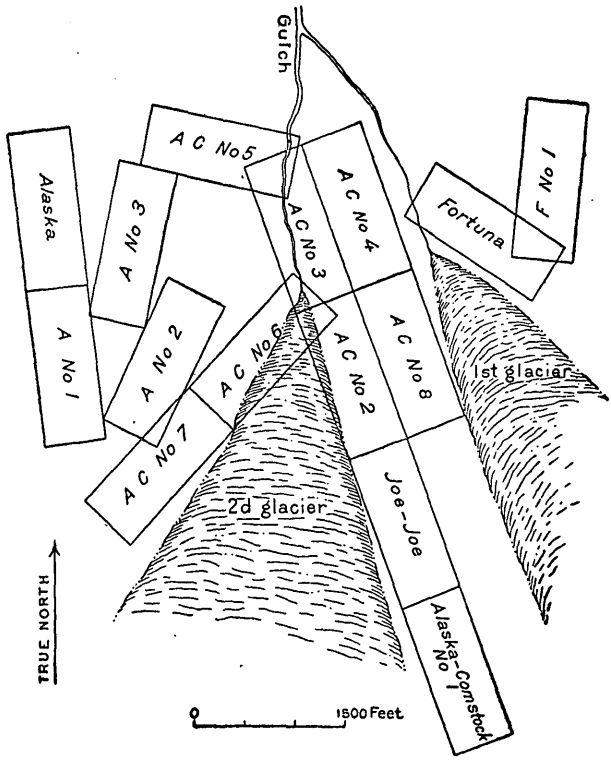


FIGURE 3.—Sketch map of portion of Texas Creek Comstock group of claims, West Fork of Texas Creek

strike for about 20 feet, is from 9 to 18 inches wide, and carries some sulphides, predominantly galena with considerable pyrite and chalcopyrite. The main vein is exposed for a difference in altitude of 60 feet and appears to be offset by faults at each end.

At an altitude of about 4,830 feet is a mineralized quartz vein striking N. 15° W. and about 10 to 15 inches wide, which may be the faulted continuation of the lower vein.

Below the discovery stake on the Joe-Joe property is a dike of light-gray andesite porphyry, which at the west turns and strikes N. 50° W. Along this portion, which strikes northwest, at the contact

of the dike and the sedimentary rocks, a quartz vein is exposed for a length of about 100 feet. The vein has an average width of about 4 feet, but it widens at one place to 8 feet and at another consists for a length of 6 feet of several stringers of quartz in a schistose pyritized country rock. The vein pinches abruptly at the southeast end and is covered toward the northwest. The lower portion of the vein is predominantly milky-white quartz; the upper portion is mineralized with heavy bands of galena, pyrite, and chalcopyrite.

At an altitude of about 4,260 feet, near the east side of the second glacier, is a quartz vein mineralized with considerable galena and a little pyrite and chalcopyrite. The vein strikes north, dips 35° E., has an average width of about 2 feet, and is exposed along the strike for 30 feet.

Also near the east side of the second glacier, at an altitude of about 4,115 feet, is a quartz vein 16 to 24 inches wide, heavily mineralized with sulphides in the upper portion but consisting almost wholly of pure-white quartz farther down the hill. Local layers, as much as 10 inches thick, of solid galena with some pyrite are present.

At an altitude of about 3,980 feet, just at the edge of the ice, a quartz vein is exposed for a length of about 30 feet. It has an average width of about 15 inches and is well mineralized with galena and a little pyrite and chalcopyrite. Several dikes of granodiorite cut the metamorphic sediments here, and the vein cuts rock of both types. Its south end is cut off as if by a fault. The vein strikes N. 35° W. and dips 65° NE.

At an altitude of 3,900 feet, in a gulch just west of the second glacier, several trenches have been made on quartz fissure veins in granodiorite. These veins are from 8 to 20 inches in width and carry the usual mineralization. A 2-inch quartz vein with molybdenite occurs in the granodiorite in the gulch below the second glacier.

Mr. Hummel furnished the following data on assays made by the Granby Smelting Co., of Anyox, B. C., of samples from the claims lying between the two glaciers:

Assays of samples from Texas Creek Comstock group

	1	2	3	4	5
Silver, ounces per ton	5.7	16.9	2.0	3.6	16.1
Gold, do	.01	.18	.05	Tr.	.03
Copper, per cent	0.61	0.58	0.06	0.14	0.17
Lead, do	5.6	72.8	3.8	4.5	28.4
Zinc, do	1.8	.0	1.2	.0	2.6

1. Across 1 foot of 30 foot vein at lowest showing on hill.
2. Across 1 foot next to last showing down, Comstock No. 2.
3. Across 56 inches, 10 feet above discovery post, Joe-Joe claim.
4. Across vein.
5. Picked samples, high grade, from Joe-Joe claim.

JOHNSON-BAYNE-HUMMEL

The Johnson-Bayne-Hummel claim, which is undeveloped, is near the head of the West Fork of Texas Creek, on the south side, at an altitude of 4,900 feet, at the foot of the third small glacier west of Ferguson Glacier. The mineralized rock consists of a fissured zone in slate, graywacke, and tuff from 3 to 6 feet wide, with stringers of quartz from a fraction of an inch to a foot wide. The quartz is locally heavily mineralized with galena and pyrite. The veins can not be traced far, as they pinch out in one direction and pass under the glacier in the other. There is considerable mineralized float in the adjacent moraine on the glacier, including one boulder of quartz 3 by 1¼ feet, very heavily mineralized with galena, pyrite, and chalcopyrite.

KENO

The Keno group of claims, staked in August, 1923, comprises nine claims on the west side of Ferguson Glacier, at altitudes of about 4,000 feet, about 3 miles south of the West Fork of Texas Creek. The mineral prospects are several quartz fissure veins in granodiorite. A small open cut has been made on one of the veins, which in the cut is 3 feet wide and is mineralized with sparse pyrite. The vein has been traced up the hillside for 400 feet by trenches and natural exposures, through a difference in altitude of about 200 feet. The predominant vein matter is milky-white quartz with sparse sulphides. Through the center of the vein is a band several inches wide of quartz heavily mineralized with streaks of solid sulphides in which galena predominates. A specimen sample of this mineral shoot is reported to assay 0.6 ounce of gold and 3 ounces of silver to the ton and 48 per cent of lead. A specimen of the prevailing white quartz of the vein was assayed by E. J. Erickson in the chemical laboratory of the United States Geological Survey and yielded a trace of gold and 0.08 ounce of silver to the ton. The vein strikes N. 40° W. and dips 80° NE. Locally it pinches to a few inches, but generally it is from 2 to 4 feet in width. Small inclusions of the wall rock are found here and there in the vein. The walls are slickensided, and the quartz breaks clean. The wall rock appears to be unsheared but shows considerable alteration to epidote.

Another vein, at an altitude of 4,440 feet, 7 inches to 2 feet wide, is exposed for about 30 feet along the strike. It is of similar character to the one just described; strikes N. 60° W., and dips 70°–80° NE.

McGRAW

Chapin[9] in 1916 indicated on his map the location of a prospect on Texas Creek known as the McGraw but did not describe it.

[9] Chapin, Theodore, Mining developments in southeastern Alaska: U. S. Geol. Survey Bull. 642, p. 95, 1916.

IRON CAP

Five claims known as the Iron Cap group lie west of the Ibex group and run parallel to the West Fork of Texas Creek. David McVey says that the vein is a band in the argillite carrying chalcopyrite and pyrite disseminated and in threads and that a sample gave an assay 0.04 ounce of gold and 6.28 ounces of silver to the ton and 2 per cent of copper.

NICKEL-COPPER DEPOSITS

DISCOVERY

The first nickeliferous mineral deposit found in southeastern Alaska was that of the Alaska Nickel Mines, located in 1911 on the outside coast of Chichagof Island between Portlock Harbor and Lisianski Strait. From 1915 to 1918 some prospecting and sampling of this property was carried on. In 1921 S. H. P. Vevelstad located 40 claims on nickeliferous lodes about 14 miles to the north, on Yakobi Island, in the vicinity of a valley basin known as the Bohemia Basin, whose mouth is on Lisianski Strait, about 2¼ miles southwest of Miner Island. In 1923 Vevelstad also located one claim near Surge Bay and two claims south of Takanis Bay, both on the west side of Yakobi Island. In 1922 I. Myre Hofstad located four claims on a nickel-copper lode lying on the north side of Snipe Bay, on the west coast of Baranof Island, about 100 miles southeast of the Alaska Nickel Mines property. A. Lagergren has claims on a nickel-copper prospect on Tenakee Inlet, Chichagof Island (Pl. II).

The Admiralty-Alaska Co. has also found a nickeliferous deposit on its property near Funter Bay, Admiralty Island.

These successive discoveries have aroused renewed interest in the subject, and it is very probable that other masses of gabbro and norite, with which the nickel is uniformly associated, will be found on Chichagof and Baranof islands.

ALASKA NICKEL MINES

The property of the Alaska Nickel Mines was not visited by the writer, and the description which follows is taken from the report by Overbeck.[10]

LOCATION

The claims of the Alaska Nickel Mines lie on the outside coast between Portlock Harbor and Lisianski Strait. The principal prospects are on Fleming Island, a small tidal island, about 25 miles by water northwest of Chichagof. The property in 1917 consisted of 18 claims and two fractions. The original

[10] Overbeck, R. M., Geology and mineral resources of the west coast of Chichagof Island: U. S. Geol. Survey Bull. 692, pp. 125–133, 1919.

locations were made in 1911, and a relocation was made in 1915. The company holding the property was called the Juneau Sea Level Copper Mines until 1917, when the name was changed to the Alaska Nickel Mines. * * * A wharf site and power site have been located by the present company.

GENERAL CHARACTER OF THE DEPOSIT

Exposures of rock in this part of the coastal plain are confined to the seashore, for everywhere else the rocks are concealed by a heavy growth of vegetation and by swamps. Three outcrops, heavily stained with iron, were noted on the shore. These outcrops form irregular areas whose maximum diameter is about 70 feet and project somewhat above the surrounding rock. The extreme outcrops are about a mile apart. The northwest cropping shows limonite, and although no sulphides were seen it is probable that they would be found under the leached zone. The 180-foot shaft was sunk beside the central outcrop, and ore is reported on the 180-foot level. No work has been done on the southeast outcrop, but the ore minerals are found on the surface. At a number of other places the ore minerals have been found disseminated through the country rock in small amounts, but it is not yet known whether this type of so-called "disseminated ore" can be handled profitably. Two of the principal outcrops are close to the contact between the igneous rock in which the ore bodies occur and the quartz-mica schist which these igneous rocks intrude. The northwest outcrop is several hundred feet from the contact; the central outcrop is a few feet from the contact; and the southeast outcrop also may be near a contact, but the heavy cloak of vegetation conceals the rock a few feet away from the outcrop. From the surface outcrops, then, it would appear that the distribution of the ore bodies is to some extent related to the contact between the igneous body and the schist. Most of the "disseminated ore" has been found near the contact, but some of it is farther away from the contact than are the two main outcrops. The only chance for underground observation was in the 80-foot level of the central outcrop. The shaft is in light-colored diorite that is free of ore minerals. The drift for about 30 feet from the shaft is in barren hornblende gabbro, but the last 20 feet are in massive ore. The contact between the barren rock and the ore-bearing portion appears to be an irregular line. There is a rather rapid transition from barren rock to rock in which there are a few disseminated sulphides and then to massive ore. The change does not appear to occur progressively but irregularly. In the face of the tunnel and in a crosscut near the face are some blocks of barren rock, but the drill holes in the face of the main tunnel are apparently in sulphides. Some movement has taken place in this tunnel, but its extent is not known. The 180-foot level could not be visited, but it is reported that ore was encountered on this level. The report that a clay gouge occurs in this level indicates that movement has taken place. The presence of niccolite on the 180-foot level indicates a secondary origin for some of the ore on that level.

MINERALOGY

The chief metals that may be of commercial importance found in this deposit are copper and nickel. Assays furnished by the company show small amounts of gold and silver. The principal sulphide minerals are pyrrhotite, chalcopyrite, and pentlandite. In the hand specimen of the rock chalcopyrite and pyrrhotite are the only minerals that can be recognized, but in a polished specimen of the ore the pentlandite can be plainly seen. A few specimens of niccolite have been obtained from both levels. The niccolite is a secondary mineral and

lines crevices in the country rock. Insufficient underground work has been done to afford data on the relative abundance of the ore minerals. In some hand specimens chalcopyrite is more abundant than pyrrhotite; in other specimens the reverse is true. * * *

PETROGRAPHY

The deposits are found in a body of medium to coarse grained igneous rock that shows considerable variation in type—variations that extend all the way from granite to gabbro. This igneous body intrudes quartz-mica schist, which is supposed to be the metamorphic phase of the graywacke that occupies much of the west coast of Chichagof Island. * * * In general, a gradation in rock type from more acidic away from the contact to less acidic near the contact appears to exist. That this gradation is due entirely to differentiation, however, is doubtful; for the most acidic bodies of rock, such as those in Cautious Pass and those in Mirror Harbor, seem to be later than the diorite and intrusive in it. The acidic dikes are definitely later than the diorite and norite. * * * The smaller light acidic dikes and bodies that cut the diorite are aplites and granites. * * * The rock that makes up most of the intrusive body falls under the general term of diorite. * * * The most basic of the rocks—hornblende gabbro and norite—are found close to the outcrops of the ore bodies. A common rock of characteristic appearance that occurs near the ore bodies is a very coarse-grained hornblende gabbro or norite. The rock weathers to large rounded boulders with rough and pitted surfaces. Small amounts of ore minerals scattered in blebs are seen at some places in these rocks. * * * A specimen of rock from the 80-foot level, about 10 feet from the shaft, is a dark-greenish medium-grained hornblende gabbro. * * * A specimen of the "disseminated ore" is a dark-brown fairly coarse grained rock. It consists chiefly of hornblende, pyroxene, and feldspar, together with disseminated pyrrhotite and chalcopyrite and a little biotite. The hornblende is brownish and strongly pleochroic. The pyroxene is orthorhombic; it occurs in lath-shaped crystals rounded at the ends and has altered somewhat to hornblende. * * * Most of the opaque minerals replace and are definitely later than the principal silicates in the section. The replacement of the pyroxene by sulphide is particularly evident. The opaque minerals also occur as grains in the original minerals. Nickel was found in this specimen. * * *

A polished surface of the ore shows pyrrhotite, pentlandite, and chalcopyrite. * * * At no place in a dozen specimens examined could any decisive evidence as to the relative time of formation of the sulphides with reference to one another be obtained. * * * They are, however, definitely later than the original silicates.

DEVELOPMENTS

S. H. P. Vevelstad furnished the writer with a copy of a report made by J. C. Rogers for the International Nickel Co. in 1917. The following data are quoted or summarized from this report:

A 6 by 8 foot shaft was sunk 175.5 feet, the first level being at 75.5 feet. The 75-foot level has 62 feet of drift northwest of shaft, 4 feet of drift southeast of shaft, and 5 feet crosscut, giving a total of 71 feet, of which 37 feet is in ore. The 175-foot level has 51 feet of main drift, 15 feet of drift southeast, and 14 feet northwest, giving a total of 80 feet. The character of the rock here is different than on the 75-foot level, the north and south drifts

being in the brecciated mass between slips or shear zones. * * * The 75-foot level at present shows a maximum ore body of 37 feet by 10 feet, inclosed at one side and ends but open on the remaining side, as massive ore extends to the end of the drift on the left-hand side.

The width of the ore as sampled in the 75-foot level ranges from 2.2 to 7.8 feet and averages about 5 feet. The nickel content ranges from 1.85 to 5.05 per cent, and copper from 0.4 to 4 per cent, with an average of 3.42 per cent of nickel and 1.58 per cent of copper over 37 feet of drift. Sulphur ranges from 8.3 to 25.3 per cent, and silica from 16.1 to 38.05 per cent. Four assays are given for widths ranging from 1.1 to 7.9 feet on the 175-foot level which show nickel from 1.65 to 5.7 per cent and copper from 0.4 to 2.3 per cent; the narrower widths gave the higher assays. Rogers states also that the rock on the 175-foot level seems to have no direct connection with the ore above.

BOHEMIA BASIN

GENERAL FEATURES

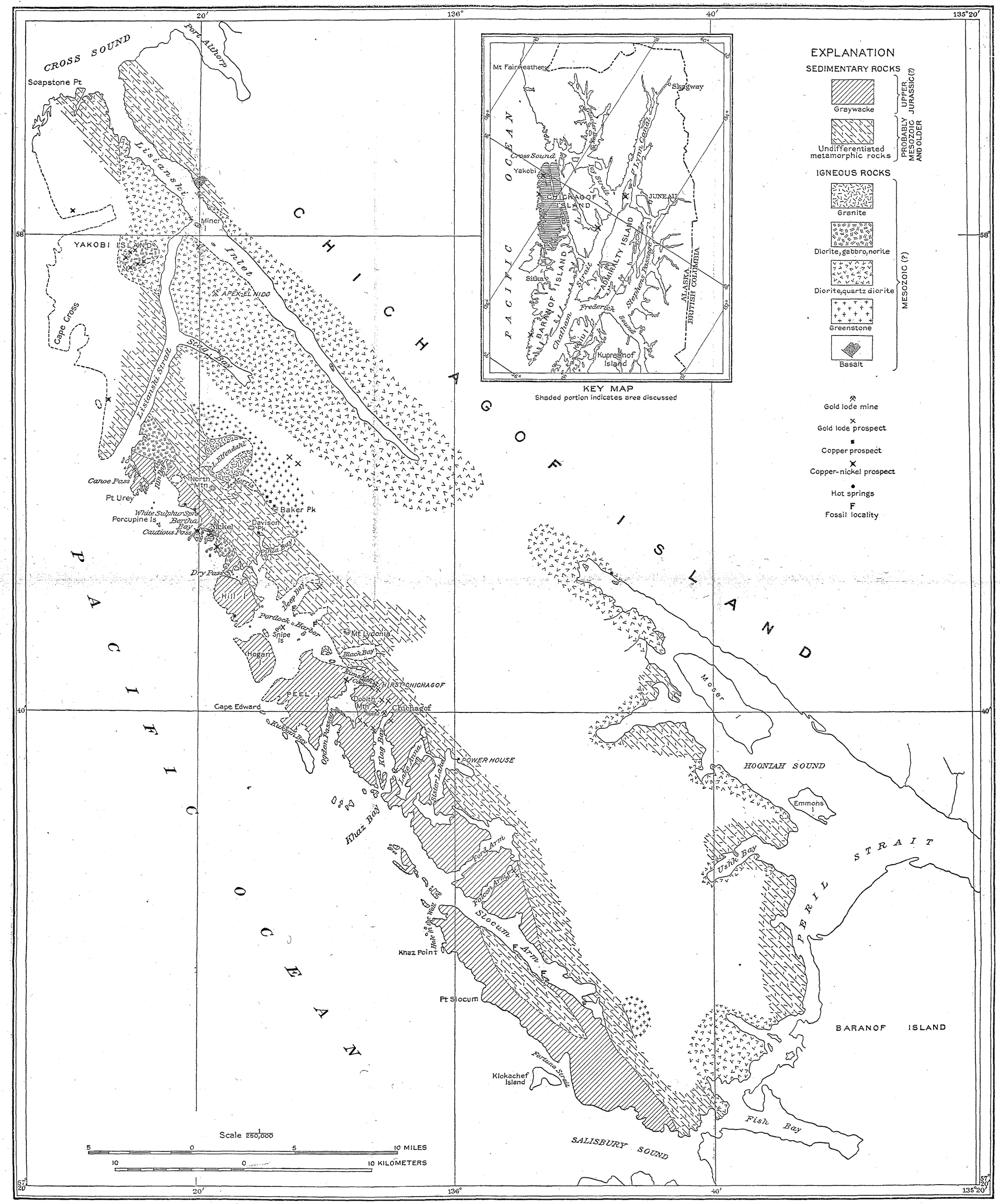
Bohemia Basin, on Yakobi Island, is a flat-floored valley that extends from Lisianski Strait due southwest for about 2¼ miles and rises gradually from sea level to a height of about 500 feet. The mouth of the basin, on Lisianski Strait, is about 2¼ miles southwest of Miner Island (Pl. II). At the head of the basin the mountains rise abruptly on all sides, except for a low narrow pass at an altitude of about 550 feet on the northwest side, which leads into Takanis Bay.

Two groups of claims have been located around this basin. The Bohemia group, 14 in number, lie at the head of the basin; and the Tasmania group, 16 in number, on the ridge along the northwest side. A blazed trail leads from the cabin just south of the mouth of the creek that drains the basin to the entrance of a tunnel on the Bohemia claims, about 2½ miles to the southwest, at an altitude of about 900 feet.

Good harborage is available on Lisianski Strait, and there is adequate timber for all purposes necessary for mining development.

One day and a half was spent in examining the deposits in the vicinity of this basin. The geology is complex, and the time spent was too short to permit more than a hasty survey of the general relations.

The nickeliferous deposits are located within a mass of gabbroic rock which appears to be of roughly elliptical shape and to have a width of about 1⅖ miles and a length of about 2 miles, the longer diameter oriented in a northeasterly direction. Bohemia Basin has been carved out of this mass by processes of weathering and river and glacial erosion. The mountains (altitude about 2,500 feet) that



GEOLOGIC SKETCH MAP OF WEST COAST OF CHICHAGOF ISLAND

form the rim of the basin consist of a bright-colored granitoid rock ranging from typical quartz diorite to a diorite with only a little quartz, and similar rock occurs at the mouth of the basin on Lisianski Strait. Gabbroic rock faces the inner slopes of the mountains and occurs in scattered outcrops projecting above the surface veneer of vegetation that covers most of the floor of the basin. It is possible, however, that the gabbroic rocks do not form as large a mass as that suggested and that diorite forms a part of the covered area. The gabbroic rocks are of extremely varied character and comprise such facies as hornblende gabbro, norite hypersthenite or segregations of hypersthene, and amphibolite resulting from the alteration of hypersthenite. The concentration of sulphides, so far as observed by the writer, is restricted to the norite.

From the top of the hill at the head of the basin a dozen rusty spots within the gabbroic mass may be seen. Only three of these were visited.

The rusty-weathering sulphide-bearing zones of the Bohemia claims lie within a mass of norite, perhaps 1,000 feet across, which is bordered on the west and southwest by hornblende gabbro and on the southeast by quartz-bearing diorite. (See fig. 4.) The extension of this mass to the northeast is covered by vegetation. The rusty zones lie near the border of the norite and strike approximately parallel to the contacts. A gulch lies along the center of the norite embayment, and the rusty zone on the east side of the gulch strikes about N. 80° E., and that on the west side of the gulch about N. 45° E. The most conspicuous rusty zone lies on the southeast side of the gulch and can be traced southwestward up the gulch for about 40 yards and in a general easterly direction from the gulch for about 100 yards. Several other rusty layers are also exposed here. Within a zone about 40 yards wide are layers of massive sulphide, rock with disseminated blebs of sulphide, and bands of barren norite. The zone dips steeply south. The developments consist of a 65-foot tunnel started to crosscut the sulphide-bearing zone about 200 feet below the outcrop. The inner 10 feet of the tunnel is in norite with disseminated sulphide; the remainder in practically barren norite except for a streak with disseminated sulphides near the entrance. Slippage planes and slickensided surfaces are common in the rocks exposed in the tunnel. A sample of the rock with disseminated sulphides, taken from the dump, averaged about 4.25 per cent of sulphide. The tunnel has been driven only far enough to enter the disseminated-sulphide zone, and not far enough to cross it completely.

Several open cuts have been made on rusty zones on the northwest side of the gulch and show similar conditions.

Very little prospecting has been done on the Tasmania group of claims. In the first rusty zone to the northeast on this group of claims, at an altitude of about 1,700 feet, lenses of solid pyrrhotite a yard in diameter are found in a band of norite carrying disseminated sulphides.

PETROGRAPHY

No systematic study or geologic map was made of the mass of rock in which the nickel deposits occur, but the following detailed observations on the character and relations of the rocks near the Bohemia tunnel and of two specimens from the Tasmania claims are recorded for the significance they have in allying the deposit with the similar type found at the Alaska Nickel Mines, at many

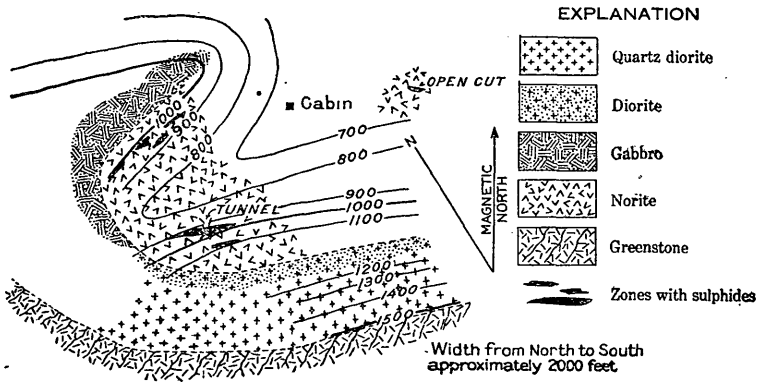


FIGURE 4.—Sketch map showing geology of nickeliferous sulphide-bearing zone, Bohemia Basin, Yakobi Island

places in Norway and Sweden, and on a much larger scale at Sudbury, Ontario. The mineral percentages are given by volume as determined by the Rosiwal method.

A specimen of the greenstone country rock in the mountain above the Bohemia tunnel is found to consist predominantly of actinolite in a groundmass of quartz and chlorite. Magnetite occurs in disseminated grains, and there is a little pyrite. The rock is an actinolite schist.

At an altitude of about 1,550 feet, 100 feet from the contact with the greenstone in the same mountain, the intrusive igneous rock is a light-colored quartz diorite, consisting of about 57 per cent of plagioclase, 19 per cent of quartz, 14 per cent of hornblende, 9 per cent of biotite, and 1 per cent of apatite and magnetite. The plagioclase is zoned and ranges in composition from calcic oligoclase to sodic labradorite averaging an andesine. About 500 feet of quartz diorite intervenes between the greenstone and the norite, but the

rock adjacent to the norite is much more basic than the rock near the greenstone and is a quartz-bearing diorite. A small depression lies along the contact of this rock and the diorite at an altitude of about 1,100 feet. A specimen taken from the south side is found to consist of 57 per cent of plagioclase ($Ab_{60}An_{40}$, andesine), 34 per cent of hornblende, 8 per cent of quartz, and a little magnetite and apatite.

On the north side of the depression is an outcrop of medium-grained rock composed of a light-greenish fibrous mineral. This rock is found in thin section to consist predominantly of a fibrous colorless amphibole (uralite) and a little plagioclase feldspar. The feldspar is fresh but is crossed by veinlets of a fibrous mineral. The rock is probably a very highly altered phase of the norite.

Fresh specimens of norite from the inner end of the tunnel on the Bohemia claims were taken from the dump for examination. The rock is medium grained and is composed predominantly of bronzite with intermingled white feldspars and in part with disseminated small blebs of sulphides. The norite was estimated from the hand specimen to consist of about 20 to 30 per cent of plagioclase and the remainder pyroxene (almost wholly bronzite) and accessory minerals. The facies with disseminated sulphides has less feldspar, possibly about 12 per cent, and about 4 to 4.25 per cent of pyrrhotite, pentlandite, and chalcopyrite, the pyrrhotite predominating. In thin section the rock is found to consist predominantly of bronzite with associated labradorite feldspar and minor amounts of monoclinic pyroxene, hornblende, olivine, and sulphides and a trace of secondary biotite and interstitial quartz. The bronzite is colorless and only faintly pleochroic and is a variety rich in the enstatite molecule (86 per cent $MgSiO_3$). The olivine occurs as corroded rounded remnants of larger grains, inclosed wholly in bronzite. The labradorite ($Ab_{35}An_{65}$) is in part of simultaneous crystallization with the bronzite and in part interstitial and later in crystallization than the bronzite. The hornblende is pale brown to green, is primary, and occurs as grains of contemporaneous crystallization with the bronzite and locally as peripheral borders to it. The pyrrhotite (with some chalcopyrite and pentlandite) forms small irregular blebs along the borders between the other grains, locally sending off threadlike veinlets between or across the other minerals. The sulphides appear to be primary and not secondary infiltrations or injections, and the chalcopyrite and pentlandite are everywhere associated with the pyrrhotite grains.

A specimen of rock taken 20 feet from the inner end of the tunnel is a fine-grained norite consisting of 56 per cent of pyroxene (pre-

dominantly hypersthene), 39 per cent of labradorite ($Ab_{25}An_{75}$), and 5 per cent of hornblende. Accessory apatite, pyrrhotite, and chalcopyrite are present. The hypersthene is in part fresh, in part altered to brownish and greenish hornblende and fibrous uralite. The feldspar is fresh and unaltered. The brown hornblende is primary and intergrown peripherally with the hypersthene, as in the coarser facies. The rock is much more altered than the coarser rock.

Noritic pegmatite veins are also found. A typical specimen consists of labradorite and hypersthene, the latter in crystals averaging an inch in length.

A specimen of norite with disseminated sulphides, from an altitude of about 940 feet on the opposite side of the gulch from the Bohemia tunnel, is a uniform dark green-gray medium-grained olivine-bearing hypersthenite or hypersthene segregation. It consists almost wholly of hypersthene, with a very little monoclinic pyroxene and about 10 per cent of olivine. Only a trace of feldspar is present. The olivine occurs as corroded grains within the pyroxene, and the sulphides as blebs along the borders of the grains. Veinlets of fibrous serpentine (bastite) with center zones of opaque grains cross the olivine grains and to a lesser extent the pyroxene. The serpentine is later than the pyrrhotite, as the veinlets locally swing around the borders of the sulphide grains.

The hill on the opposite side of the gulch from the Bohemia tunnel is made up of hornblende gabbro with a faint gneissic structure due to alternating laminae of more hornblendic and more feldspathic character. The specimen studied consists essentially of 53 per cent of labradorite feldspar ($Ab_{40}An_{60}$), 44 per cent of hornblende, and 2 per cent of quartz with accessory apatite, pyrrhotite, and chalcopyrite. A few of the hornblendes show unreplaced remnants of pyroxene. The sulphides occur as grains in the hornblende, which is not the mode of occurrence in the noritic rocks. At the head of the gulch the gabbro is darker and carries more hornblende.

Only two specimens from the Tasmania claims were examined. One of them is a uniform dark green-gray medium-grained rock weathering with a reddish hue. It consists of about 75 per cent of pyroxene in a much altered condition and 25 per cent of labradorite. The pyroxene (probably hypersthene) is almost entirely altered to a microcrystalline aggregate of talc and fibrous uralite. The plagioclase feldspar is partly replaced by chlorite along its borders but is otherwise fresh. A trace of accessory pyrrhotite and secondary iron ores is present. The other specimen is a quartz-bearing diorite which occurs as a dike in the norite. It consists of 61 per cent of andesine feldspar ($Ab_{57}An_{43}$), 30 per cent of hornblende, 7 per

cent of quartz, and 2 per cent of orthoclase, magnetite, apatite, and zircon. The three minerals last named are abundant as scattered mineral crystals.

METALLIC MINERALS

The metallic minerals comprise essentially the three primary minerals pyrrhotite, pentlandite, and chalcopyrite and the secondary minerals formed by descending surface waters, bravoite (?), and marcasite. The pentlandite and bravoite(?) can not be distinguished from the pyrrhotite in the field.

An effort was made to determine the chemical composition of the pentlandite in the "disseminated rock" on the Bohemia claims. Several hand specimens of the "disseminated norite" from the Bohemia tunnel were crushed, and the sulphides picked out by hand. The sulphides were then ground in a mortar and the pyrrhotite separated with an electromagnet. The pyrrhotite was found to be only weakly magnetic, but the pentlandite is nonmagnetic. Only 300 milligrams was thus obtained, and the amount of impurity could not be determined. A little pyrrhotite was probably present.

Chemical analysis of pentlandite from Bohemia claims

[Analyst, A. H. Phillips]

	1	1a	1b
Insoluble matter	5.83		
Cu	2.70		
Ni	21.28	24.65	0.420
Fe	35.10	37.88	.678
S (by difference)	35.09	37.47	1.170
	100.00	100.00	

1. Nonmagnetic concentrate from sulphides of disseminated norite, Bohemia claims, Yakobi Island, Alaska.
1a. Composition of pentlandite calculated free of chalcopyrite and silicates.
1b. Atomic ratio.

As shown by the atomic ratios the mineral conforms within the limits of error to the formula for pentlandite—(Ni, Fe)S—with a ratio for iron to nickel of about 5 to 3 or a little less. In physical properties the mineral is similar to the pentlandite of the Sudbury district, Ontario.

Specimens from three different localities on the Bohemia claims consisting of norite or hypersthenite with disseminated sulphides were studied with regard to the interrelations of the metallic minerals. The sulphides comprise pyrrhotite, pentlandite, and chalcopyrite. The pyrrhotite predominates, but the pentlandite forms a considerable proportion of the blebs. None of the pentlandite showed any trace of alteration, even on surfaces only half an inch below the weathered surface. The pentlandite and chalcopyrite

occur predominantly along the borders of the sulphide blebs. The pentlandite occurs as grains which usually show straight-line borders against the pyrrhotite, suggesting the traces of crystal faces. The pentlandite and chalcopyrite show mutual relations to each other. The chalcoyprite shows in part mutual relations to the pyrrhotite and in part straight-line borders, suggesting crystal faces. In one sulphide bleb a veinlet of pentlandite crosses its full length and cuts the pyrrhotite. All three minerals appear to belong to the same period of mineralization, the pentlandite and chalcoyprite perhaps beginning early and finishing late. A second generation of pentlandite is present in small amounts. It replaces the pyrrhotite locally along the borders of the chalcopyrite and the first-generation pentlandite and occurs in needle-like shapes along cracks or in patches with deeply serrate borders. An alternative explanation for the mineral relations shown is that the pentlandite and chalcopyrite are both later than the pyrrhotite and that the crystal faces of the pentlandite against the pyrrhotite are the result of replacement. This is a complex interpretation for which there does not seem to be any supporting evidence.

The sulphides of the outcrop of the ore lens above the Bohemia tunnel show very considerable alteration. Microscopic study of polished specimens of the outcrop sulphides shows that the pyrrhotite is locally replaced by veinlets of marcasite and that there is practically no pentlandite in the ore but a new nickel mineral resembling bravoite. The supposed bravoite occurs in granules of equidimensional to stringer-like form. The equidimensional grains show definite straight-line borders against the pyrrhotite and appear to be the traces of crystal faces. Only a trace of pentlandite was found in the specimens examined, but the form of the secondary mineral grains resembles the mode of occurrence of the primary pentlandite grains in the sulphide blebs of the "disseminated rock," and it is probable that the new nickel mineral is secondary after original pentlandite.

Several polished specimens from the outcrop of a 3-foot mass of solid sulphide on the Tasmania claims were examined with the microscope. The minerals comprise pyrrhotite, pentlandite, a secondary nickel mineral, chalcopyrite, and marcasite. The secondary nickel mineral for the most part forms a much interrupted skeletal network to the pyrrhotite grains. In part it occurs as grains of about the same size as those of the pyrrhotite. Some of these grains are irregular-shaped, with apophyses running out as tentacles between the adjoining pyrrhotite grains. Almost all the secondary nickel mineral contains residual remnants of partly replaced pentlandite. It is no doubt secondary after pentlandite and formed by

descending surface waters. The marcasite is similarly secondary after the pyrrhotite, forming an irregular network of replacement veinlets in the pyrrhotite. In part the replacement of the pyrrhotite by marcasite starts from the borders of the nickel mineral and works inward, but the nickel mineral itself shows only a trace of replacement by the marcasite. The secondary nickel mineral resembles bravoite in its appearance and properties.

A mineral which resembles bravoite in is chemical and physical properties forms the chief nickel mineral in the outcrop of the sulphide deposits associated with peridotite on Canyon Creek, a tributary of Copper River.[11] The writer separated the pyrrhotite from the nickel mineral with an electromagnet. An analysis of this concentrate (which is itself slightly magnetic), made by A. H. Phillips, showed the nickel mineral to be a disulphide of iron and nickel—(Fe, Ni)S_2—and to consist essentially of about 24.81 per cent of nickel, 20.68 per cent of iron, and 54.51 per cent of sulphur. The chemical formula, the physical properties, and the microchemical reactions are all similar to those of bravoite, with which it is believed to be identical. The nickel mineral, secondary after pentlandite and associated with marcasite that replaces pyrrhotite, at the Bohemia and Tasmania claims likewise is similar in physical properties and microchemical reactions to bravoite and is believed to be this mineral. Chemical analyses, however, are needed to verify this inference.

In the following table are given assays of two specimens of ore (Nos. 1 and 2) from the claims in the Bohemia Basin, made for the writer by E. T. Erickson, in the chemical laboratory of the United States Geological Survey. No. 1 came from an outcrop above the Bohemia tunnel; No. 2 from a 3-foot mass of solid sulphide on the Tasmania claims. Assays Nos. 3 and 4 were furnished by Mr. Vevelstad and were made for him by I. F. Laucks (Inc.) and the British American Nickel Corporation (Ltd.), respectively, from specimens on the Bohemia claims.

Assays of specimens of ore from claims in Bohemia Basin

	1	2	3	4
Nickel, per cent	1.72	4.09	2.18	2.45
Copper, do	.89	.82	1.55	.68
Gold, ounces per ton	----------	----------	.01	----------
Silver, do	----------	----------	.07	----------
Metals of the platinum group, do	----------	----------	.005	----------

[11] Overbeck, R. M., Nickel deposits in the lower Copper River valley: U. S. Geol. Survey Bull. 712, pp. 91–98, 1919.

SNIPE BAY.

In 1922 I. Myre Hofstad located a group of four claims on Snipe Bay, Baranof Island, about 45 miles south of Sitka. They are in the first bight inside the entrance to Snipe Bay, on the north side, in a gulch at an altitude of about 450 feet. A bare rusty spot can be plainly seen from the bay. Snipe is a good harbor and is used during the summer by many fishing boats.

The sulphides occur within a mass of gabbro or amphibolite which is intrusive into argillaceous and quartzose schist. Only a small mass of gabbro is exposed in the gulch, and its extension to the north-northwest is obscured by vegetation. At an altitude of 400 feet the contact between the gabbro and schist cuts across the bedding of the schist at an angle of about 35°, the schist striking northwest and dipping steeply northeast. The gabbro is exposed along the bed of the gulch up to an altitude of 500 feet. Schist with a general north-northwest strike is exposed locally on each side of the gulch, bordering the gabbro. Above 500 feet the hilltop is too thickly covered with vegetation to follow the continuation of the gabbro. The relations would suggest that the gabbro is a lens, dike, or sheet, striking more or less parallel to the schist and terminating with a blunt end on the south-southeast, where the contact is exposed in the gulch at an altitude of 400 feet. The possibility that this sharp crosscutting contact is due to faulting was considered, but no positive evidence of faulting was found. The exposures, however, are too much weathered and too obscure to warrant a positive statement. Along this contact the gabbro mass is about 50 feet wide. Where examined across the strike, several feet up the gulch from the contact, the gabbro along the northeast and southwest sides showed disseminated blebs and veinlets of sulphides, with a central zone of about 7 feet of solid sulphide. In the disseminated-sulphide rock chalcopyrite generally predominates, although associated with pyrrhotite in variable amounts, and locally pyrrhotite is predominant. In the solid sulphide zone pyrrhotite predominates but is associated with accessory chalcopyrite. Here and there small pyrite cubes form veinlets facing fracture surfaces in the gabbro and locally extend into the schist. Chalcopyrite veinlets are also found. The solid pyrrhotite is coarse grained. Farther up the gulch the gabbro is poorly exposed, but layers of solid fine-grained pyrrhotite, disseminated rock, and barren gabbro are found. Mr. Hofstad reports that he has traced gabbro outcrops intermittently for a distance of over 2 miles and that an outcrop occurs on the ridge above the claims.

Only one specimen of the gabbro mass was examined in detail. This particular rock is a hornblende-magnetite gabbro or amphibo-

lite, consisting of about 49 per cent of brown hornblende, 29 per cent of magnetite, 11 per cent of plagioclase, 8 per cent of chloride, 2 per cent of pyrrhotite, and 1 per cent of zoisite. The magnetite and zoisite are inclosed poikilitically in the hornblende and plagioclase and are disseminated throughout the rock in well-crystallized grains. The pyrrhotite is later than the magnetite, locally forming a groundmass for it.

The sulphides comprise pyrrhotite, chalcopyrite, pentlandite, and a nickel mineral secondary after pentlandite. The chief nickel mineral is not identifiable with the naked eye. The specimens of ore obtained were so weathered that good polished surfaces suitable for microscopic examination could not be prepared. A mineral of white color with reflected light appears, however, to lie between the grains of pyrrhotite. It gives similar reactions to the chief nickel mineral in the surface outcrops of the Bohemia Basin deposits of Yakobi Island and may be bravoite. The chalcopyrite is in grains associated with the pyrrhotite.

A specimen from the 7-foot mass of solid coarse-grained pyrrhotite (No. 1 in the subjoined table) and a grab sample of the metallized gabbro (No. 2) were analyzed by E. T. Erickson in the chemical laboratory of the United States Geological Survey, and the results are given below. Mr. Hofstad furnished a copy of a report on an assay made for him by the Tacoma smelter (No. 3).

Assays of specimens from Snipe Bay prospect

	1	2	3
Nickel.....per cent	3.57	0.43	2.62
Copper.....do	2.87	3.44	2.6
Gold	Trace.	None.	
Silver.....ounces per ton	.06	.13	
Platinum	Trace?		

BIG LEDGE

The Big Ledge claim, formerly known as the Mosquito Ledge, is on Tenakee Inlet about 1¾ miles west of the tip of East Point, about half a mile from the beach on the east side of a gulch at an altitude of 450 feet. It is held by Alfred Lagergren. Practically no development work has been done on it. The mineral deposit is in a gabbroic or diabasic dike about 20 feet wide intrusive into conglomerate. About 6 feet of the central part of the dike is sheared and highly fractured and weathers conspicuously rusty from the oxidation of disseminated sulphides. Rare metallized quartz and calcite stringers also occur in this zone. There is a conspicuous gouge on the west wall of the vein. Stringers of solid pyrrhotite as much as 6 inches

in width are present but sparse. The predominant sulphide is pyrrhotite in a disseminated form. There is a little chalcopyrite. A little pyrite occurs along fracture faces. The whole dike shows marked slickensiding on close-spaced fractures, but the intervening rock itself appears to be fresh. The dike has not been traced along the strike, and it is entirely covered.

A specimen from the claim was furnished by Mr. Vevelstad. It is a gabbroic rock heavily metallized with sulphides rich in chalcopyrite and pentlandite. The sulphides comprise pyrrhotite, chalcopyrite, pentlandite, a nickel mineral secondary after pentlandite, a little pyrite, and a trace of sphalerite. The chalcopyrite, pyrrhotite, and pentlandite appear for the most part to be contemporaneous in origin, and they corrode and replace the silicates. The chalcopyrite and pyrrhotite occur in veinlike forms, each with small veinlike blebs of the other and with associated pentlandite. The pentlandite occurs in veinlike forms and in grains and is apparently essentially contemporaneous in origin with the chalcopyrite and pyrrhotite, though it may have crystallized somewhat later than part of the pyrrhotite. In specimens of solid sulphide pentlandite forms half the mass. It is partly or completely altered to a secondary nickel mineral. A trace of sphalerite veins the chalcopyrite. A little pyrite in veinlike form locally replaces the pyrrhotite and chalcopyrite. The pyrite and the secondary nickel mineral were probably formed by descending surface waters. The secondary nickel mineral has similar properties to the bravoite of the Canyon Creek nickel prospect, in the Copper River basin, and to the secondary nickel mineral in the outcrops of the other nickeliferous sulphide masses in the Sitka district. Pentlandite also occurs in the quartz-calcite veins.

BALDY LODE

Three claims known as the Baldy Lode group were located in 1923 by Alfred Lagergren and O. Winerman on Tenakee Inlet, on the east side of Chichagof Island. They are at an altitude of about 2,500 feet, about 3 miles west of the east point of Tenakee Inlet, in a saddle of a hill marked 2,800 feet on the coast chart.

The mineral deposit, located as a possible nickeliferous lode, lies at the contact between a mass of granular intrusive rock on the southeast and marble on the northwest. A rusty oxidized mass is exposed at the contact for a width of about 20 feet. The minerals comprise a coarse-grained mixture of pyrite, magnetite, garnet, pyroxene, scattered rosettes of hematite, and a little quartz. Each of the minerals is locally well crystallized. Only a small open cut has been made on the deposit, and along the strike the contact of the intrusive rock and the marble is covered. The intrusive rock near the contact is a dio-

rite consisting by volume of about 66 per cent of andesine feldspar, 30 per cent of hornblende, 4 per cent of magnetite, and accessory microperthite and apatite. A specimen of what appears to be the same intrusive mass from the first point east of Lagergren's ranch on Tenakee Inlet is a granodiorite containing 47 per cent of andesine, 16 per cent of quartz, 16 per cent of microperthite, 12 per cent of hornblende, 8 per cent of biotite, and 1 per cent of magnetite, apatite, titanite, and zircon, by volume. There appears to be a mountain of relatively clean marble here. It is medium grained, with coarsely crystalline veinings. It is reported that two outcrops of contact-metamorphic mineral deposits are found at the southwest corner of the hill of marble and that they carry considerable pyrrhotite. Another claim is located on them.

A specimen from this lode was examined by E. T. Erickson in the chemical laboratory of the United States Geological Survey, and he states that no nickel was found in it. Nickel does not normally occur in a contact-metamorphic deposit of this type. The writer examined with the metallographic microscope several specimens collected from the outcrop and could find no nickel mineral but saw a little chalcopyrite, which is a common ore mineral in contact deposits. This deposit is not of the same type as the nickeliferous deposit on the coast of Tenakee Inlet, known as the Big Ledge.

ADMIRALTY-ALASKA

Nickeliferous pyrrhotite has been found on the War Eagle Extension claim No. 2 of the Admiralty-Alaska group, Funter Bay, Admiralty Island. At an altitude of about 1,650 to 1,700 feet a dike of olivine diabase of troctolite-like character with a high percentage of disseminated sulphides has been exposed by trenching. This dike is highly oxidized and weathered and has a characteristic nodular or spheroidal appearance. Only one wall of the dike is exposed. The country rock consists of white quartzite schist and graphitic black phyllite. The dike is exposed in a small steep gulch, along which it has been trenched for a difference in altitude of about 50 feet. There appears to be about 50 feet of the width of the dike exposed. The disseminated sulphides are almost wholly pyrrhotite with a little chalcopyrite and pentlandite. Probably stringers of solid sulphide are also present, but the rock is too deeply weathered to find them. Assays of specimens made for Mr. Pekovich, of the company, gave the following results:

Assays of specimens from War Eagle Extension No. 2

Gold.....ounces per ton.	0.10	0.03
Silver.....do....	.30	Trace.
Nickel.....per cent...	1.18	.54
Copper.....do....	1.98	1.25

ECONOMIC ASPECTS

The nickel ore at the Alaska Nickel Mines at a depth of 175 feet carries from 1.65 to 5.70 per cent of nickel; and to judge from Overbeck's descriptions the nickel mineral is practically all pentlandite. Pentlandite is a primary mineral, and it is probable that there has been little or no increase in nickel content here as a result of enrichment.

Only specimens from the surface outcrops of the sulphide masses at Snipe Bay, Yakobi Island, and Tenakee Inlet are available. In the outcrops the nickel minerals are almost wholly secondary, formed by supergene (descending) surface waters. A little original pentlandite is present, but the predominant nickel mineral is believed to be bravoite or a mineral resembling bravoite.

The replacement of pentlandite by bravoite need not necessarily involve an increase in the percentage of nickel, though local enrichment may occur. The formation of bravoite appears in general to have been restricted to the alteration of a single mineral, pentlandite. Assays for nickel on specimens from the outcrop are comparable to those obtained from the primary ore of the Alaska Nickel Mines. Unusually high nickel assays obtained locally at or near the surface may be the result of enrichment. It is the writer's opinion, however, that the primary pentlandite ore will be found at a very shallow depth below the surface and that the percentage of nickel to the total sulphides present will prove to be similar to that of the freshest samples from the outcrop. A considerable fluctuation in the percentage of even a primary ore shoot must be expected from place to place.

The nickel deposits are still in the prospecting stage, and a brief discussion of the possibility of finding other deposits in southeastern Alaska and of the characteristics of similar deposits elsewhere is given below.

The nickel-bearing sulphide deposits are associated with norite at the Bohemia Basin, with norite and hornblende gabbro at the Alaska Nickel Mines, and with hornblende gabbro (practically amphibolite) at Snipe Bay on Baranof Island. Diorite is an associate of the gabbro and norite at both the Chichagof Island localities. Another mass of diorite whose affinities are with the gabbros is mapped by Overbeck near the southwest entrance to Lisianski Strait. Two known masses of gabbro thus lie northwest of that at the Alaska Nickel Mines. The Snipe Bay mass lies 100 miles to the south. It therefore seems highly probable that other masses of gabbroic character, which would warrant prospecting for nickel-copper deposits, occur on Baranof and Chichagof islands between these localities.

The sulphides of the "disseminated" type of rock are believed to belong to the last stages of normal magmatic crystallization. The solid sulphide masses have, at least in part, been formed through segregation, transfer of material, and veinlike replacement of the silicates. The ore at Tenakee Inlet was formed essentially later than the consolidation of the associated igneous rock, in a sheared zone, and in part comprises quartz-calcite fissure veins carrying pentlandite.

In southeastern Alaska nickeliferous pyrrhotites have been found only on Chichagof and Baranof islands and their neighboring islands and on Admiralty Island, though masses of pyrrhotite are common at many of the ore deposits in the area. Three analyses of pyrrhotite from contact-metamorphic copper deposits in the Ketchikan district, made by George Steiger for F. E. and C. W. Wright, show only 0.1 to 0.2 per cent of nickel, a trace of cobalt, and no platinum or gold.

At a copper prospect on a fissure vein at Port Houghton, in the Juneau district, pyrrhotite is the major sulphide; yet the vein matter yielded only a doubtful trace of nickel. Similarly the pyrrhotite of ore lenses in schist at the Khayam mine, on Skowl Arm, Prince of Wales Island, and at the Virginia prospect, in the Hyder district, shows no nickel.

The essential similarity between the geology of the deposits at the Alaska Nickel Mines and the great deposits at Sudbury, Ontario, has been set forth by Overbeck. The Sudbury igneous mass crops out in the shape of an elliptical ring with a longer diameter of 35 to 40 miles and a maximum shorter diameter of about 16 miles. The width of the ring itself, as exposed at the surface, is in general from 2 to 3½ miles. The following statements with respect to the proportionate relation between the amount of nickel-copper ore and the volume of the norite and the occurrence of a higher percentage of nickel and copper in the sulphides of the disseminated type of rock as contrasted with the massive sulphides are of interest.[12]

> The quantity of sulphides which may be expected to occur at the contact of the nickel-bearing intrusive is roughly proportional to the volume of the adjacent norite. The surface expanse of the nickel-bearing intrusive and its thickness as shown by the dip at the contact both go to show what the volume of tributary nickel-bearing intrusive may be. * * * The pure sulphide concentrates of the ores, if made, would have practically a uniform content of 7 to 8 per cent combined metals. In the hanging wall, however (disseminated ore with about 1 per cent of nickel), where the processes of mineralization would naturally be more erratic, the sulphide concentrates would have a combined metallic content of 13.42 per cent. The solid masses of pyrrhotite contain less copper than the rocky ores.

[12] Roberts, H. M., and Longyear, R. D., Genesis of the Sudbury nickel-copper ores: Am. Inst. Min. Eng. Trans., vol. 59, pp. 40–41, 1918.

The gabbro masses, so far as exposed, on Baranof and Chichagof islands, however, are more closely allied in size with gabbro bodies carrying nickeliferous sulphide zones, such as that at the Friday claim, at Julian, Calif.; the old Gap mine, in Lancaster County, Pa.; and the many masses in Norway and Sweden. J. H. L. Vogt has made a careful study of the Norwegian deposits, and some of his conclusions are summarized here.[13]

> The numerous nickel-pyrrhotite deposits found in different countries and especially in Canada, Norway, Sweden, Pennsylvania, in the Monte Rosa district of Piedmont, etc., in their mineralogical and geological relations form a sharply defined group. The most important characteristic common to them all lies in their occurrence within or at the margins of gabbro masses, chiefly norite. * * *
>
> Of about 50 nickel-pyrrhotite occurrences distributed over Norway, the greater number occur in fresh unaltered norite which carries diallage, sometimes olivine, and at other times quartz, the latter association forming quartz norite. Some of them, however, occur in gabbro more or less greatly uralitized, the pyroxene being so greatly altered that the rocks were formerly regarded as gabbro-diorite and later as uralite gabbro. * * * The variety of gabbro which favors the nickel-pyrrhotite deposits is therefore one which carries hypersthene.

In a more recent paper[14] he writes:

> Segregations of nickel pyrrhotite are very common in norites, and in Norway alone, inclusive of some rather small deposits, 37 separate bodies of norite (and peridotite) are known to be accompanied by nickel pyrrhotite. The deposits that are associated with quite small bodies of norite and peridotite are themselves of very small dimensions. The large deposits always accompany large intrusive masses, especially of norite. However, it must not be concluded that all large norite masses must be accompanied by large deposits of nickel pyrrhotite, or that the deposits which accompany large norite bodies are themselves necessarily large.

Vogt cites as an example the norite mass at Erteli, Norway, which has an area of about 240,000 square yards and from the ore bodies of which has been produced about 110,000 tons of nickel ore containing 1,250 tons of nickel and 600 tons of copper.

As another example may be cited the Gap mine, in Lancaster County, Pa. This mine was actively operated from 1863 to 1885 and was for a time the chief nickel producer of its day, but after the development of the nickel deposits in New Caledonia and Sudbury it was closed. Its total production was from 4,000,000 to 4,500,000 pounds of nickel.[15] The ore as mined ran about 1 to 3 per cent of nickel and one-third to one-fourth as much copper. The deposit is described by Kemp[16] as pyrrhotite carrying pentlandite

[13] Beyschlag, F., Vogt, J. H. L., and Krusch, P., Ore deposits, pp. 280–281, 1914.

[14] Vogt, J. H. L., On the content of nickel in igneous rocks: Econ. Geology, vol. 18, p. 334, 1923.

[15] U. S. Geol. Survey Mineral Resources, 1882–1886.

[16] Kemp, J. F., The nickel mine at Lancaster Gap and the pyrrhotite deposits at Anthony's Nose, on the Hudson: Am. Inst. Min. Eng. Trans., vol. 24, pp. 620–633, 888, 1895.

and chalcopyrite and occurring on the borders of a lens of amphibolite or hornblendic rock which yields evidence that it is an altered gabbro or norite or peridotite. This lenticular mass or stock is about 1,500 feet long and 500 feet in maximum width and is an intrusion in mica schist.

Vogt [17] also states that

> For the larger noritic nickel deposits in Norway and Sweden, it appears that the highest percentage of nickel is found in the norite richest in hypersthene, the lowest percentage of nickel in the norite relatively poor in hypersthene, and intermediate percentages of nickel in the rocks having an intermediate content of hypersthene. In other words, the percentage of nickel in the sulphides is dependent essentially on the content of hypersthene (or hypersthene plus diallage, primary amphibole, and biotite) in the rock.

The nickel content of the sulphide ores was also found to increase with the percentage of magnesium oxide in the rock. As previously stated, the norites adjacent to the ore at the Bohemia and Tasmania claims are hypersthene segregations in which the hypersthene is rich in magnesia (80 to 86 per cent $MgSiO_3$). These data are therefore favorable indications of the nickel percentage in the sulphides, if Vogt's conclusions are of general application. At the Snipe Bay locality the rock appears to be made up largely of hornblende, which according to Vogt is likewise a favorable indication for the percentage of nickel in the sulphides.

For purposes of comparison, the nickel and copper content of ores from representative mines in Canada is given below. These data are taken from the report of the Royal Ontario Nickel Commission.

Mine	Nickel	Copper	Production to end of 1915 (tons)	Reserves (tons)
Creighton	4.4	1.5	4,611,577	10,000,000
Crean Hill	2.9	1.5	[a] 660,000	2,000,000
Frood Extension	2.0	2.0	----------	500,000
Garson	2.4	1.7	872,179	----------
Levack	3.2	1.5	----------	4,500,000
Victoria	1.6	3.3	619,612	----------

[a] Sorted ore.

There had been smelted in the Sudbury district up to the end of 1916 10,322,515 short tons of ore averaging 2.76 per cent of nickel and 1.7 per cent of copper. The total ore smelted in Ontario [18] during the five years from 1916 to 1920 was 6,568,457 tons. The value of the total imports of nickel for consumption in the United States for the five years from 1918 to 1922 amounted to $36,291,077.[19]

[17] Op. cit., p. 348.
[18] Ontario Dept. Mines, Thirteenth Ann. Rept., pt. 1, 1921.
[19] U. S. Geol. Survey Mineral Resources, 1922, pt. 1, p. 67A, 1923.

GOLD DEPOSITS IN SITKA DISTRICT

LISIANSKI DIORITIC STOCK

GENERAL FEATURES

The outstanding finds of new mineral deposits in the Sitka district in the last few years have been made within a complex mass of intrusive igneous rocks that occurs in the northwestern part of Chichagof Island. As mapped by Overbeck[20] (see Pl. II), this mass extends in a northwesterly direction from the head of Hooniah Sound parallel to Lisianski Inlet almost to Cross Sound.

Overbeck reports that the gold prospect on Yakobi Island, northwest of Miner Island and in the Lisianski dioritic stock, was located about 1887. In 1917 this prospect was relocated and a new find was made on the north side of Stag Bay about a quarter of a mile northwest of the cannery. In October, 1919, J. H. Cann staked the Apex vein, in the mountains between Lisianski Inlet and Stag Bay, from which very rich gold assays were obtained. This discovery incited renewed prospecting in this vicinity, and many other claims have since been located within this mass, the most recent in 1923 near the head of Hooniah Sound.

No careful examination has been made of the igneous rock composing the stock, but at the Apex-El Nido and Paramount prospects it is a diorite. A specimen obtained near Vevelstad's cabin on Lisianski Strait is a quartzose diorite, and another from the mountain back of the Bohemia claims is a quartz diorite. At the Pinta Bay prospects the country rock is an albite-quartz diorite, and Overbeck reports a similar rock on Lisianski Strait northwest of Miner Island. Local masses of hornblendite are found along Lisianski Strait and at the Apex workings. Aplite and porphyry dikes are common near the Apex-El Nido workings.

The variation from diorite through quartz diorite to albite-quartz diorite (or soda granite), the local included masses of hornblendite, and the aplite dikes are all features which are common to some of the outlying stocks of the Coast Range batholith on the mainland. Overbeck concluded that the mass belonged to the Coast Range group of intrusives.

The rock in the vicinity of each of the prospects is in general in a very highly shattered condition. This is confirmed by the microscopic evidence, which shows all the minerals much broken, veinlets of chlorite with a little associated ilmenite and locally abundant epidote, and secondary aggregates of calcite and sericite. The original quartz shows strain phenomena or has been crushed and

[20] Overbeck, R. M., U. S. Geol. Survey Bull. 692, pl. 2, 1919.

recrystallized with a sutured interlocking texture. Green slickensided surfaces are developed on a minute scale. Shear zones with ground-up altered rock powder of a greenish hue are common. In superficial appearance they resemble dikes, but their association with fissured zones suggests their origin. Veinings of white zoisite and yellow-green epidote are common.

The gold deposits are predominantly quartz fissure veins in diorite or hornblendite or in aplite-like dikes that are intrusive into both these rocks. The aplite-like dikes are intensely altered near the veins. Dikes of unaltered aplite and of porphyry are both found in the vicinity. One small "stockwork" has been found at the El Nido group of claims. Both the Apex and the El Nido veins are for the most part in aplite dikes. Of eight veins on which observations were made, all have strikes between N. 15° E. and N. 60° E., averaging about N. 45° E. The veins dip from 50° to 80° and are equally divided between easterly and westerly dips. They may vary considerably, both in direction and in degree of dip. Like most other fissure veins, they pinch and swell, ranging from only narrow stringers to veins 7 feet in width. At the Apex-El Nido workings they average from 1½ to 2½ feet. The El Nido vein has been traced for more than 1,000 feet along the strike, and the Apex vein for more than 2,000 feet. Both veins are exposed through a vertical distance of more than 600 feet.

The veins range from milky-white quartz with free gold and only a trace of sulphides to quartz with local pockets of almost solid arsenopyrite as much as 2 feet in width. In general the sulphide mineralization is slight. Arsenopyrite predominates, and pyrite, galena, sphalerite, chalcopyrite, gold, locally scheelite, and rarely tetrahedrite constitute the other metallic minerals.

In the Apex and El Nido veins most of the gold is invisible to the eye. The rich shoots yield gold when the quartz is crushed and panned. In all the veins coarse flakes are often found. At the Apex and El Nido veins pyrite and arsenopyrite impregnate the wall rock, which consequently carries a little gold.

The gangue is uniformly a milky-white granular quartz, with here and there a little sericite and calcite and numerous vugs lined with quartz crystals.

The phenomena at the Apex and El Nido workings suggest that the sulphides (in particular the arsenopyrite) and the gold in part crystallized contemporaneously with the quartz, but that in part the quartz veins were crushed along slickensided surfaces and that solutions circulating along them introduced new sulphides (including arsenopyrite) and gold.

The gold deposits within this mass of diorite bear a very striking resemblance to the deposits found within the Jualin diorite in the Berners Bay district, which has been described by Knopf,[21] and within the augite diorite stock on the east side of the Coast Range batholith, described by McCann.[22]

The "stockwork" at the El Nido group of claims is apparently similar to that of the Eureka and Kensington mines, in the Jualin diorite, though it is smaller and the quartz veins are mineralized with a higher percentage of sulphides.

Within the diorite of Lisianski Strait mineralized quartz veins are exposed throughout a vertical range of 2,000 feet. The characteristics of the fissures, of the mineralization, and of the alteration of the wall rock are all such as are common to veins formed at intermediate to high temperature and relatively great depth. High metal content has been found both at the surface and as deep as 300 feet below the outcrop. Although there may be some enrichment (perhaps in part mechanical) at or very near the surface, the presence of primary high-grade ore shoots is assured, and conditions in depth may be judged from conditions near the surface.

The Apex and El Nido veins show a sheeted or ribbon structure parallel to the walls. The character of the veins within the Lisianski stock is insufficiently well known to determine whether or not this structure has any significance. The following quotation from McCann[23] shows its importance in the Bridge River area, British Columbia:

> Most of the important veins in the augite diorite, however, show pronounced sheeting or ribbon structure parallel to the walls, each band being separated by a film of finely pulverized sulphides, and sometimes there is a film of gouge made of carbonates, sericite, and chlorite along these planes. In places where the different bands have slickensided surfaces exceedingly thin films of gold, also striated, coat the surfaces. The banding may have been caused originally by local concentration of sulphides, producing a somewhat banded structure. Such mineralized portions may then have formed lines of weakness along which subsequent movement within the veins took place, the sulphides being pulverized and later recrystallized in part, producing the ribbon structure now observed. * * * Only those veins which show ribbon structure formed in this way have been found to contain "bonanzas," although massive quartz veins, in which such banding is absent, contain fine specks of gold disseminated through them. Movement of a similar character has been noted in the gold-quartz veins of Grass Valley, Calif., and elsewhere.

APEX-EL NIDO

The Apex-El Nido mine, on Chichagof Island, is on Cann Creek, which enters Lisianski Inlet from the south about 5 miles southeast

[21] Knopf, Adolph, Geology of the Berners Bay region, Alaska: U. S. Geol. Survey Bull. 446, 1911.

[22] McCann, W. S., Geology and mineral deposits of the Bridge River map area, British Columbia: Canada Geol. Survey Mem. 130, 1922.

[23] Idem, pp. 59–60.

of Miner Island (fig. 5). The veins lie on the mountain slopes about 1¾ miles from the beach, at the back of a glacial basin whose floor is at an altitude of about 760 feet. The following description of the early development is abstracted from the annual reports of B. D. Stewart, mine inspector, for 1920, 1921, and 1922.

The Apex vein was located by J. H. Cann in October, 1919, and the El Nido vein, about 1,600 feet east, in June, 1920. The Apex group of claims was bonded to the Chichagof Mining Co., and development work started early in the summer of 1920 and continued through most of 1921. The company drove about 30 feet of drift alongside the vein at an altitude of 1,227 feet and completed over

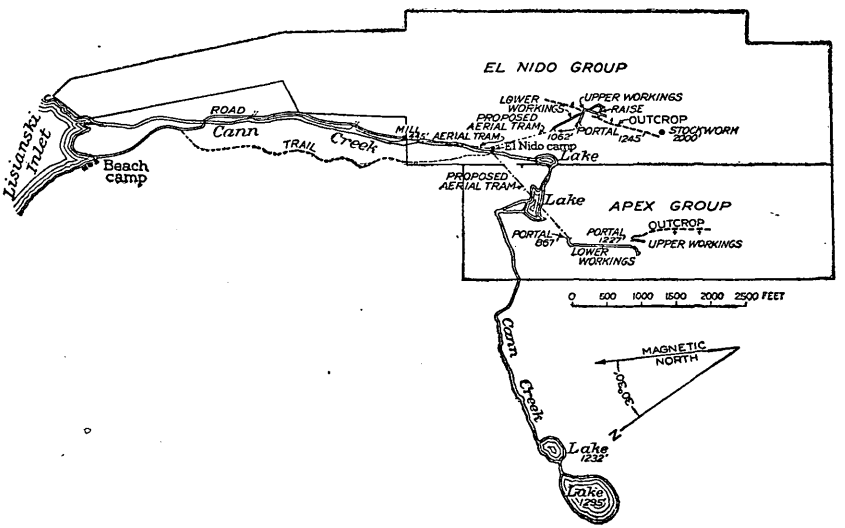


FIGURE 5.—Sketch map of Apex-El Nido gold claims, Chichagof Island

1,400 feet of tunnel, with the portal at an altitude of 867 feet, intended to crosscut to the vein. The vein was not cut as soon as was hoped; and for this and other reasons the company released its option on the property. Meanwhile, J. H. Cann and his associates were at work during 1921 in the development of the El Nido vein and drove 273 feet of crosscut tunnels and 320 feet of drifts.

In 1922 Cann and his associates extended the drift on the Apex vein for 110 feet and drove 1,100 feet of crosscut tunnels, drifts, and raises on the El Nido vein. In 1923 the Apex and El Nido groups of claims were consolidated under the name Apex-El Nido Mining Co. Work was continued on the crosscut tunnel to the Apex vein, and preparations were being made to drive a raise to intersect the vein. On Cann Creek at an altitude of 450 feet a 10-stamp mill was being erected, and the United States Forest Service

completed a corduroy road about a mile in length from the beach to the mill site. A tractor and trailer are used to haul supplies from the beach to the mill site. Tramways are contemplated from the upper camp (altitude about 800 feet) to the tunnels on the El Nido and Apex veins. There is already an aerial tram from the upper camp to the mill site. A 12 by 12 inch Blaisdell compressor, driven by a 6-foot Pelton water wheel under a 310-foot head, supplies air for the machine drills.

The Apex group includes 12 claims, on which there are a series of quartz fissure veins. The country rock is diorite, with a small local mass of hornblendite in the mountain above the Apex workings and intrusive dikes of aplite. The outcrop of the Apex vein is extraordinarily well exposed. It stands out boldly in a bare cliff face several hundred feet high, is traceable across a bench about 600 feet above the tunnel almost continuously for 200 yards to a talus slide, reappears in the face of another high cliff at the back of the talus, and can be seen extending upward in the cliff for several hundred feet. Two other quartz veins, which have not been sampled, are exposed in this cliff, one on the east and the other on the west. They are essentially parallel in strike and dip. The Apex vein is reported to have been traced for over 2,000 feet from the tunnel. The vein in general strikes northeast and dips 50°–80° NW. In width it pinches and swells from several inches to 5 feet. Where exposed in the drift tunnel for a length of 140 feet it ranges from 9 inches to 4 feet and is reported to average 31 inches. At the surface above the tunnel the average width for 100 feet is 19 inches.

The vein occupies a well-defined, persistent fracture and cuts across several varieties of igneous rock, including diorite, hornblendite, and aplite; the aplite occurs as dikes in the diorite and hornblendite. The wall rocks adjacent to the vein are intensely altered and are impregnated with disseminated sulphides. An average sample of 15 inches of the footwall in the drift at an altitude of 1,227 feet is reported to have yielded $2.48 in gold to the ton. The intensity of alteration diminishes gradually away from the vein.

Adjacent to the vein the hornblendite is bleached and altered—the hornblende to a pale-brown hue and the interstitial feldspar to a dull white. In thin section the hornblende is found to be altered to a cloudy unidentifiable aggregate with many veinlets of calcite. The feldspar is altered to sericite. The wall rock at the entrance to the drift is a very highly altered phase of the diorite in which calcite and chlorite form the major secondary minerals, associated with a little quartz and sericite and disseminated pyrite.

On a level with the drift and 5 feet distant is a mineralized quartz vein averaging 8 to 12 inches in width. The whole zone between

these two veins carries disseminated pyrite, and about 8 inches of the hanging wall of the Apex vein and 5 inches of the footwall of the upper vein has considerable disseminated sulphides. An almost vertical stringer, 9 inches wide, offshoots from the Apex vein about 100 feet above the tunnel and pinches out about 50 feet below its level. At 20 feet east of this stringer is another quartz vein about 10 inches wide, which pinches out about 65 feet below the tunnel level but extends upward to the top of the cliff. Several other narrow quartz veins carrying a little sulphide were noted in the hill above the tunnel.

The vein matter ranges from half sulphides to sparse sulphides both across the strike and along it, but on the average the sulphides form only a small percentage of the vein. The minerals include arsenopyrite, pyrite, sphalerite, chalcopyrite, sparse tetrahedrite, and free gold. Arsenopyrite is greatly predominant. Stewart reports that from the base of the outcrop to a height of at least 150 feet visible free gold was plentifully scattered over the surface of the vein. The gold occurs in very fine particles rather evenly distributed within the quartz, and pieces the size of a pinhead are occasionally seen.

The gangue is almost wholly a milky-white quartz. Quartz crystals lining small pockets in the vein are common, and here and there a little calcite is present, or little patches of sericite. Slickensided surfaces are common within the vein.

The El Nido group of claims joins the Apex group on the east and comprises 18 claims, including a power site and a mill site. The El Nido vein is a quartz vein filling a fracture in an aplite dike, which is intrusive into the diorite country rock. The vein strikes northeast and dips 50° E. Northwest of the workings the vein is near the footwall of the aplite dike, but toward the southeast it gradually works up toward the hanging wall, and at an altitude of about 1,650 feet, in the gorge of a small stream, it passes completely out of the aplite dike into the diorite for a distance of about 15 feet, pinching to several inches in width, and then returns to the aplite dike and widens again.

The aplite dike ranges from several feet to 20 feet or more in width, and the vein from 6 inches to 7 feet. Above the workings, for a length of 182 feet, the vein averages about 2½ feet in width. In the drift on the lower workings the usual width is not over 16 inches, though locally it swells to 7 feet. The vein was followed by the writer from a trench about 150 yards northeast of the tunnel for over 1,000 feet to a gorge at an altitude of about 1,650 feet. There is a covered space here, and several quartz veins are found on the opposite side. One of these may represent the continuation of the El Nido vein.

The developments consist of a 775-foot crosscut tunnel to the vein at an altitude of 1,002 feet, a 100-foot drift on the vein, and a raise on the vein to the upper workings, about 200 feet above. Another crosscut tunnel at an altitude of 1,245 feet has been driven about 225 feet to intersect the vein, and about 320 feet of drift run to the southeast on the vein.

The vein matter consists almost wholly of milky-white quartz. Here and there is a little calcite, and eyes or films of scaly pale-green sericite are common, as well as pockets lined with quartz crystals. Much of the quartz shows slickensided surfaces, and the sulphides are mostly localized there, though stringers and disseminated grains of original intergrowth with the quartz also occur. The quantity of metalliferous minerals is small. They include arsenopyrite, sphalerite, pyrite, free gold, scheelite, and a trace of chalcopyrite. Arsenopyrite predominates. The scheelite is pale yellow and occurs as disseminated grains and in narrow bands parallel to the vein walls.

Microscopic examination of a thin section of the vein from the lower workings shows it to consist of granular quartz with thin shear zones of crushed and recrystallized denticulate-textured quartz, associated with newly introduced sulphides and lenticles of sericite.

The diorite at the mouth of the lower tunnel on the El Nido workings is a dark green-gray rock with white plagioclase crystals. In thin section the rock is seen to consist of veined and shattered plagioclase in a groundmass of secondary minerals which are probably, in part, alteration products of hornblende. The plagioclase is a calcic andesine and is partly fresh and unaltered but is veined with films of chlorite associated with a little epidote and is locally altered to calcite. The veinlets and irregular areas of secondary minerals in the groundmass consist of altered plagioclase, with associated chlorite, epidote, and a little ilmenite, partly altered to leucoxene.

The aplite dikes at both the El Nido and the Apex veins are so altered that in the specimens taken their original character is not discernible. The rock consists of secondary alteration minerals, such as sericite, calcite, quartz, and chlorite, associated with quartz and altered feldspar and a little ilmenite and impregnating sulphide. Fresh specimens of similar dikes at the head of Cann Creek proved to be aplites or trachytes of both sodic and potassic character.

About a quarter of a mile southeast of the El Nido workings, at an altitude of 2,000 feet, there is a pear-shaped stockwork of brecciated altered diorite with many stringers and wide veins of quartz. The stockwork is about 20 by 35 feet, and the reticulating quartz veins form the larger part of the mass. The veins range from a fraction of an inch to 4 feet in width and carry a consider-

able percentage of coarse pyrite and the blackjack variety of sphalerite. The included fragments of diorite are altered and impregnated with pyrite. A gulch has been cut in the stockwork and is partly filled with snow, so that part of the mineral deposit is covered. Altered rock can be traced for at least 100 feet up this gulch along the continuation of the fracture on which the stockwork is located. The stockwork was apparently formed along a zone of local abrupt change of direction along the fracture or where the continuation of the fracture was slightly offset. Subsequent movement along the fracture produced at this point a fissured, brecciated zone in which the quartz veins were deposited. The fissure strikes northeast and has a steep southeast dip. The longer axis of the stockwork has a northwesterly strike. The veins on the north and west sides are essentially parallel to the borders, but those on the south side strike at an angle to the borders.

It is reported that a 13-foot sample across part of the stockwork, consisting of about 30 per cent of diorite and 70 per cent of quartz stringers from 2 to 16 inches wide, averaged $6.82 in gold and 0.44 ounce of silver to the ton. Another sample 16 feet in width is reported to have averaged $19.85 in gold to the ton.

R. F. Hill, of Juneau, prepared a report on this property for the company in which the following assay figures are given: The average value of the ore as exposed in the adit on the Apex lode is about $40 a ton, with variations from $5 to $55. The average value of 100 feet of the surface outcrop above the adit is $94.50. It is estimated that 4,000 tons of ore, with an assay value of $57, is developed between the outcrop and the adit, and that in addition 10,000 tons of ore of milling grade can reasonably be considered as in sight along the extension of the vein. On the El Nido vein, Hill estimates, there is 4,500 tons of ore with an average assay value of $33 a ton developed between the outcrop and the upper drift, and 4,000 tons of milling grade is blocked out by the upper and lower drifts and the connecting raise.

Assay values of more than $500 a ton are reported to have been obtained from samples of the surface outcrop.

PINTA BAY

The Pinta Bay Mining Co. controls four groups of claims. One is the group of seven copper claims northwest of Baker Peak, described by Overbeck.[24] Assessment work only is now being done on them. Another group of claims is located on a gold quartz vein at the head of Deep Bay. This was not visited. The workings are said

[24] Op. cit., pp. 121–122.

to comprise a crosscut tunnel 110 feet long and 18 feet of drift on a quartz vein in black slate. Free gold is reported to occur in the quartz.

The group of claims which are now under process of development comprises nine claims lying about 4½ miles north of the head of Pinta Bay, on the northeast side of a flat-floored basin at an altitude of about 750 feet. They were located in 1922 by Cox Brothers, Bolyan & Loeberg. Development work was begun the same year. A light narrow-gage 30-inch track with 12-pound rails is being built to the mill site, which lies near the tunnel entrance, 4½ miles from the beach at the head of Pinta Bay. All but three-fourths of a mile was finished in August, 1923, and it was expected that the whole job would be completed by the end of September. The railroad is being built to furnish a means of taking in a compressor and the mill parts. The equipment includes a sawmill, run by a Fordson tractor engine, which is used for sawing out ties for the railroad and lumber for the mill, and a Fordson tractor and trailers for hauling supplies on the railroad. The tractor is specially built and slung on flanged wheels. There is a very good water-power site on the creek entering Pinta Bay, and the basin at the head of the railroad offers every advantage for a mill site and camp. From 25 to 30 men have been working since May 1, 1923.

Two veins are being prospected on this group of claims. A tunnel 30 feet long has been driven on vein No. 1, and trenches have exposed it at the surface for a length of over 200 feet and for a vertical distance of 50 feet. The portal of the tunnel is at an altitude of about 800 feet. The vein is a quartz fissure deposit, predominantly in a gneissoid albite-quartz diorite but locally in aplite. The wall rock is only slightly altered, though impregnated with disseminated sulphide near the contact. The vein strikes about northeast and dips 70° NW. It is displaced in two places by faults, one resulting in an offset of the southwestern part about 20 feet to the northwest and the other resulting in an overlap of several feet. The vein matter is almost wholly milky-white quartz. Open spaces lined with quartz crystals are common. A little dolomite is present. Sulphides in general are sparse but locally occur in vein form or as disseminations. Arsenopyrite predominates, but sphalerite, galena, free gold, and a little pyrite and chalcopyrite are also found. The vein ranges from 6 to 18 inches in width; in the tunnel it is about 10 to 14 inches. The vein matter breaks free from the walls, and there is a persistent clay gouge 1 to 1½ inches wide on the hanging wall, which carries free gold. The projected strike of the vein toward the northeast carries it into greenstone immediately beyond the present exposure. At the entrance to the tunnel there is

about 4 feet of altered and silicified greenstone, which occurs as an inclusion in the quartz diorite. The greenstone is traversed by veinlets of quartz and of pyrrhotite and chalcopyrite.

No. 2 vein lies about 300 feet to the southeast, strikes about northeast, and dips 80° SE. This vein is a quartz fissure vein which cuts across greenstone, cherty quartzite, and siliceous limestone at an angle to the bedding. At an altitude of about 1,050 feet a 28-foot crosscut has been driven in the siliceous limestone to intersect the vein. Several quartz stringers were cut, also the main vein, which is here about a foot wide. The vein is exposed by trenches and strip pits at the surface for a length of 40 feet. It ranges in width from 6 to 8 inches and carries a little disseminated sphalerite, galena, free gold, and a trace of pyrite, in a gangue of quartz. Just northwest of the limestone bed a trench has exposed a quartz stringer in greenstone which lies in the general direction of the strike of the vein. About 1,500 feet to the southeast a trench has exposed about 2 feet of quartz in gneissic quartz diorite. The quartz here has a more glassy luster, typical of high-temperature veins associated with pegmatite dikes.

Samples across No. 1 vein are reported to average from $2 to $22.60 to the ton, the latter for a 16-inch width. A sample from No. 2 vein gave $4.90. Higher assays are reported from some specimens. Coarse gold has been found in both veins.

The fourth group of claims, known as the south-side group, lies about 1 mile southeast of the tunnels at the head of the railroad. L. S. Robe, superintendent, reports that the mineral deposit there is a vein of quartz 20 inches wide exposed for 300 feet. A tunnel 8 to 10 feet long has been driven on the vein. No assays have been made, but the material is reported to pan well.

PARAMOUNT

The Paramount group is reported to include nine claims held by Schotter, Dodge & Borland, located in 1920. They lie along a gulch about 1⅕ miles southeast of the point between Lisianski Strait and Lisianski Inlet. Assessment work only was done during 1923, and the veins are not sufficiently developed to give an adequate idea of their character.

At altitudes of 150 to 200 feet a quartz fissure vein in diorite has been exposed intermittently for a length of 400 feet. It ranges in width from a few inches to several feet, but in the higher measurement lenses of the country rock are included. Float believed to come from this vein is reported to carry free gold, and low assays in gold are yielded by the quartz. The vein strikes about N. 15° E. and dips 55° W. A good trail has been built from the beach to this

prospect, a distance of about 500 yards. The vein matter is milky-white quartz with practically no sulphides.

These claims were restaked in 1924 and the name changed to the Goldwan group.

Another vein occurs on the west side of the gulch at an altitude of 940 feet, where it is exposed in a cliff. This vein is in an intensely sheared and altered zone of diorite. It strikes northeast and dips 58° W. The wall rock adjacent to the vein shows slickensided surfaces on a minute scale and veinings of siliceous and epidotic material. The vein is a quartz fissure filling from 1 inch to 11 inches wide where exposed in the gulch and averaging about 6 inches. It is exposed for a length of about 50 feet in the gulch and for a vertical distance of 40 feet. It is reported to extend up a small boulder-filled tributary gulch to the top, where it is somewhat wider. The vein matter is milky-white quartz with rare sulphides (only pyrite being noted) and a little calcite and aggregates of sericite. Several feet below the vein is a black schist zone several inches wide resembling a dike but probably only a sheared phase of the diorite. It is reported that assays of picked samples showed as much as $60 a ton in gold.

OTHER CLAIMS

Other claims within the dioritic stocks are those of Lee H. Wakefield, A. Nilsen, S. H. P. Vevelstad, the Etna group, and the two prospects described by Overbeck.[25] Wakefield owns three claims and a fraction of another, parallel to the Apex group. They were staked in 1920, and only assessment work has been done on them. Nilsen's group comprises two claims staked in 1923 on the south side of Lisianski Inlet near Junction Island. The Vevelstad claims are on Yakobi Island. The Etna group comprises five claims held by J. H. Cann, on the south side of Stag Bay about 1½ miles from the entrance. The vein is reported to average 16 to 18 inches in width, to have been exposed by stripping for 150 feet, and to carry a medium gold content.

HIRST-CHICHAGOF MINE

The geology of the Hirst-Chichagof property has been described by Overbeck.[26] It lies on the northwest side of Doolth Mountain, at the head of Mine Cove on Chichagof Island, and comprises a group of ten claims with mill site. The property is equipped with a 10-stamp mill, operated by three Fairbanks-Morse Diesel engines of 10, 25, and 50 horsepower, and one Wilfley table. In August, 1923, five stamps

[25] Op. cit., p. 121.
[26] Op. cit., pp. 116–118.

were running and 20 men were employed. The underground workings have now a total length of about 3,130 feet. They include three tunnels with portals at altitudes of 95, 270, and 450 feet.

The lower tunnel is now in about 1,700 feet and is being driven forward along a new ore shoot discovered in August, 1923. This ore shoot, which is at present being stoped, has a length of about 200 feet and an average width of 27 inches on the lower level, a length of 200 feet and an average width of 24 inches on the middle level, and a length of 175 feet and an average width of 27 inches on the upper level. The lower and upper levels are 340 feet apart. The shoot has been stoped out between the lower and middle levels and for about 60 feet above the middle level. A raise is being driven from the middle level to the upper one preparatory to stoping the remainder of the lens. The gross value is reported to average about $11 to the ton. About 70 per cent of the value is recovered in the mill, and the concentrates are shipped to Tacoma.

On the lower level, 280 feet from the end of the ore shoot just described, the beginning of a new ore shoot had just been found at the time of the writer's visit. The shoot widened to 30 inches within 8 feet and is 33 inches wide at the face of the drift, 38 feet from the beginning of the shoot. The vein lies in black slate about 5 feet above a greenstone sheet, with about 5 feet of black gouge lying between the greenstone and the vein. The vein matter is milky-white quartz with graphitic films and a little disseminated pyrite. Very fine free gold is disseminated through the quartz. The vein strikes about N. 35° W. and dips steeply southwest.

GOLD PROSPECTS ON WINDHAM BAY, JUNEAU DISTRICT

About three-fifths of a mile in a straight line from the head of Windham Bay is a mineral belt along which prospecting has been continued in recent years. This mineralized belt occurs in general within the green schist series but may itself be in intercalated beds of black slate and quartz schist. The original nature of the country rock could not be positively identified, but it now occurs as a white sericitic siliceous schist The quartz stringers are abundant and range generally from a fraction of an inch to several inches in width. In addition, rich high-grade quartz stringers are found, especially in the upper or southeastern portion of the belt. These are mineralized with galena, sphalerite, and free gold. In the schist pyrite and pyrrhotite comprise the disseminated sulphides.

Helvetia.—The Helvetia Mining Co. holds 13 claims along this belt on the northwest side of Spruce Creek. An adit has been driven in along a high-grade stringer 25 feet in length, and another 350 feet

in length cutting the formation at an angle. The 350-foot adit exposed about 200 feet of slightly mineralized quartz stringers in schist, but it is reported that assay returns did not warrant further development with a small-scale plant.

Alaska Peerless.—On the southeast side of Spruce Creek, along the same mineralized band, the Alaska Peerless Co. took over four claims from Robert Durer in 1915. Two of these claims lie along a vein which is being prospected for a low-grade ore body. A tunnel about 80 feet in length, at an altitude of 850 feet, had been driven on the vein by the Helvetia Mining Co. in 1904. The Alaska Peerless Co. from 1916 to 1922 extended this tunnel to a total length of about 475 feet. At about three-fourths of this length from the portal a crosscut about 160 feet long has been driven across the vein without exposing any definite lateral walls. The vein consists of quartz stringers in a sericitic quartz schist. The rock in the hanging wall seems to be a dark sheared slate. The vein is slightly mineralized with sulphides. Pyrite is most common and is locally slightly cupriferous. Free gold occurs in some stringers. The vein as exposed in the tunnel and crosscut was assayed in 1919 and is reported to have shown an average low-grade value for the full width of 160 feet. At an altitude of about 1,100 feet the Alaska Peerless Co. has driven another tunnel about 50 feet long on the same vein, exposing rock of similar character. Stringers of high-grade ore occur here.

Yates, Rowe, and Jensen.—Southeast of the claims held by the Alaska Peerless Co., one claim and a fraction along the same vein are held by Mrs. D. W. Yates. On this property the vein has been exposed by several trenches, and at an altitude of about 1,360 feet a 35-foot tunnel, driven between 1917 and 1922, crosscuts a portion of the vein. At the entrance to the tunnel a fissure vein of quartz cuts diagonally across the formation and constitutes a high-grade stringer from 7 to 18 inches in width. In the tunnel minute pyrite cubes are conspicuously disseminated throughout several bands of the quartz-veined schists. One of these bands is 4 feet wide.

Adjoining the Yates claims on the southeast are three claims along the same belt, held by R. V. Rowe. In 1922 a crosscut of 80 feet is reported to have been made on the Fairview claim in order to intersect a high-grade stringer 9 to 12 inches wide, at a depth of about 60 feet below the outcrop. The stringer is reported to have been traced at the surface for a length of about 500 feet and is continued by a series of offset veins for 200 feet more.

Adjoining Rowe's property on the southeast along the same belt are two claims held by Gudmund Jensen. The vein here is reported to be 110 feet wide and over 2,000 feet long and to consist of quartz

stringers in schist. Small ledges and stringers flank the main vein for 100 feet on the hanging-wall and footwall sides. A high-grade stringer is found on No. 1 of the Great Mine group, on the east side of the main vein or "big ledge." On a third claim, to the east, practically at the crest of the mountain, a 20-foot shaft has been sunk by Jensen on a rich stringer of free gold. Additional claims were located on this belt in 1923.

Independent Mining Co.—The Independent Mining Co. holds two groups of claims at the head of Windham Bay. One of these groups is on the north side of the bay about a quarter of a mile from the town of Windham. The vein consists of an intimate network of quartz stringers in a brecciated greenish to light-colored sericitic phyllite. The included fragments of the country rock are partly or completely altered and silicified, so that the whole mass forms a single unit with respect to weathering processes and to mining. An open cut has been made on the vein for a length of 15 feet, and it has been traced from tidewater up the hillside to a height of about 100 feet. In the face of the open cut the vein is about 6 feet wide. Sulphides are disseminated throughout the vein and comprise pyrrhotite, pyrite, and a little sphalerite. Assays are reported to have shown medium-grade value.

The second group comprises eleven claims on the south side of the bay about a quarter of a mile west of Windham. A tunnel near sea level has been driven alongside the vein for 150 feet with several crosscuts to cut the vein. At the entrance the vein system consists of two veins of "stringer lead" type, each about 5 feet wide and separated by 2 feet of schist. The veins consist of stringers of quartz with intervening leaves of schist. About one-third of the length from the portal the vein is 9 to 10 feet wide, consisting of quartz stringers with leaves of schist; about two-thirds of the length from the portal the stringers come together to form a strong vein about 5 feet wide, which pinches abruptly at the end of the tunnel to a stringer several inches wide. The vein is in green chloritic schist and carries a little sulphide.

At an altitude of about 375 feet an adit about 60 feet in length has been driven along an intersecting vein system in black slate. The veins are of the stringer type, are from an inch to a foot thick, and lie in part at an angle to the cleavage. Locally the veins have beautifully crystallized quartz and calcite in pockets and along fissures at an angle to the bedding. The stringers are not as abundant as in the lower tunnel, but high gold assays are reported from some of the stringers, which are mineralized with pyrite, sphalerite, galena, and free gold.

HELM BAY KING GOLD MINE, KETCHIKAN DISTRICT

The prospect of the Helm Bay King Mining Co. lies on the west side of Helm Bay, on Cleveland Peninsula, in the Ketchikan district about a mile from the head of the bay. The original claim was located in 1921. This was purchased by the company, and three additional claims were staked. The developments consist of a shaft 45 feet deep and numerous crosscuts and trenches to trace the vein. The equipment comprises a blacksmith shop, a 5-foot Huntington mill with 4 by 8 inch plates, an 18-foot Wilfley-Dodge rock breaker, one 15-horsepower and two 10-horsepower water wheels operating under a 250-foot head, and a 416-foot aerial tram. A corduroy trail leads from the beach to the mill at an altitude of 125 feet. The shaft starts at an altitude of about 300 feet, one-third of a mile from the beach.

There are two veins, the Alaska and Bonanza. The Alaska was the only one under development in 1923. It lies along a shear zone in greenstone and consists of quartz veinlets, mostly of a crosscutting gash type, associated with some lenses parallel to the foliation. The quartz is milky white and carries a little calcite and locally chlorite. Sulphides are rare and consist mostly of chalcopyrite with a trace of galena. Rarely coarse flakes of free gold are found along the borders between the quartz and the schist. Pyrite in small cubes as much as a quarter of an inch in diameter is disseminated through the schist. Usually the cubes are surrounded by a bleached sericitic halo. The most heavily mineralized schist layers are almost wholly bleached and sericitized. About three-fourths of the vein zone is schist and one-fourth quartz. The ore at the bottom of the shaft for a width of 8 feet is reported to have an average value of $14 in gold to the ton. The Alaska vein zone strikes northwest and dips on the average about 75° SE. The Bonanza vein is reported to strike at an angle to the Alaska.

COPPER PROSPECTS IN JUNEAU DISTRICT

PORT HOUGHTON

Near the head of Port Houghton on the mainland there is an old copper prospect on the southwest slope of the mountain spur that runs out from the south side into the bar separating the salt lake from the main arm. A slough is shown on the chart on the south side of the arm just west of the bar. The prospect is reached by a trail starting on the east bank near the head of the slough and running about a mile to the prospect. The main tunnel opening is at an altitude of about 750 feet. There is a cabin 35 feet lower.

The ore deposit is a metalliferous fissure vein lying along a shear zone between a light-colored rusty-weathering quartz-feldspar schist and a black hornblende schist. The vein strikes N. 50°–55° W. (magnetic), parallel to the schistosity, and dips 70°–80° W. At or near its outcrop the vein has been developed along the strike for a length of about 150 yards by three open cuts and two short adits, all of which crosscut the vein. The uppermost opening is about 70 feet above the lowest open cut. In addition an adit tunnel about 110 feet long and 60 feet below the outcrop has been driven into the face of the hill to crosscut the vein. A drift about 115 feet long follows the vein from this tunnel. It is possible that the vein has been traced farther than is indicated by the open cuts, as the work was done years ago and the continuation of the vein is obscured by forest litter.

In the open cut about 50 yards south of the tunnel opening the vein is about 6 feet thick in the upper portion but pinches to 2 feet at the base. A narrow breccia zone and a pegmatite vein with a quartz-muscovite mass occur in the hanging wall. In the adit just above the tunnel the width of the metalliferous zone is about 9 feet; in the next adit, about 30 yards north-northwest, it is about 10 feet wide; and 25 yards farther north-northwest it is about 12 feet wide with the hanging wall not shown. At about 25 yards beyond is an open cut in the hornblende schist of the footwall that shows only narrow lenses of mineralization. In the breast of the drift along the vein from the tunnel about 1 foot of ore is exposed in the hanging wall.

The ore consists of pyrrhotite, pyrite, magnetite, and chalcopyrite intergrown with the gangue minerals, which are predominantly quartz, garnet, and amphibole. The garnets are from one-eighth to one-fourth inch in diameter and have fair crystal forms. The amphibole is light green and occurs in long fibrous sheafs and bundles similar to actinolite, locally forming the predominant gangue mineral. Under the metallographic microscope the sulphides and magnetite are seen to occur as grains with irregular rounded borders intergrown with the gangue minerals, or as stringers interleaved with the gangue minerals. The metallic minerals and the gangue minerals belong for the most part to the same period of formation, though in part the sulphide minerals occur along fractures in the gangue minerals, indicating a later crystallization.

The magnetite shows a well-developed octahedral parting and modified crystal outlines. Many of the grains contain abundant small inclusions of pyrrhotite arranged along parting planes or fractures. Rarely a trace of chalcopyrite is associated with this pyrrho-

tite. Locally pyrite surrounds magnetite grains or is molded against them. It thus seems certain that the magnetite was the earliest metallic mineral to begin crystallization. Much of the pyrite shows a rough crystal form with relation to other minerals, and it may have been the second mineral to start crystallizing. The chalcopyrite is in part intergrown with the other minerals and in minor part appears to be interstitial, indicating that it may have finished crystallizing later than the other metallic minerals.

The character of both the metalliferous and the gangue minerals proves that the vein belongs to the high-temperature type. The relations of the vein to the wall rocks indicate that it has been formed through fissure filling rather than by replacement. The presence of so much garnet and amphibole, however, makes it appear that there may have been considerable solution and reaction with the wall rocks, particularly with the footwall hornblende schist. Lenticular veins of quartz, very rich in garnet and sparingly metallized, occur here and there in the ore vein, and in some places lenticular veinlets of glassy quartz are very abundant in the schist.

A small grab sample across the vein at one of the adits, including both rock and ore, gave the following results on assay: Copper, 1.34 per cent; gold and nickel, doubtful traces; platinum, none.

TRACY ARM

A copper prospect on Tracy Arm was relocated by Eugene Owens in 1922 and 1923. The prospect comprises three claims known as Neglected Prize Nos. 1, 2, and 3. It is about a mile south of the point at the first elbow on Tracy Arm. The trail runs from the west side of the first gulch east of the point to a shaft at an altitude of about 800 feet.

The vein lies within a narrow belt of aplitic injection gneiss which is bordered on the east by the quartz diorite of the Coast Range and on the west by a sheet of quartz diorite intruded into schist. The vein is parallel to the foliation of the gneiss and consists of sulphides with intermingled quartz and remnants of included country rock. The relations are those common to veins injected along foliation planes or deposited in a fissured zone in gneiss. The walls are not sharply defined, for veinlets of sphalerite, pyrite, and chalcopyrite, with a quartz gangue, are found in the wall rock.

The vein lies in a belt of timber and is covered with a veneer of vegetation and forest litter for its whole length, except where uncovered by prospect pits. A shaft 16 feet deep has been sunk on the vein, and it has been exposed by six prospect pits to the southeast and three to the northwest for a total length of over 500 feet. Neither

end is shown. The vein is reported to range from 3 to 6 feet in width. Sulphides predominate over gangue and comprise pyrrhotite, sphalerite, chalcopyrite, pyrite, and a few veinlets of secondary marcasite. The gneiss is a siliceous variety consisting of quartz and feldspar with a little biotite.

Assays across the collar of the shaft are reported to run 5.6 per cent of copper and 7.3 per cent of zinc. Assays of samples from the full width of the vein in the prospect pits are reported to range from 1.5 to 4.1 per cent of copper and from 4.7 to 14.6 per cent of zinc.

POINT ASTLEY

The Point Astley property lies in the cove just east of Point Astley on Holkham Bay. The original claims are reported to have been staked as early as 1897. They were prospected by the Oceanic Mining Co. and are described by C. W. Wright,[27] as follows:

> The deposits here lie in the slate-greenstone belt, though not far to the southwest is an intrusive mass of gray diorite over a mile in width, which has probably played no small rôle in the deposition of the ores. Around this intrusive mass many of the sediments have been altered to quartzites and calcareous schists rich in mica.
>
> Irregularly distributed along the schistosity of this country rock there has been an introduction of sulphides, accompanied by quartz and calcite, with no apparent channels to which the metalliferous solutions were confined. This sort of filling has produced a mineral belt a few hundred feet wide and several hundred feet in length, within which occasional seams rich in silver and copper are encountered.
>
> The minerals are in the main bornite, pyrite, sphalerite, galena, and native silver. The proportions of the metals in these ores do not correspond to those of any other deposits in the Juneau belt.

Under the name of the Alaska Copper Mining Co. further prospecting was carried on between 1916 and 1920.

Development work has been done on two veins. One vein lies within green chloritic schist, which has probably resulted from the metamorphism and shearing of surface volcanic rocks. Some of the beds show evidences of an original fragmental character and were probably volcanic breccias; others may be tuffs and flows. The vein consists of quartz stringers in the green schist, together with mineralized schist. It is exposed along the shore at low water. Just back from tidewater an inclined shaft dipping 45° NE. has been sunk and a 100-foot crosscut run to intersect the vein in depth. A second shaft 300 feet to the southeast was sunk 60 feet and a crosscut run 40 feet to cut the vein. At 900 feet southeast of the second shaft a third shaft has been sunk 100 feet and a crosscut of 90 feet made to intersect the vein. It is reported that

[27] Wright, C. W., A reconnaissance of Admiralty Island, Alaska: U. S. Geol. Survey Bull. 287, p. 45, 1906.

three veins were encountered in this work, 8, 2, and 6 feet wide, and that an 18-inch streak of high-grade ore occurred along the footwall. The shafts were flooded at the time of the writer's visit.

A tunnel about 20 feet long cuts the other vein near the shaft just above tidewater. The vein is about 20 feet wide here and occurs in black slate. It consists of many quartz veins from a fraction of an inch to several inches in width, with bleached and mineralized muscovite schist leaves (possibly altered recrystallized slate). Almost all the sulphides occur in the intervening schist layers. The hanging wall appears to grade into the slate through a bleached and altered slate with sparingly disseminated sulphides. The ore in general is thinly banded and appears as alternating leaves or seams of metallized schist and milky-white quartz. A little less than 3 feet above the footwall a 10-inch layer of limestone with disseminated bands of sulphide is intercalated in the vein. The vein appears to pinch out about 20 yards to the northwest but is reported to extend southward into the mountain.

About 15 or 20 feet below the main vein is a stringer of ore about 1½ feet thick along which a short drift has been driven.

The metallic minerals of the vein in the slate comprise pyrite, sphalerite, bornite, galena, a trace of chalcopyrite, and a little chalcocite, covellite, and native silver. The ore is banded with alternating seams in which one or more of the minerals pyrite, bornite, and sphalerite predominate.

A specimen of ore which probably came from one of the shafts was examined with the metallographic microscope and showed the following phenomena: The predominant mineral is pyrite, which occurs in good euhedral crystals, and only rarely do the other minerals form reentrant angles in its crystal faces. The other primary sulphides, sphalerite, bornite, and galena, bear essentially mutual relations to each other, though the bornite and galena may in part be later than the sphalerite. Blebs of galena, sphalerite, and bornite occur in the pyrite; of galena and bornite in the sphalerite; and of galena and sphalerite in the bornite. The galena alone appears to be free of other minerals, and though it is commonly associated with the bornite in mutual relations it may overlap the bornite a bit, and a portion of it be a trifle younger. The bornite shows incipient alteration to chalcocite and covellite, and the galena is likewise partly replaced by a little chalcocite and covellite. The chalcocite and covellite are of secondary origin and due to descending surface waters. A bare trace of chalcopyrite occurs as minute grains in the bornite. The predominant ore consists of banded gangue and seams of sulphides, predominantly pyrite, with considerable sphalerite and a little galena and bornite.

Native silver is reported to occur locally in the veins but was not seen by the writer. Assays show that the high silver content is uniformly accompanied by high copper content. Bornite is the rich copper mineral, and the presence of secondary chalcocite and covellite in the bornite suggests the necessity for considering the hypothesis that the native silver may likewise be due to descending waters and may therefore not persist in depth. The bornite, sphalerite, galena, and chalcopyrite are definitely primary.

A specimen from the outcrop of the vein in the green schist is found to comprise the sulphides pyrite, chalcopyrite, and sphalerite. The sphalerite and chalcopyrite are contemporaneous in crystallization, but they show corrosion effects against the pyrite. All the minerals are primary.

MAGNETITE AT SNETTISHAM

The northern part of Snettisham Peninsula, on the mainland in the Juneau district, is composed of a mass of diorite and hornblendite about 2¾ miles wide, as exposed along the coast at the entrance of Port Snettisham. The eastern 1½ miles of this mass is hornblendite with associated variants. The most marked characteristic of this hornblendite mass, as of all the other masses of hornblendite in southeastern Alaska, is a rapid and large-scale variation in its texture. The predominant rock, however, is a black medium-grained variety composed almost wholly of hornblende, with accessory magnetite, apatite, and plagioclase. Coarse-grained pegmatitic variants occur within the mass and may consist of long columnar hornblende, of hornblende and biotite, of hornblende and pyroxene, of pyroxene and magnetite, or of magnetite alone. Here and there chlorite in large well-crystallized plates is intergrown with the other minerals. Rarely an epidote veinlet cuts the pegmatite veins. The hornblendite is intruded by dikes of diorite and of aplite. Narrow vein dikes of white albite occur sparingly, and rarely one composed almost wholly of pink orthoclase is found.

About 100 yards east of the first point opposite the post office at Snettisham there is a 6-foot vein of practically solid titaniferous magnetite. An open cut has been made on this vein, and in 1918 4 or 5 tons of ore was shipped to the Treadwell mines. It is reported to have carried 4 or 5 per cent of titanium.

A small specimen of the magnetite ore was polished and examined with the metallographic microscope. It consists of granular magnetite with accessory ilmenite and silicates. The ilmenite occurs almost wholly in grains from 0.2 to 1 millimeter in diameter with mutual boundaries against the magnetite, whose grain diameters are from

0.5 to 1.5 millimeters. The very small ilmenite grains occur along the boundaries of the magnetite. Ilmenite also occurs as thin microscopic lamellae parallel to the octahedral parting planes of the magnetite. Nonmetallic microscopic intergrowths of rodlike forms and rows of dots also occur along the octahedral parting planes of the magnetite, but with their pattern oriented at an angle of 45° to that of the ilmenite. The ilmenite, in the form of grains, constitutes about 8 per cent of the ore.

The country rock adjacent to the 6-foot vein is a medium-grained hornblende pyroxenite consisting of about 56 per cent of pyroxene, 26 per cent of brown hornblende, 14 per cent of magnetite, and 4 per cent of apatite. The magnetite with the associated apatite predominantly forms an interstitial mesh to the pyroxene and hornblende and rarely occurs as inclusions in the ferromagnesian minerals. The apatite is almost wholly associated with the magnetite and in part occurs as perfect crystals within it.

A most significant piece of evidence as to the probability of there being very large masses of titaniferous magnetite within the body of the hornblendite has been furnished by N. H. Heck,[28] of the United States Coast and Geodetic Survey. He shows that a map of the magnetic lines in this vicinity made by the steamer *Explorer* proves the existence of a pronounced center of local magnetic disturbance in the vicinity of Snettisham. Though apparently unaware of the existence of the magnetite prospect just described, Heck drew the following significant conclusions:

> The natural question is, What causes this great disturbance of the compass, which is felt over an area of 20 square miles of land and water and is strong over an area of 8 square miles? There is a gold mine in the vicinity, and it is safe to say that it is caused by associated minerals. Whether there is a large mass of the useful iron ore magnetite, and whether, if so, it is workable, is a matter for the future. It is certain that there is an immense mass of magnetic material.

The presence of the titaniferous magnetite vein just described suggests, in part, what the probable character of the "immense mass of magnetic material" may be.

Knopf[29] has described titaniferous magnetites in similar hornblende-pyroxene rocks near Haines, in the Skagway district. The ore there, however, occurs for the most part as disseminated deposits. A sample of ore from the Haines prospect crushed to 100-mesh and separated magnetically is reported to contain 3.91 per cent of titanium dioxide.

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[28] Heck, N. H., Where the compass fails to guide: Sci. Am., March, 1923, p. 192.

[29] Knopf, Adolph, The occurrence of iron ore near Haines: U. S. Geol. Survey Bull. 442, pp. 144–146, 1910.

WHITING RIVER SILVER PROSPECT

A silver prospect on which some work has been done in past years lies near Whiting River, which flows into Port Snettisham, on the southeast side of an ice-capped mountain ridge. (See fig. 6.) This prospect has been known since 1896 and has been relocated again and again. Its inaccessibility is a drawback. A skiff with outboard motor may, with care, be taken upstream 5 miles from Whiting Point to the cabin of Gudmund Jensen, at the head of a slough. From the cabin a blazed trail leads along the northerly side of a brook and two small lakes nearly to the head of the second lake. Then it turns up the right-hand side of a gulch to timber line and crosses a small valley filled with large boulders to a conspicuous

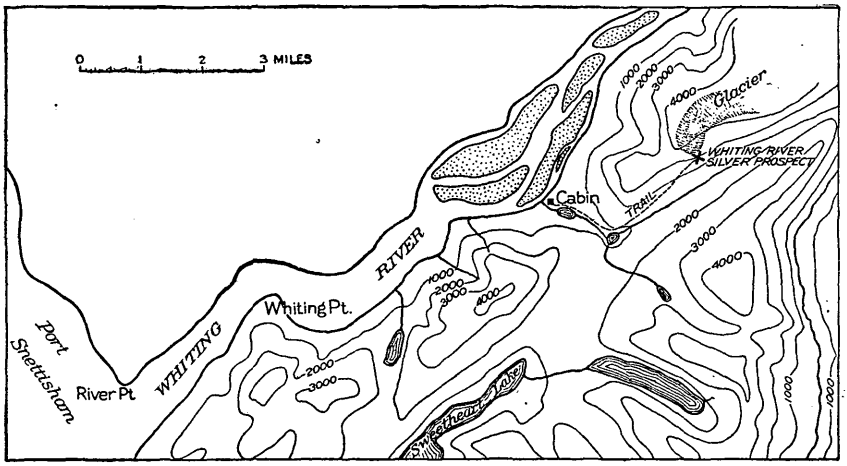

FIGURE 6.—Sketch map showing location of Whiting River silver prospect, near Port Snettisham

goat trail, which goes up the face of the mountain to the prospect. The prospect is about 3½ miles from the cabin, on the east side of a brook draining from a glacier, at an altitude of 2,800 feet.

A small open cut has been made on the vein, and a tunnel started to crosscut the vein below the outcrop. The tunnel is 118 feet long but is reported not to have been driven far enough to reach the vein. The vein is a quartz fissure vein in a wide belt of coarsely crystalline dolomite which lies within the usual quartz diorite of the Coast Range. At the face of the open cut the vein is 40 inches wide. Along the footwall there is about 10 inches of almost solid sulphides, and the rest of the vein contains several per cent of sulphides. The sulphides comprise arsenopyrite, pyrite, galena, sphalerite, and chalcopyrite. Arsenopyrite is predominant. It is reported that very high assays for silver have been obtained from selected specimens and that moderate assays are common.

The writer had no opportunity to make a careful geologic examination of this prospect. Superficial observations suggest that the vein is offset by faulting. Quartz porphyry dikes are found in the dolomite, and the mineral deposits are probably genetically connected with the magma that gave rise to the dikes.

BARITE IN PETERSBURG DISTRICT

In the Petersburg district barite was discovered on the northwest end of Kuiu Island, in the vicinity of the Keku Islets, and along the west shore of Saginaw Bay (fig. 7). Three claims were located by Hungerford and two by Barrows in 1923 on the veins about 4 miles southeast of Point Cornwallis. Opposite a small island a series of conglomerate and volcanic rocks, including rhyolitic tuffs, breccias, and flows, crop out along the shore. They are much broken up, shattered, and fissured. The stronger fissures have in general a northerly strike, but they are irregular in trend, with many subsidiary fractures. The veins filling the fissures range from a fraction of an inch to 4 or 5 feet in width and pinch and swell markedly along the strike. One strong vein, from a fraction of an inch to 2 feet wide, can be traced 200 feet. Minute veinlets of barite fill short gashes throughout the volcanic rocks. The barite is usually of coarse, lamellar character and has a pinkish hue. A few veins are pure white and translucent and have a radiate columnar structure.

The felsite breccias are also found on the north end of the west side of the long island about 3 miles southeast of Point Cornwallis. Veinlets of barite several inches wide are common here. Opposite this island on Kuiu Island the felsite volcanic rocks and conglomerate are overlain by basaltic volcanic rocks with many veinlets of brilliant red jasper.

At the east end of the eastern island of a pair of long islands about 7 miles southeast of Point Cornwallis barite veins are exposed along a fissured zone in limestone. This zone is the result of faulting between greenstone and limestone. Along it are wide veins of chalcedony with drusy quartz crystals lining the many open spaces and locally associated with barite. Veins of chalcedony as much as 10 feet wide were seen here. In part the veins follow the contact of basalt dikes that are intrusive into the limestone. Many barite veinlets occur in the limestone, but they are usually not over several inches wide and where wider pinch and swell abruptly. Locally traces of galena and pyrite are associated with the barite. Calcite is also common in the barite and chalcedony veins. The barite is white and in tabular crystals adjacent to limestone fragments.

On the southwest side of Saginaw Bay, just about midway between the head and the mouth, is a small cove in which an old cabin

and piling still stand. Silurian limestone beds crop out here, and for a considerable distance to the south they are fractured across the bedding and the fissures are filled with coarse lamellar barite of a pinkish hue. These veins range from mere facings of the fractures and short irregular veinlets to well-defined veins an inch to a foot in width, but most of them are narrow. Barite veinlets were also noted in the limestone beds to the north of the cove.

At the tip of the west headland of Saginaw Bay barite veins occur in abundance in a series of interbedded volcanic conglomerates of reddish and greenish hue, similar to those on Keku Straits. The

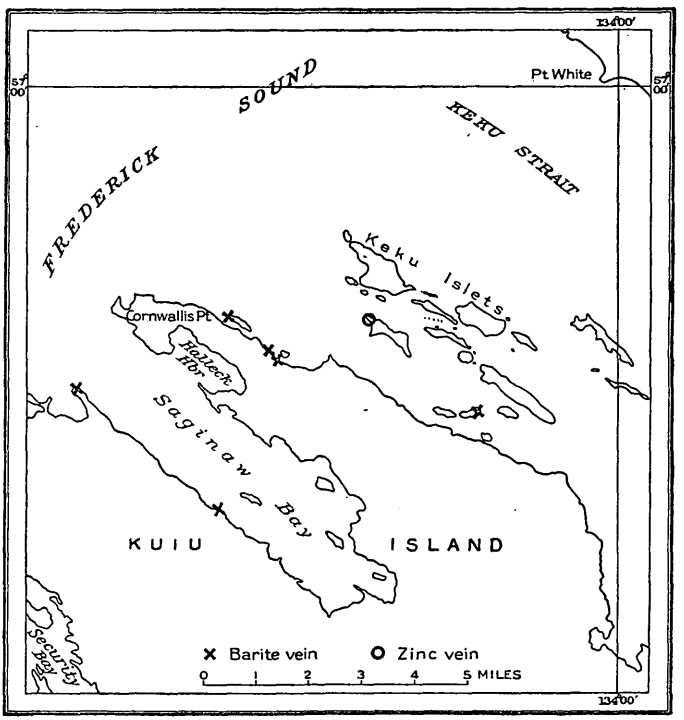

FIGURE 7.—Map showing location of mineral deposits at northwest end of Kuiu Island.

veins are from an inch to a foot in width, and the main fissures strike about N. 35° W.

The origin of the veins is not evident. Basalt dikes, however, are found in their vicinity, and there is a possibility that the mineralization followed the intrusion of these dikes and was effected by solutions that originated in the same underlying magma as the dikes and deposited their dissolved mineral matter in the fissured volcanic rock, conglomerate, and limestone. The structure of the veins and the association of chalcedony with the barite at one locality suggest that they are of the low-temperature, low-pressure, near-surface type. The zinc veins of ladder type in the basalt dikes on the Keku Islets

are probably of similar origin and belong to the same period of mineralization.

A large volume of barite is present in the veins along the southwest sides of Keku Straits and Saginaw Bay, but the mineral matter as exposed is distributed in a great number of gash veins instead of being concentrated in strong, well-defined fissures. It is possible, however, that as the mineralization was so extensive prospecting may discover veins of commercial size.

Other deposits of barite in southeastern Alaska are found on the Castle Islands, in Duncan Canal, Kupreanof Island,[30] and at Lime Point, on Prince of Wales Island.[31] Claims on the Castle Islands have been patented by the Alaska Treadwell Gold Mining Co.

Narrow stringers of barite are also found just south of Bibora Point, on the southeast end of St. Ignace Island, which lies off the west coast of Prince of Wales Island. They consist of white lamellar barite in beds of sandstone and conglomerate.

KEKU ISLETS ZINC VEIN, PETERSBURG DISTRICT

A metalliferous vein with a mode of occurrence unusual in the Petersburg district is found on one of the Keku Islets, off the north end of Kuiu Island. The islet is the large one due south of the northwesternmost large islet of the group. (See fig. 7.)

The islet is for the most part formed of gently warped interbedded sandstone and conglomerate. The pebbles in the conglomerate are chert, limestone, and fragments of other rocks. Traces of carbonized plant remains are found in the sandstone. Basalt dikes are common on the island. The age of the sedimentary beds is uncertain, but the geographic location and the presence of a few intercalated limestone beds suggest that they are Carboniferous. The dikes may be either Mesozoic or Tertiary but are probably Tertiary.

Many of the dikes are crossed by fractures filled with calcite, but these fractures are usually lacking in metalliferous minerals, and there has been little or no alteration of the wall rock. One such dike, however, is crossed by metalliferous veinlets adjacent to which sulphides have been locally introduced into the country rock. This dike is on the west side of the northwest side of the northwest tip of the island, about 150 yards south of the point. The dike strikes about N. 60° W. and cuts across the conglomerate beds, which strike about N. 15° W. It is exposed along the beach for a length of about 150 yards. At the south end it is about 7 feet wide, but

[30] Burchard, E. F., A barite deposit near Wrangell: U. S. Geol. Survey Bull. 592, pp. 109–117, 1914. Buddington, A. F., Mineral deposits of the Wrangell district: U. S. Geol. Survey Bull. 739, pp. 72–73, 1923.

[31] Chapin, Theodore, Mining developments in southeastern Alaska: U. S. Geol. Survey Bull. 642, p. 104, 1915.

toward the northwest it splits, and the two parts are separated by a band of conglomerate. One offshoot maintains about the same width as the original; the other widens from about 2 feet to 7 feet. The fresh basalt is a normal black felsitic rock, consisting of interlocking labradorite laths and pyroxene in ophitic texture. Titaniferous magnetite, commonly in skeleton crystals, is a common accessory. Some interstitial quartz and microperthite are present.

The dike and its branches are broken by fractures oriented roughly at right angles to the walls, somewhat after the fashion of the rungs of a ladder. These fractures are filled with sphalerite, and the wall rock adjoining the fractures is altered and bleached white. As seen in thin section, this alteration has consisted in the partial replacement of the feldspars by calcite and the alteration of the groundmass of the rock, with separation of many discrete particles of magnetite. The pyroxenes are as fresh as in the unaltered rock. The sphalerite veinlets are from a fraction of an inch to an inch wide and from a foot to several feet apart. The altered zones are in places as much as a foot wide and include veinlets of sphalerite aggregating several inches. Locally the sphalerite impregnates the altered rock. The veinlets are confined almost exclusively to the dikes and rarely cross the contact into the country rock, though they occur along the contact of the dikes with the sediments.

Locally adjacent to the dike are lenses of minutely brecciated flinty or cherty quartz with interstitial fillings and veinings of pyrite and marcasite. The pyrite was evidently earlier than the marcasite, as the marcasite forms the central portions of the veinlets and the pyrite the walls. Some of the pyrite veinlets have drusy surfaces coated with minute pyrite octahedra. Both the chert and the pyrite-marcasite veinlets have in turn been minutely brecciated and fractured, and the fissures have been filled with sphalerite similar to that which fills the fractures in the dikes. Only a trace of pyrite occurs with the sphalerite that fills the fractures in the dikes. Pyrite occurs sparingly, however, as an accessory mineral in the altered wall rock adjacent to the veins. Only a little gangue, mostly calcite and locally flamboyant quartz, is associated with the sphalerite in the veinlets.

A sample of the vein matter of the sphalerite veins was assayed and yielded 37.4 per cent of zinc, 0.24 ounce of silver to the ton, and a doubtful trace of gold. A sample of the cherty pyritic vein matter adjacent to the dike was assayed for gold with negative results. These results indicate that the occurrence is of scientific interest only, as it is the only one yet found in these districts where ore minerals are positively associated with intrusive rocks that do not belong to the Coast Range group.