MINING IN SOUTHEASTERN ALASKA.

By CHARLES W. WRIGHT.

INTRODUCTION.

The year 1908 has marked but little advance in the mining industry of southeastern Alaska as compared with previous years. At some of the gold mines in the Juneau district—the Treadwell group and the Perseverance and Eagle River mines—a substantial gain was made and extensive mining and water-power projects have been undertaken which promise well for considerable activity during 1909. The copper mines of the Ketchikan district, on the other hand, have suffered a considerable setback because of the decrease in the market value of the metal, and some of the mines were idle throughout the year.

As each successive year has added to the general knowledge of the distribution of the rock formations and ore deposits in southeastern Alaska, it has been customary to give a résumé of the general geology in the annual progress reports. This year a repetition of these facts is deemed unnecessary in view of the fact that detailed reports on the Juneau, Ketchikan, and Wrangell mining districts have been issued. This summary report will therefore deal mainly with the progress of the mine developments in southeastern Alaska during the year and will include a preliminary statement regarding the geology and ore deposits of Kasaan Peninsula and Hetta Inlet, areas which were mapped in detail during the last summer.

GOLD MINES AND PROSPECTS.

GENERAL STATEMENT.

There are a large number of prospects in southeastern Alaska on which auriferous quartz veins have been developed to a greater or less extent, and many of them yield high gold values. Many of such deposits, however, lack the required tonnage of ore to make mines, and only a few of these veins have been large gold producers. The greatest output has been obtained from the extensive low-grade lode deposits, and on these the future of the district as a gold producer largely depends. The lode deposits have been found principally

along the mainland in the Juneau district, and consist of the more heavily mineralized portions of the country rock within the mineral zone which has been described as the "Juneau gold belt."[a] Many of these mineralized bodies carry only valueless traces of the precious metals, but there are doubtless some unexplored deposits that carry sufficient valuable ore to make mines, and a greater effort should be made to find and develop such ore bodies.

It has been shown at the Treadwell, Perseverance, and Alaska-Juneau mines, where a large tonnage is available, that ore can be mined and milled for about $1 a ton. However, the fact must not be overlooked that a large daily production and a plant adequate to handle it is necessary for such economical mining. The greater part of the gold contained in the deposits mined is extracted by amalgamation, though the sulphide minerals carry considerable gold and most of the stamp mills are equipped with a concentration plant, the concentrates from the ores being shipped to the smelters for treatment.

GOLD PRODUCTION.

The production from the gold mines in southeastern Alaska for 1907 and an approximation of their output for 1908 are given in the following table:

Production of the gold mines in southeastern Alaska.

Year.	Ore mined.	Gold.		Silver.		Average per ton.			
						Gold.		Silver.	
		Amount.	Value.	Amount.	Value.	Amount.	Value.	Amount.	Value.
	Tons.	*Ounces.*		*Ounces.*		*Ounce.*		*Ounce.*	
1907...	1,206,639	132,300	$2,734,885	22,203	$14,653	0.110	$2.27	0.18	$0.012
1908[a]..	1,650,000	165,844	3,428,000	35,849	19,000	.100	2.07	.21	.011

[a] Estimated.

The increase in the production for 1908 is due to the greater output from the Perseverance and Eagle River mines and the Treadwell group.

JUNEAU DISTRICT.

MINES ON DOUGLAS ISLAND.

The only mining operations in progress on Douglas Island during the year were at the Treadwell group. These mines are so well known that only a brief mention of the recent developments will be made. One of the principal features of economic interest has been the increase

[a] Bull. U. S. Geol. Survey No. 287, 1906, pp. 22-38.

in the power-producing facilities and the reduction in the cost of power. Last year oil was introduced in place of coal, and this year a considerable reduction of expense is reported because of this change of fuel. The amount of water power has been increased during the year by the completion of a new 72-foot dam across the basin at the head of Fish Creek, and another 60-foot dam at an elevation of 1,200 feet on Ready Bullion Creek is nearly completed. These storage basins will add considerably to the present water supply during the winter months. A much greater engineering problem is the development of the water power from Lake Turner on the east side of Taku Inlet, which is being undertaken by the Treadwell Mining Companies. Lake Turner is 7.9 miles long, averages half a mile in width, and in places exceeds 100 feet in depth. With the completion of a dam at the mouth of the lake an elevation of 65 feet above tide water will be obtained, and it is estimated that 10,000 horsepower can be developed throughout the year. The transmission of this electric power across Taku Inlet will require a cable span of 2½ miles, and thence it is a distance of 18 miles to Treadwell.

The Treadwell mine has been opened largely on the 1,450-foot level, which will be used as a base level for deeper exploration, and to which the Seven Hundred Foot and Mexican shafts will be extended. Below this level the shafts will be inclined to follow the dip of the ore body. The ore mined during the year was principally from the 900-foot and 1,050-foot levels, and to some extent from the 600-foot, 750-foot, and 1,250-foot levels.

On the Seven Hundred Foot claim the 100-stamp mill was reconstructed and put in operation early in February. A new shaft house was built, the shaft was extended to the 1,450-foot level, and the 1,250-foot level was partly developed. The ore mined was derived mainly from the 880-foot and 990-foot levels.

The main developments at the Mexican mine consist of the extension of the shaft which will eventually be connected with the 1,450-foot level of the Treadwell mine. Work was continued on the 1,100-foot level, and the ore extracted was principally from the 770-foot, 880-foot, and 990-foot levels.

At the Ready Bullion mine the 1,500-foot level was opened and developments were nearly completed. The 750-foot level was extended to explore the south ore body exposed on the surface. At this level it was found to be separated from the middle ore body by 12 feet of slate country rock, but its lateral dimensions have not yet been determined. The ore mined was from the 1,200-foot, 1,300-foot, and 1,500-foot levels.

The production statistics for 1908 from these mines show an output of 1,367,920 tons, yielding $2,999,420, or an average of $2.17 per ton.

GOLD CREEK MINES.

There are three large lode mines on Gold Creek—the Perseverance, Alaska-Juneau, and Ebner. These properties are all located along the same mineral zone which has been described in detail in a previous report.[a]

Considerable progress was made at the Perseverance mine this year, though operations were handicapped by a lack of sufficient power. Development work was carried on throughout the year, and the main ore body was opened at the tunnel level for a length of 1,500 feet, its width varying from 60 to 100 feet. Twenty-five feet above this level the intermediate level, from which the stopes are being started, has been extended over a length of 1,400 feet, and chutes have been driven at intervals of 20 feet to connect with the tunnel level. The 100-stamp mill on the property was started June 1 and was operated continuously until the end of October. The mine developments will be continued throughout the winter and 100 additional stamps are to be added to the mill.

At the Alaska-Juneau mine mining was renewed the last of June and continued until the middle of October. During this period 35 men were employed and the 30-stamp mill on the property was in continuous operation. The ore milled was derived principally from the open pits, and the mine developments consisted in extending a raise from the upper-pit tunnel to connect with the upper pit. The output was about the same as for 1907.

Operations at the Ebner mine were suspended throughout the year pending a sale of the property.

At the Hallam group of claims, adjoining the Ebner mine on the northwest, surface explorations were in progress during the summer, and encouraging results are reported.

Placer mining was in progress in Silverbow Basin for several weeks early in the summer, but a lack of equipment prevented extensive operations and little was accomplished.

MINES NORTH OF JUNEAU.

The principal mining operations along the mineral zone extending from Juneau to Berners Bay were at the Eagle River mine, where developments were carried on throughout the year. The ore body that is being mined is a well-defined quartz vein inclosed in the slates and locally enriched by ore shoots. This vein deposit is displaced by faults which have caused much difficulty in its exploration. The underground workings were extended on the four tunnel levels through the main fault, which includes a width of 50 to 100 feet of

[a] Bull. U. S. Geol. Survey No. 287, 1906, pp. 56–85.

crushed material, and the ore body was located. About 50 feet beyond the main fault a second displacement was encountered with about 6 inches of gouge along the fault plane, and further explorations on the first, second, and third levels opened the vein deposits, which had apparently been displaced about 70 feet to the north. Most of the ore mined was derived from the upper workings above tunnel No. 1. The 20-stamp mill was run to its full capacity during the year, except in the winter months, when only 5 stamps could be operated because of a lack of water for power purposes. This difficulty, however, has been partly eliminated by the building of a flume to a creek near Eagle Glacier, from which it is believed a sufficient water supply will be obtained to give ample power during the winter months.

To the north of Eagle River, at Yankee Basin, a crew of men was employed during the summer to develop the Dividend and adjoining claims. The crosscut tunnel on the Dividend claim is 1,170 feet in length, intersecting the lode at a point 990 feet from its mouth at a depth of 350 feet. From this tunnel a drift has been extended for 250 feet to the southeast along the ore body, and considerable ore was thus developed. On the Black Chief group the Gold Pan vein has been developed by a crosscut 90 feet long intersecting the vein at a depth of 75 feet and by a 22-foot drift along the vein. In the creek, 150 feet below this tunnel, a second vein from 2 to 5 feet wide has been partly developed. On the B. C. claim, to the south of the Black Chief, a 100-foot tunnel and 100 feet of crosscutting have been completed and a well-defined quartz vein has been developed. On the other properties within this area assessment work is said to have been done, and on some of them a small amount of development work was done.

At Echo Inlet several men were employed to explore the Gold Standard group of claims, and considerable progress was reported.

The Jualin mine, the only property in the Berners Bay area where mining was done during the year, was worked under lease by a small crew during the winter and spring months. Early in the summer, however, these operations were suspended, and the property has since been idle.

On the numerous prospects on Salmon Creek, McGinnis Creek, Montana Basin, Peterson Creek, and Windfall Creek work has been carried on principally by the owners, and only in a few places have the developments been in excess of the annual assessment requirements.

MINES SOUTH OF JUNEAU.

The mines south of Juneau have been inactive during the year, except the Crystal mine, at Port Snettisham, where work was resumed in April and 10 men were employed until November. During this

period developments were extended from the upper level toward the surface of the Crystal vein, which varies from 18 inches to 5 feet in width, and considerable ore was stoped out. On the southeast end of the Daisy Bell claim the vein was stripped along the surface for 200 feet, a tramway was built to the mill, and a small amount of ore was mined. The 5-stamp mill was in operation for fifty days, and an average of 15 tons of ore a day was treated during this time.

At the Holkham Bay group of claims, on the south side of Endicott Arm, a little development work was done along the surface on the main ore body, a quartz vein, and considerable advance was made in the crosscut channel, which it is supposed will cut the vein 400 feet from its mouth.

Explorations at Limestone Inlet have been advanced on the Enterprise and Arizona groups of claims. These properties are on the north side of the inlet, at an elevation of 1,000 to 1,500 feet and from one-half to three-quarters of a mile from tide water. The ore bodies are auriferous quartz veins inclosed in a granitic rock, which intrudes the slates and greenstones bordering the shores of the inlet. On the Enterprise claim a quartz vein from 3 inches to 9 feet wide and averaging 5 feet has been exposed by surface excavations for several hundred feet. This vein strikes N. 25° E. and dips 45° NW.; its valuable content is principally free gold. A similar quartz vein, averaging 1½ feet in width, occurs on the Arizona claims, and has been developed by surface cuts for 800 feet. This vein is parallel in strike and dip to the Enterprise vein and also carries free gold. On both of these properties other quartz veins have been discovered but have not yet been developed. Galena, sphalerite, chalcopyrite, and pyrite are present in the veins in small amounts.

Small developments on some of the properties in the vicinity of Windham Bay and on the Sunny Day prospects, at the south entrance to Endicott Arm, are reported, but no extensive mining operations have been carried on in these sections.

ADMIRALTY ISLAND.

Little progress has been made in the development of the properties on Admiralty Island. On the claims of the Mansfield Gold Mining Company a few men were employed throughout the year in driving the crosscut tunnel to cut the vein at a depth of several hundred feet. This tunnel was reported to be 250 feet in length. Surface explorations are said to have revealed other valuable vein deposits on the property. Assessment work is reported to have been done on the Mammoth group, the Portage group, and the prospects at Hawkes Inlet.

SITKA MINING DISTRICT.

The principal mining interests during the last few years in the Sitka district have been in the vicinity of Klag Bay, on the west coast of Chichagof Island, at the De Groff mine and the Mills prospects. These properties are apparently on the same quartz vein, which averages about 5 feet in width and in which the ore occurs in shoots from 40 to 60 feet long. On the De Groff property two such ore shoots have been developed at three different levels by tunnels following the vein. The 4-stamp mill on the property has been operated the greater part of the year, and a considerable gold production is reported. On the Mills prospects, located above and on the northern extension of the De Groff properties, development work was advanced on the surface and in the two main drift tunnels, and ore shoots are reported to have been found within the vein. On the Hirst and Bahrt claims, at Hirst Cove, just north of Klag Bay, prospecting was done during the summer.

The mines and prospects in the vicinity of Silver Bay on Baranof Island have received little attention this year, and no important developments are to be recorded.

WRANGELL MINING DISTRICT.

The mines and prospects within the Wrangell mining district have been inactive during the last year, and except assessment work little has been accomplished. On the Portage Mountain group, at the head of Duncan Canal, a small crew of men was employed during the winter to drive a tunnel to prospect a vein at an elevation of 900 feet, and 60 feet of this work was accomplished.

On Woewodski Island no work was in progress at the Hattie and Smith camps, properties of the Olympic Mining Company. One mile above the Smith camp, on the east side of the lake, a quartz vein was discovered, on which a 40-foot drift tunnel was extended, and encouraging results were reported.

KETCHIKAN MINING DISTRICT.

Little interest has been shown in gold mines and prospects in the Ketchikan district during the year, and except the gold contained in the copper ores the production of this metal was very small.

At Dolomi, on Prince of Wales Island, developments have been confined to the sinking of a shaft on the Jessie claim to a depth of 226 feet. On the 125-foot level drifts were extended for 150 feet, and considerable ore is said to have been developed. A 25-horsepower hoist and boiler plant was installed, also a 2-drill air compressor. On the Valparaiso, Amazon, and other claims only assessment work was done.

The prospects in the vicinity of Hollis, on Twelvemile Arm, have been idle, except the Julia claim, at the mouth of Harris Creek. On this property a pump and air compressor were installed and a small amount of development work was done in the shaft. Assessment work alone is reported from the other properties adjacent to Twelvemile Arm.

At the Goldstream mine and other prospects on Gravina Island no work was done until late in the year, when the annual assessment work was performed.

No developments were in progress at the prospects on Cleveland Peninsula, except at the Old Glory group, where ore was mined and milled in the 2-stamp mill during the spring and a small yield reported.

No important mine improvements or new discoveries are reported on Revillagigedo Island, and most of the prospects were idle throughout the year.

COPPER MINES AND PROSPECTS.

GENERAL OUTLINE.

All the producing copper mines in southeastern Alaska are located on Prince of Wales Island, in the Ketchikan mining district. During 1908 only five of the ten producers of 1907 made shipments, and one prospect, the It, was developed to the producing stage. The metal production from the copper ores was less than half of that for 1907, but the grade of ore shipped was considerably higher than in previous years. In general the mines are working low-grade copper deposits, averaging from 50 to 80 pounds of copper to the ton, though, by sorting the ores, it is possible at some of the mines to increase the grade of the product. There has been practically no change since last year in the cost of producing copper from these mines, but the market value of the metal has decreased from an average of 20 cents to 13 cents a pound. The cost of mining ranges from $1 to $3.50 a ton; haulage from the mine to the wharf from 15 to 50 cents a ton; transportation from Alaska to the smelters at Tacoma or in British Columbia from $1.50 to $3 a ton, including the cost of loading and unloading. The smelters will pay approximately as follows for the ore: Total copper values less 1 per cent and less 3 cents per pound refining charges; 90 per cent of gold and silver values; 10 cents per unit bonus for iron in excess of silica and 10 cents per unit penalty for silica in excess of iron. The charges for treatment are from $1 to $3 per ton. Thus, with the price of copper at 15 cents under existing conditions a copper deposit of large tonnage on Prince of Wales Island should contain at least 3 per cent of copper and $1 to the ton in gold to defray the cost of production. However, some deposits of lower-grade ore may be sorted so as to bring the ore content above 3 per cent of copper.

Deposits containing a considerable excess in iron are more favorable than those with a siliceous gangue. Where the ore is smelted in Alaska the costs of transportation are less, but the expense for smelting is somewhat greater.

There are a large number of copper deposits on Prince of Wales Island where small masses or veins of copper ore are exposed and from which high assay values are obtained. On these the locator performs the required assessment work each year, which often amounts to very little, or even in some instances simply to a relocation. Most of the deposits lack the tonnage of ore which is the essential factor to make a mine, and the surface indications at many of the prospects are unfavorable for the development of any considerable tonnage. It is therefore advisable for the prospector, after he has satisfied himself that some of his mineral claims lack the necessary tonnage, to abandon them, even though they show some rich ore, and to lend his efforts to the development of other more favorable properties, or to the search for new and more promising ore bodies.

PRODUCTION.

The following table shows the ore tonnage and its content of copper, gold, and silver produced from the copper mines in southeastern Alaska during 1907 and 1908:

Production of copper ore in southeastern Alaska.[a]

Year.	Ore mined.	Copper.		Gold.		Silver.	
		Amount.	Value.	Amount.	Value.	Amount.	Value.
	Tons.	*Pounds.*		*Ounces.*		*Ounces.*	
1907	79,982	4,758,814	$951,761	3,384	$69,960	44,196	$29,143
1908[b]	46,700	3,937,700	519,776	2,806	58,000	39,622	21,000

[a] Computations based on average price of copper $0.20 a pound and silver $0.67 an ounce for 1907, and copper $0.132 and silver $0.53 for 1908.
[b] The figures for 1908 are based partly on estimates.

KETCHIKAN MINING DISTRICT.

KASAAN PENINSULA.

GENERAL STATEMENT.

Kasaan Peninsula is a promontory 18 miles long and 3 to 6 miles wide on the east side of Prince of Wales Island. It is a heavily timbered, mountainous area, with dome-shaped summits reaching altitudes of 1,000 to 2,800 feet and deeply dissected by narrow valleys and gulches. The occurrence of copper on this peninsula was known to the Russians as early as 1865, but not until 1900 were actual developments undertaken. Copper production began in 1905, and the total output at the close of 1907 was approximately 7,000,000 pounds.

The average content per ton of ore mined during this period was 48 pounds of copper, 0.035 ounces of gold, and 0.27 ounces of silver, or an average total value of about $10 a ton. The copper production for 1908 is considerably less than that for 1907, as some of the principal producers were idle throughout the year.

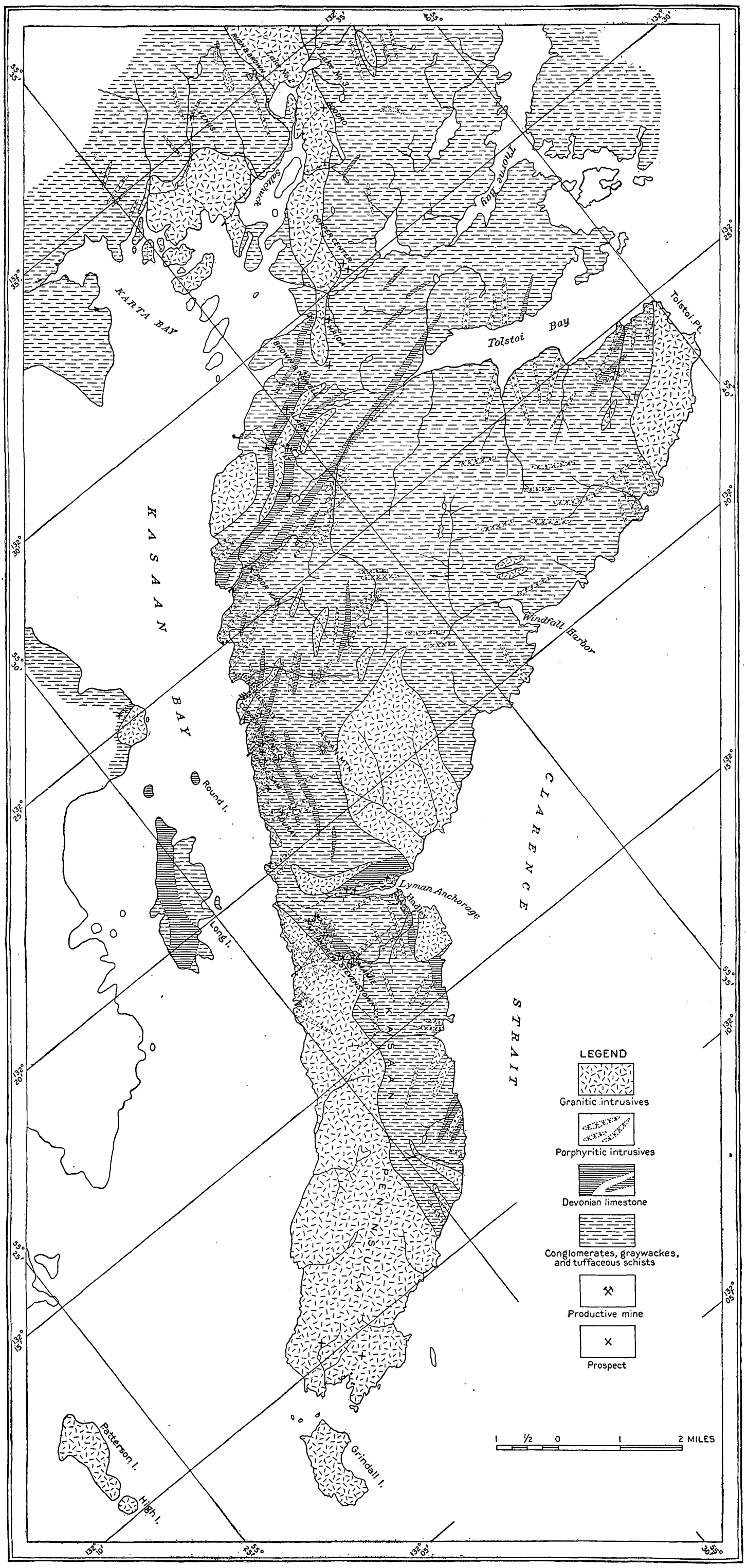
GEOLOGY.

The geologic formations exposed on Kasaan Peninsula are made up of stratified rocks, including those of sedimentary and volcanic origin, and of intrusive granite and porphyritic rocks (Pl. II). The stratified rocks are of consequence to the prospector as the inclosing rocks of the ore bodies, the occurrence of which depends on their composition; the intrusives are significant because they are referred to as the original source of the ore deposits. It is therefore important to know with which of the intrusives and intruded rocks the ore deposits are most commonly found. The accompanying sketch map (Pl. II) shows the distribution of the rocks and the location of the mines and prospects.

The stratified rocks are principally graywackes interbedded with limestones and conglomerates, all of which have been considerably metamorphosed. The tuffaceous material occurs intermixed with the sedimentary rocks in beds of considerable thickness. The graywackes, which are the most widely distributed, are fine to coarse grained rocks of clastic texture, composed largely of feldspar with amphibole crystals scattered more or less abundantly throughout. The bedded structure is lacking in many places and the rock closely resembles a massive igneous rock, though on the weathered surfaces the clastic texture may be readily recognized. The conglomerates are composed of pebbles and cobbles of graywacke, quartzite, limestone, and igneous rocks of granitic and porphyritic textures. There is both a younger and an older succession of graywackes and conglomerates, the discussion of which is left for the detailed report. Limestone beds are intercalated with the graywackes and conglomerates, but are generally crystallized to such an extent that all possible evidence of their age is obliterated. However, on Long Island, which occupies the central portion of Kasaan Bay, limestone beds carrying Devonian fossils occur, and these probably represent the same geologic horizon as the strata on the peninsula.

The structure of the stratified rocks is that of a closely folded synclinorium with a general northwest strike and northeast dip. This structure, however, is interrupted locally by the intrusive masses, and at these places the bedding planes of the stratified rocks are usually parallel with the lines of contact of the intrusives.

The intrusive rocks, which apparently make up the main mass of the peninsula, are exposed over about one-third of the surface area



GEOLOGIC MAP OF KASAAN PENINSULA, PRINCE OF WALES ISLAND.

represented on the map, the individual masses being elongated in a northwesterly direction parallel with the structure of the stratified rocks. The granitic intrusives include granodiorite, syenite, hornblende diorite, and a little granite, and probably represent several minor epochs of igneous invasion during one general period, though in some of the rocks this difference in composition may be attributed to differentiations within the igneous magma during solidification. At the contacts of these granodiorite batholiths various phenomena are presented, such as masses of slightly altered and sheared granodiorite surrounded by unaltered granodiorite, showing sharp contacts in some places, while in others the two phases merge gradually into each other. This suggests a peripheral solidification of the igneous batholith, fracturing of this outer portion, and subsequent introduction of molten rock into the interstices. Again, we find fragments of highly metamorphosed stratified rocks forming angular inclusions in the igneous mass. Some of these fragments are recognized as such only by the presence of parallel lines of biotite flakes, the other portion of the inclusion having been replaced by the intruding magma. A related feature is noticeable in the schist strata adjacent to the contact, which show an introduction of feldspar, quartz, and other pegmatitic minerals along the bedding planes. Such occurrences suggest a partial replacement of the invaded beds by igneous material.

The granodiorite and adjacent metamorphic rocks are intruded by pegmatite dikes, but these are not plentiful. In composition they are closely related to the granodiorites and were probably derived from the same underlying magma.

After the intrusion of the granitic rocks, porphyritic dikes, many of them several hundred feet wide, invaded the stratified rocks as well as the granodiorite. This invasion, like that of the granitic rocks, was accompanied by the introduction of ore deposits.

The most recent rock formations are represented by the numerous smaller basalt and diabasic dikes which crosscut all the rock formations and also the ore bodies.

ORE DEPOSITS.

The ore deposits on Kasaan Peninsula, unlike most workable copper deposits in the States, consist of original or primary ores. Four types of ore bodies, defined by their occurrence and mineral composition, are recognized, as follows:

(1) Contact-metamorphic deposits occurring in irregular masses, from 10 to 250 feet in dimensions, along the contacts of the intrusive rocks (usually with limestones) and composed essentially of chalcopyrite, magnetite, pyrrhotite, and pyrite in a gangue of amphibole, orthoclase, epidote, garnet, and calcite.

(2) Lode deposits occupying shear zones from 5 to 30 feet wide in the stratified rocks and composed of chalcopyrite, pyrite, and usually sphalerite with some quartz and calcite, the ore occurring in lenses and disseminated in the inclosing rock.

(3) Vein deposits occupying fissures from 1 foot to 6 feet wide in the limestones and locally along intrusive dikes and composed of galena, sphalerite, chalcopyrite, and tetrahedrite in a gangue of quartz, calcite, and barite.

(4) Disseminated deposits occurring as irregular masses without defined limits and composed of bornite and chalcopyrite in small masses and particles disseminated in basic diorite intrusives and associated with biotite, epidote, and calcite.

The contact-metamorphic deposits are by far the most important and have been the principal copper producers. A lode deposit has been developed at the Rush & Brown mine, and from it a considerable yield of copper has been derived. Deposits of the third and fourth classes have been prospected at several points, but have not as yet been developed into metal producers.

The copper deposits which are now being mined belong to the first class and consist of low-grade base ores containing high percentages of iron and lime. They yield, therefore, a desirable product for fluxing purposes at the smelters in British Columbia and at Tacoma.

MINE DEVELOPMENTS.

The mines on Kasaan Peninsula were inactive during the winter, and some were idle throughout the year. Early in the summer the Mamie and Stevenstown mines were consolidated under one management and a lease on the smelter was obtained. During August the smelting plant was reconstructed and improved so as to treat a larger tonnage more economically than had been done in previous years, and at the mines the underground workings were pumped out, necessary repairs made, and ore developments extended. Early in September the smelter was put in operation, and from that time until the first of November an average of 360 tons of ore was treated daily. The lack of siliceous ores necessitated the suspension of operations in November, and the smelter was to be closed during the winter of 1908–9. At the mines development work will be in progress throughout the winter in the search for and opening of new ore reserves.

The Mount Andrew property, which adjoins the Stevenstown on the northwest, was not operated during the year.

The It Mining Company, which was organized early in 1908, has been actively engaged in developing the It and adjacent prospects. The copper deposit on the It claims has been explored by a tunnel, crosscuts, and a 66-foot raise to the surface, mostly through ore, and a small body of ore has been developed, the dimensions of which have

not been determined. This is a contact deposit with diorite to the southwest and limestone to the northeast, forming the hanging wall. The mineral zone is about 100 feet wide at this point, and along its northwest extension similar deposits are being explored on the Alarm and Reed claims. The ore consists of chalcopyrite, pyrrhotite, and pyrite in a gangue of garnet, epidote, and calcite. The lack of magnetite in these deposits, though that mineral dominates in most of the other deposits on the peninsula, and the presence of pyrrhotite, which is lacking in most of the other deposits, are of interest. Work was not begun on this property until May, but by the end of September a surface tramway 1 mile long, ore bunkers, and a wharf were completed. The first ore shipment was made October 5 to the Hadley smelter, and in November shipments were made to the Tyee smelter at Ladysmith, British Columbia.

The Rush & Brown mine was idle, except for the assessment work, which was accomplished during the summer. However, at the close of the year ore from the bunkers at the wharf, which had been filled in 1907, was shipped to the Tacoma smelter.

At the Goodro, Venus, Copper Center, Brown & Newell, Poor Man, Ouray, Hole in the Wall, and other prospects on Kasaan Peninsula assessment work was reported to have been done, and in some places small developments were in progress.

HETTA INLET.

GENERAL STATEMENT.

Kasaan Peninsula on the east coast and Hetta Inlet on the west coast of Prince of Wales Island constitute the two most important copper-mining areas in southeastern Alaska. The mines and prospects adjacent to Hetta Inlet are included within an area of 50 square miles, at the center of which is Copper Mountain, and during the last year the production from this area exceeded that of the mines on Kasaan Peninsula. During the summer the Alaska road commission constructed a trail from Sulzer, the principal town, to the head of Hetta Inlet, a distance of 3½ miles, thus connecting the town with the wagon road which leads across a portage to the head of Cholmondeley Sound, on the east side of Prince of Wales Island, and affording a short route for travel and mail to Ketchikan. A customs office was also established at Sulzer early in the year.

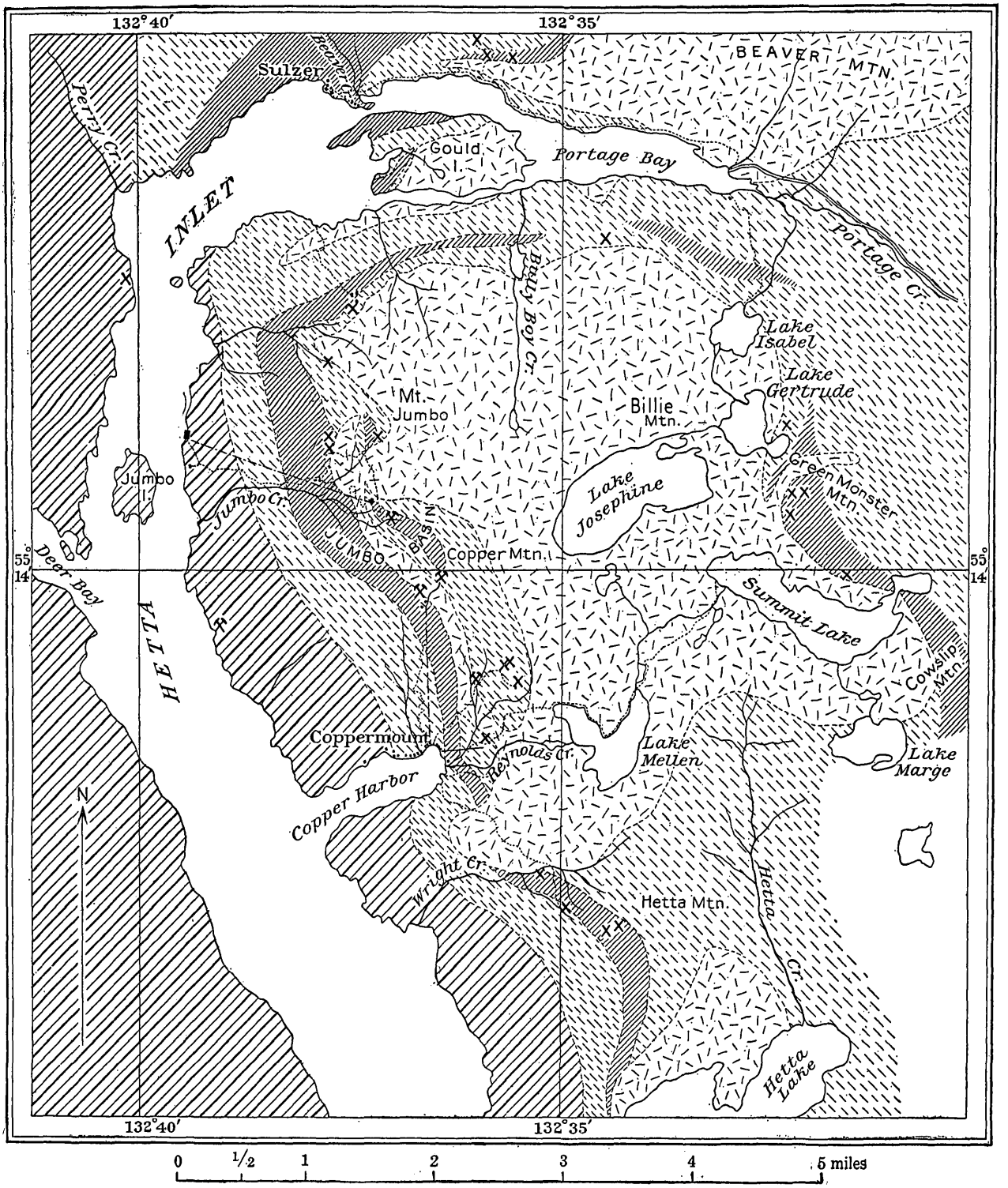
Copper Mountain, which occupies the central portion of the area, has an altitude of 3,961 feet and is the highest peak on Prince of Wales Island. The surrounding topography is abrupt and shows the characteristics of glacial erosion, such as pyramidal peaks, domed summits, amphitheaters, and scooped basins now occupied by lakes. These lakes are important as reservoirs of water for power, which has been developed for both mining and smelting purposes.

GEOLOGY.

The general geology of this area has been described in previous reports, but in view of the additional data obtained while mapping the area in detail during the last summer a restatement of the salient facts pertaining to the geology and ore deposits may be of interest. To present these more clearly a sketch map (Pl. III) is given, showing the general distribution of the rock formations and the positions of the mines and prospects. The most striking geologic feature is the irregular granitic intrusive mass which occupies the central portion of the area. From this mass spurs or dikes, from 30 to 600 feet in width, branch out into the surrounding bedded rocks. In composition this granitic rock varies from a granodiorite to a peridotite, the average rock being an albite diorite. The periphery of the intrusive mass is in places more basic or richer in femic minerals than the central portion, and these minerals, as well as the feldspars, are to some extent replaced by epidote, garnet, sulphides, and other minerals. The granite is surrounded by a succession of metamorphic schists with interstratified limestone beds, the latter being entirely marmorized. These schists are much wrinkled and sheared, and include both calcareous and siliceous varieties. Nearer the intrusive contact they are further altered to a hornstein or amphibolite, which is usually banded with parallel beds of epidosite and rarely garnetite. Locally they are commonly termed greenstones because of their compact, indurated character. These schists are impregnated with the sulphide minerals pyrite and pyrrhotite, which in places form massive bodies, though the amount of copper in them is rarely sufficient to make ore. The limestones are economically of greater importance, as they have assisted materially in the formation of the ore bodies. The principal limestone belt extends from Hetta Mountain northwestward over New York Mountain and into Jumbo Basin; another belt occurs on Green Monster and Cowslip mountains. Narrow bands of schist are interstratified in these limestones, and in turn narrow beds of limestone are interstratified in the schists. Overlying and to the west of the main limestone belt is a considerable thickness of altered siliceous schists which are conformable on the limestone and grade upward into a succession of amphibole and chlorite schists interstratified with quartzites and showing no limestone. These chlorite and amphibole schists, with interstratified quartzites and slates and a few beds of a massive greenstone, probably representing an ancient lava, constitute the slate and greenstone formation which borders the shores of Hetta Inlet.

ORE DEPOSITS.

There are two classes of ore deposits in the Copper Mountain area—contact deposits, occurring between the granite and limestone or



LEGEND

- Granite intrusives
- Metamorphic schists
- Limestone
- Greenstone tuffs, slates, and quartzites
- Productive mine
- Mineral prospect

GEOLOGIC MAP OF COPPER MOUNTAIN REGION, PRINCE OF WALES ISLAND.

schist, and vein or shear-zone deposits, occurring along the bedding planes of the greenstone schist and quartzites.

The contact deposits, which are the most important, occur principally in Jumbo Basin, where they have been extensively mined, though smaller deposits of the same type have been prospected at many points around the contact of the granitic mass. The ore bodies consist of sulphides of copper and iron in a gangue of garnet, epidote, calcite, and some quartz. Certain deposits are associated with much magnetite; in others this mineral is lacking and pyrrhotite is present. The contact rock or gangue within which these deposits occur, like the ore bodies themselves, is sporadic in its occurrence. Locally in Jumbo Basin mineralization is developed across a width of several hundred feet, but at other places the granite and limestone lie close together, no contact minerals having been developed. The character of the deposits also depends on the adjacent country rock. Where limestone occurs the copper sulphides and gangue minerals are present in large masses and veins of ore following the original channels extend into the limestone. Where the schists constitute the contact rock, the mineralization is less concentrated and the sulphides are disseminated along the bedding planes for a considerable distance from the contact, only locally forming small masses.

The vein or shear-zone deposits occur principally in the greenstone schists and quartzites, and as a rule are parallel with the bedding planes. They consist of pyrite, chalcopyrite, and small amounts of sphalerite, and these minerals occur in massive veins from a few inches to a few feet wide and disseminated in the altered inclosing rock. Such deposits have been developed at the Corbin and Red Wing mines, which, however, have been only small copper producers.

MINE DEVELOPMENTS.

The mines and prospects of the Hetta Inlet region have been fully described in previous reports, and it remains only to discuss the latest developments. The Jumbo mine has been the principal copper producer during the year, and most of the development within the area has been done at this mine. The mine is located at an elevation between 1,500 and 2,000 feet on the north slope of Copper Mountain. An aerial tramway, 9,000 feet long, connects it with ore bunkers of 2,000 tons' capacity at the wharf. At the mine developments were extended along the main sulphide body, which is now exposed over a length of 120 feet, averaging 30 feet in width. On and above this same level a second sulphide body, separated from the main deposit by 70 feet of contact rock, was opened early in the year, and from it a large tonnage of ore has been mined. The

No. 4 level, which was started just above the upper terminal of the tramway, was extended for 320 feet, and two small ore bodies were crosscut, from which a small tonnage has been derived. This level is now being advanced to undercut the raise in No. 3 tunnel, and it will eventually serve as a passageway for all the ore mined from the workings above, thus doing away with the necessity of the auxiliary 600-foot tram. Surface explorations on the northeast side of Jumbo Basin, between the magnetite deposit and the mine, have revealed new deposits of chalcopyrite associated with magnetite, and it is planned to develop these ore bodies during the winter.

At the property of the Cuprite Copper Company, which adjoins the Jumbo claim on the east, developments were extended during the winter. Two tunnels 80 and 130 feet long were driven in the contact zone and small masses of ore were exposed. The general results were not satisfactory, and the work was stopped during the spring.

Considerable prospecting was done on Hetta Mountain during the summer, and a number of mineral claims were surveyed for patent. Other claims extending southeastward from Copper Mountain were also prospected and surveyed.

The properties of the Alaska Copper Company, including the smelting plant, and the Corbin mine, owned by the Alaska Metals Company, were idle throughout the year.

Operations at the Red Wing mine were resumed in August and small ore shipments were made. The ore body is a vein deposit inclosed in greenstone schists and quartzites which parallel the shore line. It lies close to tide water and at the lower or 100-foot level salt water was entering the mine workings in small amounts along the walls of a crosscutting diabase dike. During the summer the ore was mined from the stopes above the lower level, and careful investigations were made in regard to the practicability of extending these workings farther in depth.

On the Texas, Russian Bear, Gould, and other prospects within the area small amounts of development work were done, but no important discoveries are reported.

NIBLACK ANCHORAGE.

The Niblack mine, at the head of Niblack Anchorage, an embayment on the east coast of Prince of Wales Island, was operated from April 15 to October 30. During this period the shaft was sunk to a depth of 360 feet and developments were extended on the 300-foot level, where two ore bodies were opened. A raise was made in one of these deposits to connect with the 225-foot level, and most of the ore thus developed was mined. Several shipments to the Tacoma smelter were made during the summer.

NORTH ARM.

Developments at the Cymru mine, on Mineral Creek, three-quarters of a mile from the head of North Arm, on the east side of Prince of Wales Island, were in progress early in the spring. A vertical compartment shaft was started in the foot wall of the ore bodies, to replace the incline shaft, and surface improvements were begun and partly completed. In July, however, it was found necessary to suspend all operations.

OTHER PROSPECTS.

In the vicinity of McLean Arm, near the south end of Prince of Wales Island, prospecting for copper has been done in recent years and many claims have been staked. The Johnson & Gouley prospect is located at a point 1,500 feet in elevation and 2 miles from the beach on the south side of McLeans Arm, 4 miles from its entrance. Small masses of chalcopyrite are reported to have been found on this prospect, and have been developed by surface cuts.

Just south of McLeans Arm at Mallard Bay are the Daly-West and Thompson copper prospects, on which small amounts of development work were done during the summer. Prospecting on the north arm of Mallard Bay revealed a brecciated vein deposit carrying copper ore inclosed in greenstone schists and exposed on the beach with a westerly strike. This vein is said to have been followed to a point 1,200 feet from the beach and 150 feet in elevation, where a similar ore occurs. The property is located as the Veta group, and the developments consist of surface cuts and a short tunnel.

At Sea Otter Harbor, on the west side of Dall Island, considerable prospecting has been done on the Shellhouse claims, which extend from the beach on the south side of the bay to the top of the mountain, at an elevation of 2,400 feet. Here several bodies of chalcopyrite-pyrrhotite ore in a quartz-calcite gangue inclosed in limestone and siliceous schist have been found and prospected on the surface. The Miller claims are adjacent to the Shellhouse property, and on them similar deposits are exposed by surface cuts.

On the south end of Gravina Island, at Seal Bay, a tunnel was started late in the summer to crosscut the rock formations in the endeavor to locate ore bodies, some of which are exposed on the surface. In October this work was being rapidly advanced, and it was planned to extend the tunnel to a length of 2,000 feet. No improvements are reported from the prospects at Dall Head or Vallenar Bay.

SILVER-LEAD PROSPECTS.

At only a few localities have deposits of silver-lead ores been found in southeastern Alaska, and none of these deposits were productive during the year. The Moonshine prospect, the property of the

Alaska Galena Company, was idle except for assessment work and small developments carried on by three men employed during the year. The main 200-foot tunnel was extended, and in the fall a body of galena ore was reported to have been found in it, thus encouraging further developments. The silver-lead prospects in Groundhog and Glacier basins, at the head of Mill Creek on the mainland east of Wrangell, were idle except for the assessment work which is reported to have been done.

New discoveries are reported on a creek entering the north end of Blake Channel east of Wrangell Island. Veins of silver-lead ore were found at points 3 and 4 miles from the mouth of this creek and located as the Mount Wedar group and Mount Berg group. Most of the developments were made on the Mount Berg claim and consist of a 150-foot crosscut tunnel and surface cuts. These deposits are said to be similar to those at Glacier Basin and occur in the metamorphic schist country rock.

BUILDING STONES AND MATERIALS.

The principal building stones of southeastern Alaska are marble and granite, and the building materials are gypsum and cement rock. The distribution, quality, and market for these products were discussed in last year's report,[a] and here it is necessary only to consider the recent progress of developments. Marble is the only building stone that has been placed on the market and gypsum is the only building material that is being mined.

MARBLE.

The principal marble quarry in southeastern Alaska is located at Calder Bay, on the north end of Prince of Wales Island. At this quarry, the property of the Alaska Marble Company, developments have been carried to an average depth of 45 feet, the area of the floor being 60 by 90 feet. At this level a tunnel has been started under the hill, the plan being to excavate a large room underground. This room will be gradually enlarged and eventually the quarry operations will be protected from the weather by a roof of stone, and can thus be carried on throughout the winter. The marble at this depth is reported to be better than that near the surface, being comparable with the best grades of Italian white marble. Large shipments were made during the year to Seattle, Tacoma, and San Francisco, and a much greater production is planned for 1909.

The Ham Island marble properties, in the Wrangell mining district, were bonded early in September, and a crew of men was employed to determine the extent of the deposits on this island. The work con-

[a] Bull. U. S. Geol. Survey No. 345, 1908, pp. 116-126.

sisted of surface excavations and diamond-drill explorations. Except small blocks for local use, there was no production from this locality.

Small explorations are reported to have been made on the Marble Island and Tokeen Bay marble deposits in Davidson Inlet.

GYPSUM.

The only locality in southeastern Alaska at which gypsum is being mined is Iyoukeen Cove, on the east side of Chichagof Island. The geology and occurrence of gypsum in this vicinity were discussed in last year's progress report (Bulletin 345) and need not be taken up here. At this mine deposits of gypsum of large dimensions have been developed, though as yet their extent has not been determined. The mine workings consist of a 190-foot shaft from which two levels, at points 90 feet and 160 feet in depth, have been extended. During the year the work has consisted in opening stopes and putting in raises and chutes to facilitate the extraction of the rock. At a point 225 feet east of the shaft a raise was made from the lower level to the surface, thus forming a passageway for the men and giving better ventilation in the mine. A large tonnage was produced during the year and shipped to the plaster plant at Tacoma to be prepared for market.

CONCLUSIONS.

The metal mines in southeastern Alaska which have yielded the greatest output have been those mining the low-grade gold deposits. Their production has been gradually increased from year to year, and the possibilities are that a still greater output will be made in future years. The ore reserves are large, and the amount of ore developed is kept well in advance of that mined. The copper mines, on the other hand, are operating on relatively small ore bodies, which can be extracted in a short time, and the development of new ore reserves is a serious problem at many of the localities. It is therefore a question whether the present copper production will be largely increased in the future.

On Kasaan Peninsula and in the vicinity of Copper Mountain some of the copper mines are developing copper ores rich in magnetite, which constitute a desirable product for the smelters at Tacoma and in British Columbia, and because of their iron content are of increased value. There are in this region large bodies of magnetite ore which contain from 0.5 to 1.5 per cent of copper, but at present they can not be mined with profit as copper ore. They would, however, be of value as iron ore if there was a market for iron ore on the Pacific coast. The copper content could be readily separated from the magnetite mechanically by fine grinding and magnetic concentration, and thus the copper values could be won. Such treatment, however, would necessitate

a briquetting of the ground magnetite before it could be used for reduction to pig iron. The electric process of smelting has been used on similar magnetite ores in California, and future developments may find it applicable in the Ketchikan district. At present about 2,000,000 tons of magnetite are developed on Prince of Wales Island, and a much greater tonnage is possible. These ores for the most part contain practically no phosphorus or detrimental impurities.

Other deposits of iron ore, as yet undeveloped, occur as magmatic segregations along the mainland adjacent to the Coast Range intrusive rocks. These deposits are being explored in the vicinity of Haines and other points on the mainland coast.