PLATINUM-BEARING AURIFEROUS GRAVELS OF CHISTOCHINA RIVER.

By THEODORE CHAPIN.

INTRODUCTION.

Slate Creek is the best known of a number of productive gold-bearing placer streams on the headwaters of Chistochina River, on the south side of the Alaska Range, in the upper Copper River basin. The other gold-bearing streams are Ruby Gulch, Chisna River, and Lime Creek, all of which are within a few miles of Slate Creek.

GEOLOGY.

CARBONIFEROUS ROCKS.

The oldest rocks of the region are the Chisna and Mankomen formations, both of Carboniferous age. As originally described, the Chisna formation, the older, consists of tuffs, quartzites, and conglomerates; the Mankomen formation is essentially black slate and limestone.

TERTIARY CONGLOMERATE.

Unconformably overlying the Mankomen rocks is a conglomerate composed essentially of well-rounded boulders of amygdaloidal greenstone, diorite, and quartz, with lesser amounts of black slate, limestone, schist, and porphyry. It is commonly of a brick-red color, due to the solutions of iron oxide that have penetrated it, and is known locally as the red conglomerate. The greenstone pebbles are the most permeable of the boulders and are often almost entirely weathered, containing only a small core of unaltered rock. The diorite pebbles are less permeable, but they generally contain a stained shell and are extensively fractured in parallel planes across the boulders. These fracture planes appear to have been channels of solution, and along each plane, although the boulder shows no displacement, is a polished surface resembling a slickenside. The conglomerate contains locally a great many boulders of Mankomen rocks, both slate and limestone, but no Chisna rocks.

Fault blocks of similar conglomerate (see fig. 1), one of which occurs in the bed of Slate Creek and a parallel one that extends from the head of Ruby Creek westward to John Grosh Gulch, and an

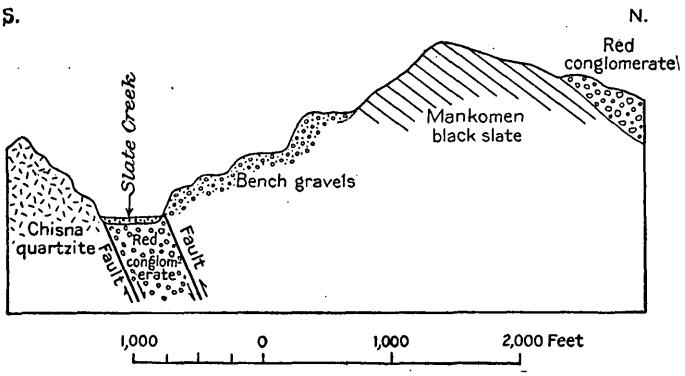

FIGURE 1.—Structure section across Slate Creek 1½ miles above its mouth.

unknown distance beyond, are believed to be composed of rocks of the same formation and have reached their present position through faulting. These rocks are not believed by the miners to be the same formation as the auriferous conglomerate that caps the ridge at the head of Miller Gulch. The conglomerate of the fault blocks is not known to carry any appreciable amount of gold, but it does contain a little sandstone and shale that carries thin seams of coal in places. The conglomerate on the ridge above Miller Gulch and Big Four Gulch is called "wash" by the miners, owing to the presence of a thick covering of residual detritus made up of rounded boulders derived from the conglomerate. The firmly cemented conglomerate, however, is exposed in a number of places. The difference in the content of gold is easily explained by the fact that the conglomerate at the head of Miller Gulch lies at the normal base of the conglomerate, where the heavy minerals would naturally be concentrated, whereas in the fault blocks of conglomerate the base is nowhere exposed. The presence of the coal seams in the fault blocks but not on the Miller-Big Four divide, and at other places where the conglomerate rests normally upon other rocks, is easily explained by the fact that the rocks exposed in the fault blocks represent a higher part of the section. The contact of the conglomerate with the Chisna formation on Slate Creek is a fault. At the head of Miller Gulch the conglomerate unconformably overlies the Mankomen formation and on Ruby Creek and John Grosh Gulch it occupies a fault block that has dropped down between Mankomen rocks on both sides. This conglomerate on Slate Creek probably belongs to the Gakona formation, of Eocene age, as mapped by Moffit [1] in the Chistochina district.

[1] Moffit, F. H., U. S. Geol. Survey Bull. 498, 1912.

GLACIAL GRAVELS AND STREAM GRAVELS.

The bench gravels of glacial origin and the stream gravels are younger formations than the Tertiary conglomerate and are of special interest on account of their valuable deposits of gold and platinum.

DISTRIBUTION OF THE FORMATIONS AND STRUCTURE.

The distribution of the formations is dependent upon the structure. (See fig. 1, p. 138.) The Chisna formation, which at this place is made up of quartzite, tuffaceous conglomerate, and breccia, occupies an area south of Slate Creek. It is bordered by a fault that extends along the south bank of the valley of Slate Creek. This appears to be one of a system of parallel faults that extend in an east-west direction and dip toward the north. Four main faults which were observed show two downfaulted blocks of conglomerate inclosed between Mankomen and Chisna rocks. The main fault appears to be the one on the south side of Slate Creek, which has brought into contact the Carboniferous Chisna rocks and the Tertiary conglomerate. One of the downfaulted blocks of conglomerate is about coincident with the bed of Slate Creek. A parallel block of downthrown conglomerate extends across the heads of Ruby Creek and John Grosh Gulch. Along the upper contact of each of these fault blocks there was thrust faulting, so that at present the Carboniferous rocks of the Mankomen formation actually overlie the Tertiary conglomerate.

OCCURRENCE OF GOLD AND PLATINUM.

Gold and platinum occur in three formations (see fig. 1, p. 138) and appear to represent three stages of concentration. The original bedrock source of the gold and platinum is not known, as lodes of neither metal have been found in this region. The first concentration appears to be the "red conglomerate," which represents a cemented gold and platinum bearing gravel. A second concentration is found in the glacial gravels that form high benches on the south side of Slate Creek. These benches are made up of material derived by the erosion of the conglomerate and other rocks. The third concentration has taken place in the stream gravels. These three formations, the Tertiary conglomerate, the bench gravels, and the stream gravels, all of which carry both gold and platinum, are regarded as promising sources of these metals. The stream gravels are very rich in gold and have been worked for a number of years. The bench gravels have not been extensively tested, but rich deposits of gold that occur within the bench deposits have been mined at a profit, and recent prospecting and sampling at a number of places

indicate that there are very large deposits of this gravel which can be worked at a profit when sufficient water is available for washing it. There is less chance of finding workable deposits in the conglomerate, but recent prospecting has shown that it, too, may be profitably mined for gold and platinum.

The gold and platinum usually occur together and appear to have the same source as far back as the rocks of the region record their history. There are no near-by basic rocks from which the platinum is likely to have been derived. The only basic rocks present are some small dikes that cut the platinum-bearing conglomerates.

MINING.

The output of gold on Slate Creek in 1917 is estimated at $100,000. No assays or other tests have been made to determine the relative amount of platinum accompanying the gold, but it is estimated to be a little over 1 per cent of the volume of the gold. As the amount of platinum bears such a small proportion to that of the gold, its increased production is not easy to bring about.

In 1917 the principal productive mining was on Slate Creek, where two hydraulic plants were in operation but a number of outfits were mining on a small scale. The M. E. W. Gold Mining Co., operated by J. M. Elmer, F. B. Walker, and Ross B. Watkins, was the largest producer. The M. E. W. property comprises more than 20 claims and extends from a point near the moraine of Chistochina glacier, at the mouth of Slate Creek, to the lower end of the claims of the Jack Miller estate, near the mouth of Miller Gulch. It includes also claims near the divide of Slate Creek and Chisna River, claims on Big Four Creek, and bench claims on Slate Creek that extend to the ridge between Pyramid Peak and the head of Miller Gulch. Options were taken in 1914, and the property was acquired during the following year and prospecting and drilling were done. Most of the season in 1916 was also spent in dead work, but a short run was made and $9,000 worth of gold taken out. A cut 1,300 feet long was made along the south bank of Slate Creek from the mouth to the present position of the open cut. A flume and ditch was also constructed to bring in the water for hydraulicking. This ditch takes water from Chistochina glacier about a mile above the mouth of Slate Creek and at present supplies 1,500 inches of water, which is utilized by three giants. Two giants are used to move gravels at the sluice head and one to stack tailings. A head of 125 feet is maintained at the open cut and 175 feet at the tailings giant. It is planned to develop more water power on the west side of Chistochina glacier and bring it across the moraine.

In 1917 work was commenced June 15 and continued until September. Work at the time of the writer's visit had been largely confined to two open cuts on Slate Creek. The deposits are in part in virgin ground and in part in rich gravels which had been once partly worked by the hand method of shoveling into sluice boxes. The old method never proved satisfactory, for the gradient of the stream is too low to admit of easy disposal of tailings, and floods often interfered with the work.

Besides the productive mining on Slate Creek, assessment and development work has been continued on Big Four Creek and on the bench gravels of Slate Creek. The bench gravels contain extensive deposits of gold and platinum, and from their elevated position could be easily hydraulicked when water is obtained.

The claims of the Jack Miller estate were worked on about the usual scale. Twelve men were employed and bench gravels at the mouth of Miller Gulch were hydraulicked. Above the Jack Miller claims three or four small outfits were occupied in groundsluicing and shoveling in. No productive mining was in progress on any of the other creeks.

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MINING ON PRINCE WILLIAM SOUND.

By BERTRAND L. JOHNSON.

GENERAL FEATURES.

The mineralization of the closely folded rock beds that border Prince William Sound introduced into them a considerable variety of minerals, among which were gold, silver, chalcopyrite, chalmersite, pyrite, pyrrhotite, arsenopyrite, galena, sphalerite, stibnite, quartz, epidote, albite, chlorite, calcite, and ankerite. The valuable metals of the ores of this region are copper, gold, and silver. The gold thus far observed is native. The copper occurs chiefly as chalcopyrite, but another copper-iron sulphide, chalmersite, which contains about 23½ per cent of copper, has been recognized at properties on Solomon Gulch, Landlocked Bay, and Knight Island. Silver has been noted as an alloy of the native gold and is also associated with some of the copper ores, but in what combinations is not known.

The ore deposits of this region may be broadly grouped into two classes—copper deposits and gold-bearing quartz lodes. The mineral associations in both gold and copper deposits are in general the same. The copper mines produce large quantities of gold or silver or both, and the gold-quartz lodes contain very small quantities of chalcopyrite.

The gold quartz ores are free milling. They are crushed locally in small stamp or roller mills and the concentrates are shipped to smelters. The copper ores are sulphides and require smelting, with or without previous concentration. At one plant a flotation process is in operation. As no local smelters are available, the copper ores are shipped to smelters at Tacoma, Wash., and Anyox, British Columbia, where their copper, gold, and silver contents are recovered.

The productive mines on Prince William Sound in 1917, so far as known, included nine copper and eight gold mines. A much larger quantity of copper ore than of gold-bearing quartz was mined and treated, and the total value of the metals obtained from the copper ores was several times that of the metals from the gold quartz ores. The value of the total mineral output of the Prince William Sound region in 1917 was $4,667,929, compared with $2,975,200 in 1916.

COPPER MINING.

GENERAL CONDITIONS.

Copper mining was actively carried on in the Prince William Sound region in 1917 and a large production of copper was made. The regular producers, the Kennecott Copper Corporation at Latouche; the Ellamar Mining Co., at Ellamar; and the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), owner of the Midas mine in the Valdez district, made large shipments as usual. Considerable ore was also shipped by the Latouche Copper Mining Co. from the Blackbird group on Latouche Island; the Alaska Mines Corporation controlling the Schlosser property, on Port Fidalgo; the Fidalgo Mining Co., on Port Fidalgo; and the Dickey Copper Co., on Port Fidalgo. Small shipments were reported from the property of Harry Moore on Knight Island and from that of the Patten Cooperating Co. The Threeman Mining Co., on Landlocked Bay, which has shipped much ore in previous years, made no shipments in 1917. Development work was done on some of the nonproducing properties and assessment work is reported on many others. Crude ore was shipped from all the producing properties and in addition copper-bearing flotation concentrates were shipped from the Beatson-Bonanza mine, on Latouche Island. The copper-bearing mineral in all the ore shipped was chalcopyrite. Much of the copper ore mined also carries either gold or silver or both.

WORK DONE DURING THE YEAR.

LATOUCHE AND KNIGHT ISLANDS.

Large operations were in progress at the Beatson Bonanza mine of the Kennecott Copper Corporation throughout the year; the enlargement of the milling plant to a capacity of 1,600 tons daily was in progress, with consequent changes in power plant and mine. An average force of 345 men was employed by the company during the year. A large amusement hall, including moving pictures, bowling alleys, and clubrooms for the use of the employees, was completed early in the year. Other surface improvements included a new store and warehouse, several new houses, a new compressor plant and building, and some small buildings and sheds. The head frame of the shaft was framed during the winter and erected in the spring. Three Diesel engines were installed in the power plant. The capacity of the shipping bunkers was doubled. Additional crushing and flotation equipment was installed in the mill.

A new shaft was completed and put in operation during the year, and a hoist capable of handling 5-ton skips was installed. The main haulage ways and drifts were widened to accommodate larger cars, and two 4½-ton storage-battery electric locomotives were installed.

A 500-ton concrete ore pocket was also finished. A big manway raise was completed between the main level and the top of the ore bluff. Considerable diamond-drill work was done during the year, some of it on the 100-foot level. No other work was done on this lower level during the year. The normal development work was in progress through the rest of the mine, and stoping operations were carried on between the main haulage level and the surface and eastward into the hill above the bluff pit level.

The Blackbird claim of the Latouche Copper Mining Co. on Latouche Island was opened up and operated by Mr. W. A. Dickey. This claim lies just to the north of the Beatson-Bonanza mine, and the deposit under development on the Blackbird appears to lie in the northward extension of the same mineralized zone which includes the Beatson-Bonanza. Considerable underground development work, done both on the main-tunnel level and between this level and the surface, has developed an ore-bearing zone reported to be from 12 to 50 feet in width and said to be traceable underground for 700 feet. During the year crosscuts and drifts were run to the extent of 300 feet, and four stopes were opened up. Operations were in progress from June to October, inclusive. In October about 25 men were employed. A new wharf was erected during the year, a new blacksmith shop was built at the mouth of the tunnel, and repair work was done on other buildings and the tram line. Several shipments of ore were made from the property during 1917. The last previous shipment was in 1907.

Little was done on the other copper properties on Latouche Island. No development work in known to have been done on the Reynolds Alaska Development Co.'s property on Horseshoe Bay or on the property of the Seattle-Alaska Copper Co. on Montgomery Bay.

On Knight Island no productive operations were in progress. The largest developments were on Rua Cove at the Copper Bullion claims (Rua property), which had previously been taken over by Mr. W. A. Dickey. A cabin and a house were erected near the shore of the cove, another building was completed at the upper camp, and a new blacksmith shop was built at the mouth of the tunnel. A small water-power plant, with a two-drill compressor and two drills, was also installed. Underground work completed during the year totaled about 600 feet of tunnel and crosscuts. An average force of 10 men was employed during the summer. Operations were discontinued for the year on September 14, 1917, after a large body of low-grade copper ore had been partly blocked out.

Some of the pyrrhotite ores of Mummy and Drier bays are reported to carry nickel, and during the season short tunnels were driven on the nickel-bearing lodes and some diamond drilling was done.

On the Copper Coin group on Drier Bay a small wharf was erected in the spring, and a compressor and supplies were placed on the ground but not installed. Only two or three men were at work on the property during the year, and no underground work is known to have been done.

On the Pandora group on the Bay of Isles the only work done in 1917 consisted of some open cuts. This lead is now reported traceable a little over 1,000 feet.

Small shipments of copper ore are reported from the Copper Queen claim on Hogan Bay and from a property of Harry Moore on Drier Bay.

UNAKWIK INLET, WELLS BAY, LONG BAY, AND GLACIER ISLAND.

A new copper discovery, on property called the Globe claims, was made back of Long Bay during 1917. The ore body is reported to be of low grade, several feet in width, and two claims in length. No development work was done.

On Cedar Bay, the Lenora group of five claims was surveyed for patent in 1917. Very little underground development work was done during the year. Three men were at work on the property for three months in the spring, and about 75 feet of tunnel was driven. A small force of men is also reported to have worked underground on the property late in the fall. Only assessment work is reported on other properties in this vicinity.

On Glacier Island assessment work is reported on the Portsmouth and Scotia Bell claims of Jens Jensen. The ore body lies a little more than half a mile south of Finski Bay. The country rock is greenstone, and the ore minerals consist of quartz, epidote, pyrite, and chalcopyrite. Some development work has been done on mineralized showings along a pronounced gully which apparently follows a large shear zone. The lower tunnel, which has about 225 feet of workings, is at an elevation of about 250 feet. The main drift, 150 feet in length, is on a shattered zone along a nearly north-south break that shows only a thin trace of gouge. This fracture dips 65° W. The maximum mineralized width of the shattered greenstone is about 3½ feet, and the mineralization appears to be traceable about 60 feet. The ore is a hard, shattered greenstone firmly cemented by sulphide-bearing quartz. A crosscut to the west encountered a mineralized shear zone that strikes N. 20° E. and dips 70° W., along which about 30 feet of drifts have been driven. A width of 10 feet of slightly cupriferous pyrite is reported to have been cut at one point in this shear, which may be the main shear followed by the gulch. The upper tunnel, at about 500 feet elevation, is driven 30 feet on a mineralized shear zone that outcrops on the east side of the gulch.

This showing is not traceable very far on the surface. The face of the tunnel shows 4 feet of shattered greenstone cemented by much quartz that carries sulphides, chiefly chalcopyrite. A streak of nearly solid chalcopyrite, which has a maximum width of 3 inches, runs along the hanging wall. Just over the mouth of this tunnel this shear strikes N. 5° W. and dips about 65° W., and the mineralized portion of the shear has a width of 5 to 12 inches.

Between these two tunnels there are some mineralized outcrops on which a little open-cut work has been done. The mineral deposit in each place is in a sheared or shattered greenstone and has a width of 1 to 6 feet, but the mineralization is traced only short distances by the present development work.

PORT VALDEZ DISTRICT.

The Midas mine of the Granby Consolidated Mining, Smelting & Power Co., on Solomon Gulch, was actively developed during the year and was one of the important shippers of crude copper ore of the Prince William Sound region. An average force of about 50 men were employed during the year on the property. Surface improvements consisted of the erection of a new cook and bunk house and some open-cut work. The principal underground developments consisted in the sinking of an inclined winze, which has a dip of 60°, from No. 2 adit to a depth of 100 feet. No. 1 adit was also extended and considerable drifting done.

A detailed account of the geology of this copper deposit and the copper-bearing area of the Port Valdez and Jack Bay district in which it is found is given elsewhere in this bulletin (pp. 157–173).

ELLAMAR DISTRICT.

The plant of the Ellamar Mining Co. was operated steadily the entire year except for shutdowns of two weeks in the summer and a few days in December. An average force of a little over 100 men was employed during the year. Surface improvements consisted of the erection of a social hall, the construction of a new warehouse on the dock, the shifting of the pump house to a new location in the glory hole, and the installation of foundations for a new power house. Most of the underground work this year has been between the surface and the 200-foot level. The water level was down to a few feet below the 500-foot level and the 500-foot level was open, but no work was being done on that level during 1917. Some work was done on the 100, 200, 300, and 400 foot levels, but stoping operations were confined to stopes between the 300-foot level and the surface. Some diamond drilling was also done. Regular shipments were continued as usual.

No shipments were made from the property of the Threeman Mining Co., on Landlocked Bay, and only one man is reported to have been at work on the property during the year.

On the property of the Hemple Copper Mining Co. on Landlocked Bay development work started in May. Six men were at work during the summer, but on October 1 the crew was reduced to three men. Work was temporarily stopped early in October but is said to have been resumed again about December 15. The work done up to October was all in tunnel No. 1 and consisted in driving a 110-foot crosscut, which cut a slightly mineralized shear zone at its inner end. On October 8 the shear zone showed a width of 8 feet, but at that date the inner wall of the shear had not been encountered. This shear strikes N. 70° W. and dips to the east.

Up to October 1 no work had been done in 1917 on the property of the Landlock Bay Copper Mining Co., on Landlocked Bay.

Twenty-two men are reported to have been at work early in the spring on the property of the Standard Copper Mines Co., near the entrance to Landlocked Bay. Later in the season a force of only 10 men was employed and for a period of about a month during the summer only 1 man was retained on the property. On October 8 only the watchman was on the ground. A new cookhouse and bunk house were erected on the mountain side, and a small building was put up at one of the tunnel mouths. The tram was also fixed and was operated during the summer. Some underground work was also done. The wharf was repaired, but no shipments of ore were made during the year.

Only assessment work is reported on the Buckeye group on Landlocked Bay.

PORT FIDALGO.

Development work was in progress at two of the copper mines on Port Fidalgo, and shipments of ore are reported from all three mines. The Fidalgo Mining Co. worked steadily with an average force of 7 or 8 men and with a maximum number of about 13 throughout the year. Considerable underground development work was done, and some ore was shipped. Stoping operations were carried out between tunnels Nos. 1 and 2 and above tunnel No. 2. Tunnel No. 2 was extended and a crosscut already started was driven about 150 feet toward a new lead to the east. A new lower tunnel (started in 1916) was extended to a length of 300 feet. Considerable stripping was also done on the new lead.

The Alaska Mines Corporation operated the old Schlosser property continuously throughout the year with a crew of 27 to 33 men. Underground work was done on four levels, and stoping operations were carried on over several of the levels. The ore deposit consists of lenses of sulphides occupying a linked system of shears. The ore

zone as now developed has a width of 100 feet and strikes about N. 20° E. and dips nearly vertically. The ore shoots pitch to the north parallel to the hillside. Several hundred feet of development work besides stoping is reported to have been done in 1917.

The Dickey Copper Co., owner of the Mason and Gleason claims on Irish Cove, is not known to have operated during the year, although a shipment of ore is said to have been made from this property.

Ed. Banzer is reported to have done a little work on a copper property near the head of Port Fidalgo, but no details are available at present.

CORDOVA AND VICINITY.

Development was in progress during part of 1917 on a copper property on Fleming Spit. The operations were in charge of Mr. R. E. Hutchinson. The company, the Tacoma-Cordova Mines Co., employed a force of three or four men from June to September, inclusive. Considerable work was done in two tunnels about 250 feet apart vertically, and a number of open cuts were made on the outcrop of the ore body under development.

GOLD MINING.

GENERAL CONDITIONS.

The gold produced in the Prince William Sound region, other than that obtained from the gold-bearing copper ores, comes from both gold quartz lodes and gold placers. The placer deposits are few, small, and irregularly distributed. They are worked only intermittently, on a very small scale, and contribute little to the gold production. The producing gold quartz lodes are in the Port Wells and the Port Valdez districts. The Granite mine, on Port Wells, and the Cliff and Ramsay-Rutherford mines in the Port Valdez district are the largest producers.

WORK DONE DURING THE YEAR.

PORT WELLS DISTRICT.

The Granite mine was the most productive property in the Port Wells district in 1917 as in the previous years. This property was in operation during the spring, but milling was stopped about the middle of May, and all operations were discontinued on June 1. About 40 men are said to have been employed during the spring operations. The property is to remain shut down until water power can be installed.

The Thomas-Culross Mining Co., on Culross Island, completed the installation of a milling plant early in the spring, and the mill was in operation during a part of the season. From 5 to 20 men are said to have been employed. A small shipment of ore is also said to have been made to the Tacoma smelter.

The Alaska Homestake Mining Co., whose property is on Harriman Fiord, report the installation of a 12-ton gyratory mill, crusher, and concentrator in 1917. The mill is said to have been operated only a few days. Development work on the property at the close of 1917 is said to consist of an upper tunnel 225 feet long, a shaft 67 feet deep, and a lower tunnel 150 feet long connected with the shaft. About 18 men were employed on the property during the season.

A new mill and aerial tram were erected on the Sweepstakes property on Harriman Fiord in 1917 but were not operated.

On the Hermann-Eaton property on Bettles Bay a water-power plant, air compressor, and machine drills were installed. A crosscut tunnel several hundred feet in length, driven at an elevation of about 350 feet, is said to have intersected the lead on the claims late in the fall. From 5 to 9 men were employed on the property at different times during the year. The property was closed down for the year early in October.

Development work is reported to have been in progress on the Banner group on Bettles Bay, and the adit tunnel on that property is said to have been extended to a length of over 400 feet.

Three hundred feet of development work is reported on the Wagner & Johnson group at Golden.

At the Osceola group on College Fiord drifting was continued on the lead, and the tunnel is said to have been extended 200 feet during the summer to a total length of about 400 feet. Five men were employed on the property, and operations were in progress only during the summer.

A crosscut tunnel was driven on the property of Chris Pedersen on Pigot Bay and a little drifting done on a lead in the tunnel.

Two men were engaged in development work on the Tomboy group on Pigot Bay.

Assessment work is said to have been done on many other properties.

PORT VALDEZ DISTRICT.

The producing properties in 1917 in the Port Valdez district included the Cliff, Ramsay-Rutherford, Valdez Gold, Cube, and Slide. Development work was in progress on a few other properties, and the annual assessment was done on many others.

The Cliff mine operated throughout the year, although the mill was run only intermittently. During January and February 18 to 20 men were employed, and the remainder of the year about 9 men. As the shaft and lower levels were flooded, all underground work was confined to the 100-foot level and the levels above and to the stopes between these levels. About 450 feet of drifts and crosscuts are reported to have been driven during 1917.

The Ramsay-Rutherford, after operating during part of the year, closed down early in June. The mill is reported to have been in operation from January 1 to June 4, although not running continuously. Mining operations ceased June 7. From 13 to 19 men were employed at different times during the season. Surface improvements are said to have consisted in the installation of an air compressor. Underground about 150 feet of drifting is reported on the lower levels. Stoping operations were carried on between several of the levels.

The Valdez Gold Co. reports only assessment work. From 5 to 7 men were at work on the property during July, August, and part of September. A very few tons of ore was milled and only a little underground work was done.

The Cube Mining Co. operated its mill during February and part of March and also for about a month beginning May 7. About 25 men were employed during the spring. The property was closed down early in July.

A small shipment of ore was made from the Slide gold quartz claim near the head of Mineral Creek during the year.

On the Alaska Gold Hill, formerly known as the Black Diamond property, 5 or 6 men were employed from January to September, two buildings were erected, and also a blacksmith shop at the tunnel mouth. This shop was later torn down. The upper tunnel was extended to a length of 605 feet.

The Valdez Mining Co. let a contract late in the fall to extend the lower tunnel on their Valdez Glacier property a distance of 75 feet.

Some development work is also said to have been in progress during the year on the property of the Patten Mining Co. near Swanport with a force of 6 or 7 men.

On the Shoup Glacier properties a little development work was in progress. Two men were at work on the Nymond property, and about 100 feet of tunnel is said to have been driven. Work was also done on the Olson and McDonald properties.

At the Gold King mine on Columbia Glacier 4 men were at work up to the end of April. The mill was not run. Late in the fall it is reported that a contract was let for sinking 50 feet farther a winze which had been sunk 15 feet during the spring developments.

At the Mayfield on Columbia Glacier 2 men did the annual assessment work, which is reported to have consisted in driving an additional 20 feet in the upper tunnel.

MINERAL RESOURCES OF JACK BAY DISTRICT AND VICINITY, PRINCE WILLIAM SOUND.

By BERTRAND L. JOHNSON.

INTRODUCTION.

The object of this preliminary report is to describe briefly the distribution, geologic relations, and characteristics of the mineral deposits of the Jack Bay district and the adjacent area surrounding the upper portion of the adjoining valley of Solomon Gulch. A brief presentation of the geographic factors immediately bearing on the economic development of the mineral deposits of these areas precedes a short summary of the geology. The general description of the mineral deposits is followed by detailed descriptions of the few ore bodies which have so far been found. A more complete account of the geology and mineral resources of these areas will be incorporated in the final report on the Port Valdez and Jack Bay districts now in preparation.

Detailed geologic mapping of the Jack Bay district and vicinity was done in the summer of 1917. Several trips had been made in previous years, however, to the area adjacent to the Midas copper mine, near the head of Solomon Gulch, in order to study the mineralization of that area while studying the geology and mineral resources of the adjacent Port Valdez district, and in 1912 the writer was associated with Mr. S. R. Capps in a study of the geology and mineral deposits of the Ellamar district, which adjoins the Jack Bay district on the south.

GEOGRAPHY.

The Jack Bay district comprises the small part of the Chugach Mountains that borders the northeast corner of Prince William Sound, which is drained by the several streams entering Jack Bay. (See fig. 2.) This report also discusses the mountainous area that surrounds the head of Solomon Gulch and Allison Creek, the waters of which flow off the northern slopes of the mountains bordering the north side of the south arm of Jack Bay into Port Valdez. The area under consideration adjoins on the north the mountainous Port Valdez district and on the south the less rugged Ellamar district. The western limit is the broad Valdez Arm of Prince William Sound.

This area is one of strong relief. The Chugach Mountains, which inclose Jack Bay, rise from sea level to elevations ranging from 3,000 to nearly 6,000 feet. The lower hills and mountains bordering the entrance to Jack Bay and the western portion of the ridge between the two arms of Jack Bay have the rounded characteristic forms of glacially overridden hills. The high peaks and ridges which surround the headwaters of the streams that drain into the heads of

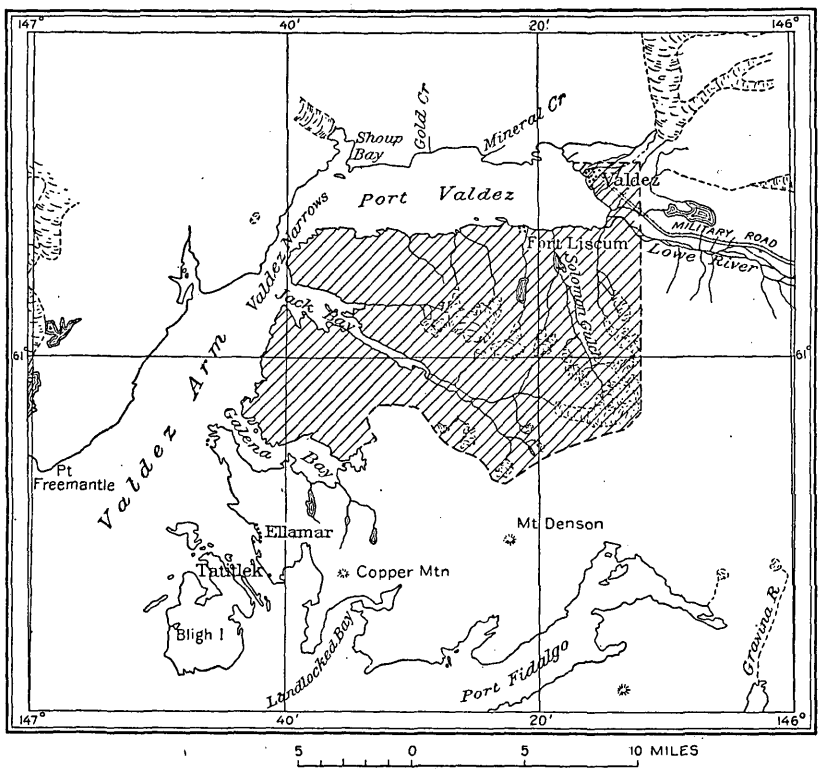


FIGURE 2.—Index map showing location of the Jack Bay district.

both arms of the bay, however, are sharp and pinnacled, and remnants of the glacial sculptors of this rugged alpine topography rest in their ice-carved basins and feed many of the larger streams. In marked contrast to the rugged topography of most of the district are the flat gravel-covered lowlands at the heads of both arms of Jack Bay and the long, narrow gravel-floored basin of Solomon Gulch.

Glaciers cover a relatively small part of the district but feed many of the larger streams. They are all of the alpine type. One through glacier lies in a col that connects Solomon Gulch with the headwaters of the main stream that drains into the south arm of Jack Bay, and another in cols that connect Sawmill Creek and a

parallel stream adjacent to it on the west with the valley of a stream that enters the head of the north fork of Jack Bay. The remaining glaciers are valley-head glaciers or lie in cirques along the valley walls and are concentrated chiefly along the north side of the ridge on the north side of the south arm of Jack Bay.

The shore line of both arms of Jack Bay is smooth and even. The shores are steep, in may places precipitous, and rocky, with few islands except along the westward continuation of the range which separates the two forks of Jack Bay. The heads of both arms are filled by tidal mud flats sloping up into the gravel-covered flood plains of glacial streams. Small deltas lie at the mouths of some of the other streams. Near Valdez Arm two small wide-mouthed coves indent the southern shore of Jack Bay.

The drainage of the Jack Bay district enters one or the other arm of Jack Bay. Solomon Gulch and Allison Creek flow northward into Port Valdez. The streams that enter Jack Bay are all less than 6 miles in length and drain narrow, steep-sided glaciated valleys. Solomon Gulch is about 7½ miles and Allison Creek a little over 4 miles in length. All these streams derive a considerable part of their water supply from melting snow or ice, and the stream flow is subject to wide variations during the year. Two power plants have been in operation on the lower end of Solomon Gulch in the Port Valdez district in recent years, but there are none in the Jack Bay district. There are some small undeveloped water powers in the Jack Bay district.

The climate of the Jack Bay district closely resembles that of the adjacent Port Valdez district. Both districts are somewhat colder and drier than the more southern parts of Prince William Sound, which are more directly exposed to the influence of the Pacific Ocean. Numerical comparisons of the climatic factors of these two districts can not be made, however, because of the lack of weather observations within the area here referred to as the Jack Bay district. At Valdez and Fort Liscum, situated at sea level, in the Port Valdez district, weather records extend over a considerable period of time. These records show a total annual precipitation of about 56 inches at Valdez and 74 inches at Fort Liscum; the annual snowfall at Fort Liscum is at least 30 feet. The average temperature for the three summer months in the Port Valdez district is 52° F. and for the three winter months 21° F. Similarly situated portions of the Jack Bay district would appear to have a slightly greater rainfall and to be slightly warmer, owing to the somewhat greater exposure of this district to the ameliorating influences of the Pacific Ocean. Climatic conditions in the higher portions of the district are much more severe.

Only that portion of the area covered by this report which immediately borders the shores of Jack Bay and Valdez Arm is forested.

The upper limit of timber extends from a few hundred feet above sea level in the bottom of the valley at the head of the north arm of Jack Bay to elevations of about 1,750 feet near the mouth of the bay. Spruce and hemlock greatly predominate, and only a few cottonwoods are found. The local timber from this and adjacent districts is suitable for mine workings and rough lumber, but the better grades of lumber are brought from Seattle. All of the timbered portion of the Jack Bay district lies within the Chugach National Forest. Those portions of Allison Creek and Solomon Gulch valleys covered by this report are not timbered.

The larger animals reported to be native to this area include the bear, mountain goat, and mountain sheep. Both the goats and the sheep are said to have been obtained in the high mountains surrounding the head of Jack Bay, but only goats were seen during the present field season. Evidences of bears are plentiful in many places and both brown and black bears are reported.

Wolverines, marmots, weasels, and porcupines are native to the area. Squirrels and rabbits are found in the adjacent Port Valdez district and probably range over parts of this area. Mink, marten, otter, and other small fur-bearing animals found in the adjacent districts are probably also to be obtained here, although no evidences of their presence were seen in the summer of 1917.

Ptarmigan live in the portions of the region above timber line, and grouse are found in the spruce forests. Geese, ducks, sandpipers, and other waterfowl and shore birds are obtainable here in season. Bald eagles, owls, cormorants, gulls, terns, magpies, blue jays, ravens, crows, divers, and smaller birds are abundant.

Several varieties of salmon are caught in Jack Bay for the canneries at Valdez, Cordova, and Port Nellie Juan. Salmon trout, bass, and flounders are also obtained. Blackfish and whales are occasionally reported in the waters of Valdez Arm. Seals are common, both in Jack Bay and Valdez Arm. The waters of the glacier streams flowing into the head of Jack Bay are milky from suspended rock flour, but the salmon ascend these streams for at least short distances. The few clear-water streams that enter the bay appear to be too precipitous in gradient to offer shelter to fresh-water fish.

Valdez, the supply point of the Jack Bay district and for those portions of the Port Valdez district covered by this report, lies at the head of Port Valdez. The town has a population of several hundred and is provided with wharves, bank, hotels, stores, public schools, telephones, and electric lights. A good stock of supplies is kept on hand, and prices are not high, except for fuel. In the past the town has suffered from occasional floods of the streams from the Valdez Glacier, but it is now protected by a dike that was built in 1913-14.

Valdez is the coastal terminus of the Valdez-Fairbanks military road. It is connected by cable with Seward, Cordova, Juneau, and other points on the Alaska coast and with Seattle, and by telegraph with Fairbanks. Port Valdez is open to navigation throughout the year. Valdez can be reached in six days by steamer from Seattle. Two companies operate steamers to Valdez, giving a summer service of about eight times a month and a winter service of four to six times a month. Freight charges in 1916 between Seattle and Valdez ranged from $3 to $45 a ton according to classification. Passenger rates in 1917 between Seattle and Valdez were as follows: First-class, upper deck, $50; first-class, lower deck, $47.50, and second-class, $30. Regular stops in the Port Valdez district are Valdez and Fort Liscum, but there is also a wharf at the Midas mine. There are no stops in the Jack Bay district.

Transportation along the coast is effected largely by the use of gasoline launches, which can usually be hired for $10 to $30 a day. Regular service is maintained between Valdez and Fort Liscum by the post boat and between the wharf of the Granby Consolidated Mining, Smelting & Power Co. (Ltd.) and Valdez by the company launch.

Much of the Jack Bay district and the adjacent portions of the Port Valdez district are but a short distance from tidewater. The Midas mine and the country adjacent to the Solomon Basin are readily reached from the wagon road which has been built from a point on the south side of Port Valdez a short distance east of Fort Liscum up into Solomon Basin. There are no roads in the Jack Bay district, and but one prospect is connected with tidewater by a trail. An aerial tram operated by the Granby Consolidated Mining, Smelting & Power Co. (Ltd.) between its wharf on Port Valdez and the Midas mine near the head of Solomon Gulch is used only for the transfer of ore and supplies.

GEOLOGY.

DIVISIONS OF THE ROCKS.

The Jack Bay district lies in the southern part of the Chugach Mountains, which, in those portions bordering Prince William Sound, consist of folded and faulted Mesozoic (?) rocks—graywackes, argillites, slates, and subordinate amounts of conglomerates and dark-colored limestones—altered in places to schistose types and intruded at diverse points by granites and basic igneous rocks of Mesozoic or Tertiary age. (See Pl. III.)

The sedimentary rocks of the Prince William Sound region were subdivided by the earlier geologists [1] into two great divisions—the Valdez and Orca groups. The Valdez group was described as consisting principally of graywacke and slate, and it was presumed to be older, more metamorphosed, and to lie unconformably beneath another great series of sediments of somewhat similar lithologic character, named the Orca group. The Orca rocks were stated to consist of interbedded slates and graywackes with extensive basic lava flows and thick conglomerate beds. The Valdez group was mapped as occurring on the northern and western shores of the sound, whereas the Orca rocks outcropped on the eastern shore and also formed the islands of the sound. The Jack Bay district lies within the Valdez group of these writers. It includes, however, some small areas of greenstone of the Orca group and on its southern border an area of conglomerate probably also of Orca age.

ROCKS OF THE VALDEZ GROUP.

LITHOLOGIC SUBDIVISIONS.

The rocks of the Valdez group in the Jack Bay district are all regionally metamorphosed types of sedimentary rocks. The variety is not great and but two lithologic subdivisions have been made, the graywackes and the black slates. A thick black slate formation on the east side of Valdez Arm between Jack and Galena bays appears to underlie the massive graywackes south of Jack Bay. Broad bands of black slates and argillite, however, also occur interbedded with the massive graywackes. In fact, all gradations exist, both in texture and in thickness of beds, for the rocks range from slates to conglomerates and the beds from narrow alternating bands of slate and graywacke to massive members of both rocks. The areas mapped as slate are underlain dominantly by slate and argillite together with minor amounts of graywacke. The graywacke areas are underlain dominantly by graywackes but in places contain a greater or less proportion of slates and argillites.

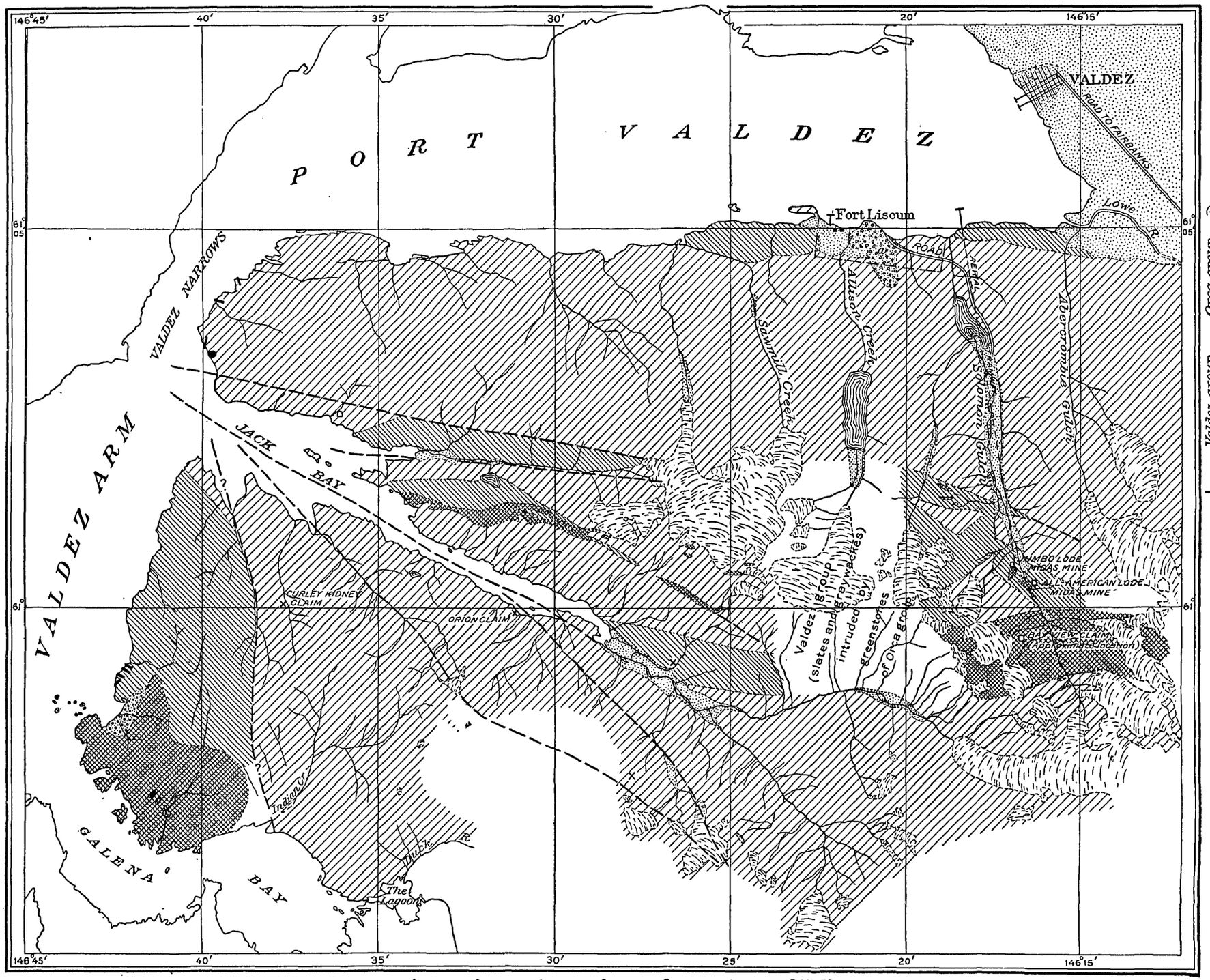
THE GRAYWACKES.

The graywackes and argillites cover a much larger portion of the area considered in this report than any of the other formations. They cover the entire portion of the Jack Bay district south of Jack Bay except for the small areas of slate and greenstone along Valdez Arm,

[1] Schrader, F. C., A reconnaissance of a part of Prince William Sound and the Copper River district, Alaska in 1898: U. S. Geol. Survey Twentieth Ann. Rept., p. 7, pp. 404–417, 1900.

Schrader, F. C., and Spencer, A. C., The geology and mineral resources of a portion of the Copper River district, Alaska: U. S. Geol. Survey special publication, pp. 32–40, 1901.

Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: U. S. Geol. Survey Bull. 443, pp. 11, 20–33, 51–52, 1910.



EXPLANATION

- Gravels, sands, and silts (a, landslide debris) — QUATERNARY
- Intrusive granite — MESOZOIC OR TERTIARY
- Basic dikes (Southern group of Orca age) — MESOZOIC OR TERTIARY
- Orca group: Conglomerates — MESOZOIC OR TERTIARY
- UNCONFORMITY (?)
- Orca group: Greenstones — MESOZOIC OR TERTIARY
- UNCONFORMITY
- Valdez group: Graywackes — MESOZOIC (?)
- Valdez group: Slates — MESOZOIC (?)
- Fault
- Copper mine or copper prospect
- Gold quartz prospect

GEOLOGIC SKETCH MAP OF JACK BAY AND VICINITY.

most of the northern part of this district, and much of the central portion between the two arms of Jack Bay and around the head of Solomon Gulch. The rocks grade from fine conglomeratic graywackes in a few places through gray to dark-gray coarse-grained graywackes containing feldspathic material to the darker fine-grained argillites and slates. The formation is largely made up of graywacke, but the proportion of the other types of rocks differs widely. The area south of the south arm of Jack Bay contains very little argillite and slate, but these two types are very abundant in the graywacke series between the two arms of Jack Bay and are quite abundant in the northern part of the district and along the middle section of the Solomon Gulch valley. The graywackes in most places are well bedded, and the thickness of individual beds ranges from a few inches to many feet. Most of the rocks are rather fine grained and are composed of subangular fragments of quartz and plagioclase feldspar, comparatively little decomposed, in a carbonaceous, calcareous, and argillaceous matrix. At one place in the mountains between the arms of Jack Bay a rather coarse grained graywacke contained numerous flat fragments of a mottled light-greenish chlorite schist. Locally the graywackes adjacent to the igneous intrusions and also at some other places have been slightly altered to a reddish-brown biotite-bearing graywacke.

BLACK SLATES.

The black slates are best developed along the east coast of Valdez Arm between Jack and Galena bays, along the north side of the streams draining into the heads of both arms of Jack Bay, and near the Midas mine on Solomon Gulch. The slates are dark-gray to black, very fine grained rocks and in many places have exceptionally well-developed slaty cleavage. A small amount of interbedded graywacke and argillite occurs in this formation. Many of the areas that contain slate have been intruded by the greenstones of the Orca group, and the slates adjacent to these intrusions have been altered to rocks resembling hornstones and charts or to knotenschiefer. The knotenschiefer are especially prominent at the head of Solomon Gulch. Many of the smaller greenstone intrusives in the slates in some of the disturbed areas have become schistose, their schistosity paralleling the cleavage of the slates. Some of the areas of slate in the vicinity of the greenstone intrusives have been mineralized.

AGE OF THE VALDEZ GROUP.

The age of sedimentary rocks here assigned to the Valdez group is not definitely known. The present determination of a probable Mesozoic age for these rocks rests upon the unsatisfactory evidence of one fossil, a worm tube, *Terebellina palachei* Ulrich, which was

found in 1917 in the massive graywacke series on the south side of Jack Bay. Similar tubes have been found by Grant in the black slates just north of the entrance to Galena Bay. These fossils are not diagnostic and serve only to determine the possible age of the containing rocks within wide limits. The present knowledge of this fossil appears to indicate a post-Triassic and probably Mesozoic age for it and for the containing rocks.

ROCKS OF THE ORCA GROUP.

LITHOLOGIC SUBDIVISIONS.

The Orca group includes both sedimentary and igneous rocks and consists of a thick series of basic lava flows, many basic intrusive bodies genetically related to the extrusives, and contemporaneous sediments. The intrusive phases of the igneous rocks are more abundant than the extrusive in this area, although the latter type are represented, to a certain extent at least, in the greenstone area just north of the entrance to Galena Bay. All these igneous rocks are now largely altered to greenstones. No Orca sediments other than the conglomerates have been recognized. These conglomerates, which lie above the greenstone and contain pebbles derived from it, are tentatively placed in the Orca group. The presence of the greenstone pebbles in the conglomerate can not positively be construed as indicating an unconformity between the lavas and the conglomerate, for the flows may have been partly subaerial, erupted contemporaneously with the deposition of the conglomerate, and the greenstone boulders and pebbles may have been obtained from those portions of the flows exposed above sea level or near enough to sea level to suffer erosion.

GREENSTONES.

All the igneous rocks of this area are in this preliminary report grouped under the general term "greenstones." These greenstones and their schistose equivalents, the green schists, are the derivatives of basic igneous rocks of both intrusive and extrusive types. They comprise flows, dikes, sills, bosses, and some large irregular intrusive masses. These basic rocks in many parts of this area intruded the graywackes and slates of the Valdez group, showing a marked preference for the slates. In the southwestern part of the Jack Bay district and in the adjacent Ellamar district they broke through the crust and flowed out over the surface of the sedimentary rocks.

The largest single mass of greenstone lying within the area covered by this report crosses the head of Solomon Gulch a short distance above the Midas mine. This mass is known to extend in an east and west direction from the crest of the divide between the Solomon Gulch and Jack Bay drainage far up on the eastern slope of the valley

of Solomon Gulch, and it probably extends beyond the area mapped for a considerable distance. Its width at the bottom of Solomon Gulch is 1 mile. Many sills of greenstone lie parallel to the contact in the slates and graywackes along the southern border of this mass.

A small part of the immense greenstone area of the Ellamar district extends into the southwestern part of this area just north of the mouth of Galena Bay. It is surrounded on the north and northeast by slates and is partly overlain on the west by a small area of conglomerate.. Inclusions of black slate occur in this greenstone along its western shore southwest of the conglomerate area. Ellipsoidal flow structures are visible in places on the western slope of this mass and also along the shore. Several basic dikes and sills, probably of the same age as the main body of the greenstone, cut the slates on the eastern shore of Valdez Arm just north of this large greenstone mass.

A long, narrow mass of greenstone 3 miles in length, of irregular width and only one-fourth mile wide in its widest place, has intruded the slates and graywackes in the western part of the mountains between the arms of Jack Bay. It contains many inclusions of the country rock, some of which are slightly mineralized. Numerous sills and dikes occur in the mountains a little farther east.

A small boss of greenstone about 1,000 feet in diameter lies in the slates just south of the Jumbo lode of the Midas mine. Near the All-American lode, also on the same property, sills and dikes, and some small irregular masses of greenstone are intrusive into the slate and argillite country rock and are well exposed in the canyon of Solomon Gulch to the west of that ore body.

The greenstones are all fine grained. The textures include aphanitic, finely porphyritic, diabasic, and schistose. Diabasic textures were observed in the dikes, in the sills, and in some of the larger masses. Some of the dikes have aphanitic contacts and dense, fine-grained, or finely porphyritic centers. The color of the greenstones ranges from light greenish gray to dark green. The fine-grained dike rocks are nearly black and in some places have lighter purplish-gray contacts. The schistose greenstones of the large area at the head of Solomon Gulch are dark green. In some places the original structure and texture have been completely masked by the schistosity developed by the shearing of the greenstones by later movements, so that the rocks in many places now appear as light-green bands of chlorite schist. This schistosity often occurs in sills and dikes in the slates.

The greenstones are slightly mineralized in some places. Chalcopyrite, pyrrhotite, pyrite, ankerite, and quartz were noted. The outcrops of these mineralized greenstones are usually rusty.

CONGLOMERATES.

The largest exposure of conglomerate at present considered as of Orca age in the Jack Bay district lies along the eastern side of a small cove in the east side of Valdez Arm, about 1 mile north of Galena Bay. The only other occurrence of conglomerate of this age within this district is near by on a small island, one of the outer islands of the group at the north side of the entrance to Galena Bay and about a mile west of the first-mentioned locality. The large exposure along the eastern shore of the cove north of Galena Bay is about 1 mile in length and has a maximum width, near its southern end, of three-tenths of a mile. The conglomerate rests in a marked depression within the arms of the older slates and graywackes and the greenstones of the Orca group and lies on the western slope of the large greenstone mass forming the hills to the southeast. It is best exposed along the shore of the cove. The vertical bluff at the south end of the cove decreases in elevation and slope northward to a low, gently sloping outcrop at the north end of the bay. The general tone of the rock is a dark bluish gray, and it resembles in many ways an indurated dark-colored till.

The conglomerate near the southern end of the bluff is a massive coarse-grained heterogeneous mixture with no sign of bedding. There are abundant angular to subangular boulders of all sizes, the largest of which are several feet in diameter. Most of the boulders, however, are small and less than a foot in diameter. They consist chiefly of greenstone, graywacke, slate, and argillite. A few small, exceptionally well rounded pebbles of siliceous argillite are found. The greenstone boulders appear most abundantly in the lower part of the southern end of the bluff. To the northward the conglomerate is finer grained, and a few thin lenticular beds of graywacke 1 to 4 inches thick, which strike N. 30°–45° E. and dip 12°–25° W., appear in the conglomerate. The pebbles in the conglomerate at the north end of the bluff are mostly 1 to 2 inches in diameter, although in places larger boulders occur.

Except for the greenstone boulders, which weather a light yellowish brown, the pebbles, boulders, and matrix are all dark. The matrix of the conglomerate is predominantly argillaceous.

AGE OF THE ORCA GROUP.

No definite evidence is available regarding the age of the Orca rocks of this area. The greenstones intrude the Mesozoic (?) rocks of the Valdez group, so that it can be said that they are post-Valdez in age, but further than this no definite statements can be made, and it can only be stated that the volcanic activity took place either in the Jurassic or in some later period of the Mesozoic or Tertiary.

There is no paleontologic evidence available as to the age of the conglomerates. From lithologic and stratigraphic evidence they appear to be younger than the greenstones and may possibly be separated from them by an unconformity.

QUATERNARY DEPOSITS.

The Quaternary deposits, which were laid down by water and ice during an epoch of glaciation that has not yet closed are the youngest sediments of the district. The area has experienced intense glacial erosion, and most of the material eroded was carried by the ice far beyond the confines of the district. The Quaternary deposits consequently cover relatively small areas and rest unconformably on the glacial abraded surfaces of the igneous and consolidated sedimentary rocks of the district. They consist of unconsolidated material. The materials of these deposits were derived largely by the erosion of local glaciers from the bedrock of the area and consist dominantly of graywacke, argillite, slate, conglomerate, and greenstone. A small percentage of foreign material, however, is included, as is indicated by the presence of boulders of granitic and dioritic character on the eastern shore of Valdez Arm between Jack and Galena bays. No intrusions of the character of these boulders are known in place in the Jack Bay or Port Valdez districts.

The unconsolidated Quaternary sediments consist of glacial deposits; the gravel, sand, and silt deposits of the present glacial streams; small marine sand spits, short, narrow, barrier beaches, and little beaches filling the smaller indentations in the shore line; alluvial fans; and rather inconspicuous accumulations of talus.

A thin, patchy mantle or veneer of glacial till—a heterogeneous mixture of boulders and pebbles in a fine, compact sticky blue clay—covers the lower-lying parts of the district, and low bluffs of till a few feet in elevation front the shore in places on Halibut Point and the shore to the west and south.

The fluvioglacial deposits were laid down by anastomosing and aggrading overloaded glacial streams from valley glaciers, and their deposition in front of the retreating ice tongues is still in progress. They consist of washed boulders, pebbles, gravels, sand, and silt, derived from the graywacke, argillite, greenstones, and conglomerate bedrock, and occupy long, narrow, glacially excavated rock basins, as on Solomon Gulch and on the main creek flowing into the head of the north arm of Jack Bay, or they form outwash delta plains which fill the heads of both arms of Jack Bay.

On the geologic map (Pl. III, p. 158) only the larger fluvioglacial areas of Jack Bay and Solomon Gulch, the few small alluvial fans which occur at the mouths of some of the streams discharging into Jack Bay, and a sand spit in the southwestern part of the district,

near Galena Bay, are indicated by the Quaternary pattern. The glacial deposits, as they are too small and patchy to completely mask the underlying bedrock, are not mapped.

MINERAL RESOURCES.

GENERAL FEATURES.

The mineral resources of the Jack Bay district and those portions of the adjacent Port Valdez district covered by this report consist of lode deposits which contain copper, gold, and silver. In the following discussions of the relations of the ore deposits, two types of ores, copper-bearing sulphide ores and gold quartz ores, are recognized. At present only the copper ores are mined, but all the valuable metals mentioned are obtained from them. The copper ore of the Midas mine, the only productive property of the area under consideration, contains in addition to its copper content considerable amounts of gold and silver. No facilities are available locally for the smelting of these base ores, and the copper ore from the Midas mine, in the past, after being hand-sorted, has been shipped, for further treatment and for the recovery of its valuable contents, to the smelter of the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), at Anyox, British Columbia, and to the smelter of the Tacoma Smelting Co., at Tacoma, Wash. But few gold-bearing quartz veins have been discovered, and none of those yet found have been of sufficient present or prospective value to justify extensive development work on them. Some of the quartz veins contain chalcopyrite, the valuable copper mineral in the copper-bearing sulphide ores, but the amount present in these quartz veins is very small, and it is of no value as a source of copper.

The first mineral location in this area was made in 1901 by H. E. Ellis, when he staked what is now known as the All-American lode of the Midas. A little development work was done on this lode in 1905. The following year the Jumbo lode of the Midas property was located. This lode received considerable attention under different owners in 1911, 1912, and 1913. In October, 1913, the present owners of the Midas, the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), purchased the property and have brought it to its present position as an important copper producer of the Prince William Sound region. As a result of the gold quartz boom in the Port Valdez district in 1910 and 1911, the adjacent Jack Bay district received considerable attention. Few discoveries of gold quartz veins were made, however, in this rather barren-looking district, and little development work was done on the lodes found. Some slightly mineralized copper showings were staked on which short tunnels were driven, but the general belief that this portion of Prince William

Sound was underlain by auriferous rocks of the Valdez group appears to have hindered the search for copper lodes and the development of the known copper deposits.

At present the Midas mine is the only property that is actively and continuously worked, and assessment work is being done on only a few other properties.

The area considered in this report lies entirely within the Valdez recording district, the recording office of which is at Valdez.

GEOGRAPHIC DISTRIBUTION OF THE ORE DEPOSITS.

The Jack Bay district and that portion of the Port Valdez district covered by this report lie between the Port Valdez gold quartz district on the north and the Ellamar copper district on the south and immediately adjoin both districts. Both copper-bearing sulphide deposits and gold quartz veins occur in this area. The copper mineralization is restricted to two small areas, one of which lies between the two arms of Jack Bay and the other surrounds the upper end of Solomon Gulch and extends into the adjacent valleys. Copper deposits of proved economic value have thus far been found only within the Solomon Gulch area. The gold-bearing quartz veins lie mostly to the south of the south arm of Jack Bay, although a small vein was observed in the broad slate band north of the head of this arm.

The mineralization has a known vertical range of at least 2,500 feet, extending from sea level in the Orion quartz claim and the copper prospect on the north shore of the south arm of Jack Bay to the Bayview copper prospect nearly 2,000 feet above sea level on Solomon Gulch and the gold quartz veins south of Jack Bay at an elevation of about 2,500 feet. Both gold and copper prospects occur at intermediate levels. The Midas mine is at an elevation of about 800 feet.

The only regularly producing property within the area discussed in this report is the Midas mine of the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), near the head of Solomon Gulch. No shipments of ore are known to have been made either to smelters or to custom mills from any of the gold or copper prospects of this area.

GEOLOGIC RELATIONS OF THE ORE DEPOSITS.

The copper deposits are closely associated with masses of intrusive greenstone. They occur either in shear zones in the greenstones or in near-by sedimentary rocks, or else as mineralized inclusions of sedimentary rocks in the greenstones. They furthermore appear to favor the black slates and argillites rather than the graywackes. In the adjacent Ellamar district the black slates include some impure dark limestones, and it is not improbable that some as yet unrecog-

nized dark limestones may likewise occur in the black slate series of this area and in the Midas mine much of the sulphide impregnation and replacement may be the result of the action of sheared calcareous sediments upon the mineralizing solutions.

The gold quartz deposits occupy simple fissures. Most of them are in the folded and faulted massive graywacke series south of the south arm of Jack Bay, but one occupies a fissure that cuts the broad band of black slates on the north side of the head of that arm of Jack Bay. Three of the quartz veins measured strike nearly north and south. The other two had strikes of N. 40° E. and N. 75° W. The dips range from 60° to vertical. The veins are narrow, not exceeding 3 feet. The character of the country rock appears to have had little if any chemical effect upon the deposition of the few gold quartz lodes of the district. The country rock of the veins, however, has been somewhat affected by the mineralizing solutions and now in some places is impregnated with pyrite.

The mineralogy of both types of ore is simple; the minerals are few and are common to most of the properties of that type. Two small mineralized shear zones on Solomon Gulch, however, in addition to the minerals usually found in the copper deposits, contain chalmersite, $CuFe_2S_3$, a rare copper-iron sulphide that carries about 23.5 per cent of copper, which has not yet been observed in the other copper-bearing ores of this area.

The economically important copper-bearing mineral is chalcopyrite. Gold and silver both occur in the copper ores and also in the gold quartz veins. The gold is probably native. In the gold quartz veins the silver is alloyed with the gold. The combination in which the silver occurs in the copper ores is not known.

The original metallic minerals of the copper ores are chalcopyrite, chalmersite, pyrrhotite, pyrite, sphalerite, arsenopyrite, galena, gold, and silver. The nonmetallic minerals associated with these minerals in the copper ores are quartz and calcite. In the gold quartz veins arsenopyrite, pyrrhotite, pyrite, gold, and silver are the ore minerals, and quartz was the only gangue mineral noted. Limonite occurs in the weathered outcrops of both gold and copper deposits but most abundantly on those of the copper deposits.

In all the mineral deposits of this area which were examined the primary sulphides are exposed at or very near the surface, although the outcrops of the ore bodies have in places been slightly modified by the postglacial oxidation of the sulphides in the veins since the comparatively recent glaciation of this area.

GENESIS OF THE ORE DEPOSITS.

Two distinct periods of mineralization are now thought to exist in the Prince William Sound region, one in which gold quartz veins were formed in association with the intrusion of granites and the

other in which copper ores were deposited in connection with the intrusion of large greenstone masses. The Jack Bay district lies between one of the typical gold quartz districts of the Prince William Sound region, the Port Valdez district, and a typical copper district, the Ellamar district. In the adjacent Port Valdez district the gold-bearing quartz veins appear to be genetically related to small bosses of granite. In the Ellamar copper district on the south the copper deposits are associated with greenstones and are probably genetically related to them. In the Ellamar district, also, there are a few gold-bearing quartz veins which appear to have the same relations to the greenstones as the copper deposits and which were probably formed during the same period of mineralization as the copper deposits and by solutions from the same source. In the Jack Bay district and in those parts of the Port Valdez district considered here the copper deposits are associated with greenstones and the mineralizing solutions which deposited the copper deposits appear to have been genetically related to these basic intrusive rocks. The few quartz veins may likewise owe their origin to these same mineralizing solutions or they may be of the same age and origin as the gold quartz veins of the Port Valdez district. The evidence at hand is not conclusive.

SUGGESTIONS FOR PROSPECTING.

The possibility of finding gold quartz lodes of economic importance in the future in this area appears slight. Though the area is much fissured and a few of these fissures are known to be filled with slightly mineralized quartz, the small granite bosses and acidic dikes with which the gold-bearing quartz veins of this region are usually associated are lacking. Several of these bosses and dikes occur in the adjacent Port Valdez gold district, however, and some of the mineralizing solutions which formed the gold lodes of that district may possibly have traveled far enough along the many fissures of the region to enter and fill some of the numerous fractures of the Jack Bay area.

The chances for copper prospecting are better, although most of the area is underlain by massive graywackes which offer little if any inducement to the copper prospector. The most favorable situations in which to search for copper lodes would seem to be in the black slate and argillite areas, which are in the vicinity of masses of intrusive greenstones.

MINES AND PROSPECTS.

SOLOMON GULCH PROPERTIES.

MIDAS MINE.

The Midas copper mine, now the property of the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), of Canada, is on the west side of Solomon Gulch, about 4½ miles from Port Valdez, and at an elevation of about 800 feet above sea level. The property covers two separate ore deposits. The Jumbo lode, where the present extensive developments are being made, is on the west side of the valley near the head of the broad gravel flat which fills Solomon Basin and at the base of the high mountain ridge which forms the west wall of the valley of Solomon Gulch. The All-American lode is about half a mile upstream from this locality and in the middle of the valley bottom just above the head of the gravel flat. The nearest available standing timber is about 4½ miles away, near the lower end of Solomon Gulch.

The All-American lode was originally located by H. E. Ellis as "King Solomon's Copper Mines Nos. 1 and 2" in 1901. It was later located by C. G. Debney and relocated in 1904 by him as the All-American Nos. 1 and 2. In 1905 an option on the claims was given to B. D. Brown and P. J. L. Parker, and in the summer of that year a shaft and crosscut totaling 150 feet were driven by them on this group. The Jumbo lode was located in 1906 by Mary G. Debney. In 1911 J. A. Carson procured an option on the property and later assigned it to A. E. Grigsby and T. J. Devinney, who transferred their interests to the Midas Copper Co. in July, 1912. Some development work was done in 1911 and 1912, and about 100 tons of copper ore was shipped to the Tacoma smelter in 1912. The Midas Copper Co. bonded the property to the Alaska Development & Mineral Co. from September 21, 1912, to June 27, 1913. Considerable underground work was done by this company before the property was turned back to the owners. In October, 1913, the Midas Copper Co. sold the property to the present owners, the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), of Canada, who started development work the following spring. The first shipment of ore under the present ownership was made in August, 1916, and the mine has been an important shipper ever since. A maximum force of 130 men were employed during the construction of the tram line. The average force employed on the property in 1917 was 50 men.

The principal method of transportation of supplies between the Midas mine and the wharf is an 80-bucket Riblet tram line, 5¼ miles in length. The erection of the tram line was started in May, 1914. Work on it was discontinued on September 1, 1914, as a result of

the European war and was not started again until the following April. The tram line was first put in operation in August, 1915, and has been operated much of the time since. The tram line is driven by a 35-horsepower 220-volt two-phase General Electric motor, current for which is furnished by the local electric-light plant on Solomon Gulch.

All passenger travel between the mine and the camp on the shore is over the trail to the foot of the reservoir and then either over the wagon road to the shore near Fort Liscum or over one of two trails to the wharf.

Surface improvements on the property include a wagon road from the shore of Port Valdez to the mine; an aerial tram, 5¼ miles in length, from the bay to the mine; a wharf and 3,000-ton storage bins at the coast terminal of the tram; several buildings on the shore near the wharf; ore bunkers, blacksmith shop, cook and bunk house, five cottages, sheds, and an air-compressor building at the mine. A 200-horsepower Diesel engine was installed at the mine in 1916 and furnishes all the power needed at the mine at present. This engine is used to drive a 160-horsepower Imperial-type Ingersoll-Rand air compressor and a 54-kilowatt 125-volt direct-current generator, which furnishes light for the camp buildings and the mine and power for the sorting belt and various small machinery.

The underground developments on the principal ore body, the Jumbo lode, total nearly 4,000 feet in length and consist chiefly of four tunnels, 500 to 900 feet in length, driven largely in the ore-bearing zone; several raises; stopes between the three lower tunnels; and an inclined winze with a dip of 60°, which starts in No. 2 tunnel and extends to a depth of 100 feet. The vertical interval between the lowest and highest tunnel is 290 feet. Considerable open-cut work and stripping has also been done on the east side of the valley in an attempt to trace the eastward extension of this lode. On the All-American lode there are some shallow shafts and open cuts. The underground work on this group, which was done in 1905, is said to total about 150 feet.

The Jumbo and All-American lodes lie within a broad band, composed dominantly of black slates, which has been intruded at several places by small bosses, sills, and dikes of greenstone. Interbedded with the black slates are also argillites, cherts, graywackes, and quartzites. Schistose phases of these rocks have resulted from the extensive deformation to which they have been subjected. This slate band crosses Solomon Gulch in a general southeasterly direction, but the individual strikes of the bedding recorded at different places range from S. 70° E. to S. 83° E. The dips of the beds are from 40° to 67° N. This slate band appears to grade upward rather abruptly to the northeast into a graywacke series, the individual beds of gray-

wacke ranging from a few inches to more than 20 feet in thickness. On the southwest the slate band is apparently faulted against the massive heavy-bedded graywackes of the peak southwest of the mine. A large boss of greenstone crops out within the slate band on the west side of Solomon Gulch, immediately south of the Jumbo lode. Numerous sills, dikes, and lenses of greenstone are exposed along both sides of the canyon just west of the All-American workings.

The present developments show two apparently distinct ore bodies—the Jumbo lode on the west side of the valley, where the present extensive developments are being made, and the All-American lode about half a mile upstream from this locality, in the middle of the valley bottom. Both deposits occur in mineralized shear zones. The Jumbo lead has been traced for over 800 feet into the hill by the tunnels. On the surface the highest showing of ore is about 650 feet above the lower tunnel. The general strike of the crushed zone appears to be a little north of east, but the strikes of individual shears within the major shear zone range from N. 75° W. to S. 62° W. and the dips range from 40° to 70° N. The lead splits in the two lower adits, the branches having strikes of N. 75° W. and S. 65° W. The width of the ore-bearing shear underground ranges from a few inches to 20 feet, but the average width of ore is between 3 and 4 feet. An overthrust fault occurs in the graywackes along the probable extension of the Jumbo lead to the southwest and may be the continuation of the Jumbo break. The All-American lode appears as a sulphide-impregnated shear zone in the sedimentary rocks on the north side of the greenstone intrusions which are exposed in the canyon near by. The ore body strikes a little south of east and dips 60° N. The mineralized zone is wider than the Jumbo lode, and the ore in this zone is said to be of lower grade than that in the developed ore body of the Jumbo. The outcrop of the All-American lode as exposed by the open cuts has a width of about 25 feet.

The ores are partly replacements and impregnations of the crushed country rocks and partly the result of cementation of small fractures by the ore minerals. The sulphide minerals present are pyrite, chalcopyrite, pyrrhotite, and sphalerite. Abundant beds of fine-grained pyrite are found in places. A little quartz is associated with the sulphides, and in the driving of the lower tunnel on the Jumbo lode lenses of quartz which had a maximum thickness of 1 foot were encountered. Sulphide-bearing quartz stringers are also reported to occur along the footwall of the shear zone on this lode. Gold and silver are reported in assays of the ores, but neither metal has been observed in specimens. Some limonite has resulted from the surficial oxidation of the iron-bearing sulphides, and malachite stains from the carbonation of the chalcopyrite.

BAYVIEW CLAIM.

The Bayview copper claim has been staked recently on a mineralized zone in the large greenstone area that crosses the head of Solomon Gulch. The claim is on the west side of Solomon Gulch, near the foot of a hanging glacier at an elevation of about 2,500 feet and about 1½ miles south of the Midas mine.

OTHER COPPER DEPOSITS ON SOLOMON GULCH.

Small sulphide lenses that carry chalcopyrite and chalmersite occur in short, narrow shear zones in the graywackes and slates along the southern contact of the large intrusive greenstone mass at the head of Solomon Gulch. These mineralized shears were found in similar places on both sides of the valley. The mineralization is too slight to be of economic importance but is of scientific interest as furnishing the only occurrence as yet known of the rare copper mineral chalmersite ($CuFe_2S_3$) in the Port Valdez or Jack Bay districts. Other minerals present in these small shears are chalcopyrite, quartz, and limonite.

JACK BAY PROPERTIES.

COPPER PROSPECTS ON JACK BAY.

A tunnel about 40 feet in length has been driven at an elevation of 600 feet on the north side of the north arm of Jack Bay to the northeast of the large island between the two arms of Jack Bay. The country rock is a fine-grained bedded graywacke. The tunnel is driven on a shear zone that strikes N. 10° E. and dips 70° W. The tunnel is driven at the foot of a bluff at the lower exposed end of the shear, which shows in the face of the bluff above the tunnel for about 50 feet with a width of 2 to 4 feet. The walls of the shear are free and well defined and have a thin gouge in some places. The filling of the shear zone is not very badly sheared, and the shear is only slightly mineralized. The sulphides present in the ore are arsenopyrite, chalcopyrite, pyrrhotite, sphalerite, and galena. Quartz, calcite, and the crushed and altered country rock are the nonmetallic components of the ore. Some of the quartz occurs as small stringers. Limonite is present in the weathered ore.

A small mass of greenstone intrudes the sedimentary rocks on the north side of the south arm of Jack Bay about 1 mile east of the tip of the point between the two arms of the bay. Many inclusions of the slate and argillite country rock are contained in this greenstone, and these inclusions are slightly metamorphosed and mineralized. The mineralization, however, everywhere appears very much too slight for the mineralized rock to constitute a possible ore body. These mineralized inclusions have been located as copper prospects,

and in one of the larger inclusions a tunnel 25 feet in length and with a 25-foot approach has been driven a few feet above high tide. Pyrite, pyrrhotite, chalcopyrite, sphalerite, and a very little quartz are recognizable in the mineralized rock at this locality.

Some mineralization appears in the sedimentary rocks along the northern contact of the intrusive greenstone mass on the crest of the divide between the two arms of Jack Bay, but this mineralization seems slight. Apparently, too, it has not attracted prospectors, as no evidence of development work was seen on any of the rusty croppings.

Slightly mineralized float—iron-stained metamorphosed slates that carry specks of chalcopyrite and pyrrhotite—was found in creek wash from the broad area of slate along the north side of the flat at the head of the south fork of Jack Bay. Heavily mineralized float that carries chalcopyrite and galena is said to have been found on Friday Creek. The lead from which this float came has not been located, and it is not known whether this lead outcrops within the valley of Friday Creek or whether the float was carried into that valley from the eastern portions of the Jack Bay district by the glaciers.

GOLD QUARTZ PROSPECTS.

Curly Kidney prospect.—The Curly Kidney claim was located by E. Rohrbach in 1910 in the valley of a small unnamed creek flowing into Jack Bay from the south about 2 miles east of the entrance. A 25-foot tunnel has been driven on the west bank of the creek at an elevation of about 600 feet above sea level, and some stripping has been done in the canyon a little farther upstream. The country rock is dominantly graywacke accompanied by a little argillite. The tunnel is driven in a southerly direction on a shear zone 2 to 4 feet in width, which strikes S. 5° E. and dips about 80° E. This shear is very slightly mineralized. There is a small amount of quartz in very small stringers and a little pyrite both in the quartz and in the sheared material. The main showing on the property appears to be farther upstream in the bottom of the stream canyon at an elevation of 670 feet, on what is probably one of a system of closely linked shear zones. The strike of this shear zone is about north and south, the dip nearly vertical, and the width as exposed is from 2 to 10 feet and probably wider in places, where at present the shear is not fully exposed. This shear contains a few lenses and stringers of quartz which have a maximum thickness of 3 feet. These stringers and lenses are short, and most of them are only a few inches thick. In most of the shear no quartz is visible at all. Arsenopyrite was the only sulphide seen in the ore. Assays of the ore are reported by the owner to show gold in the quartz.

Orion claim.—The Orion claim is at sea level on the south side of the south arm of Jack Bay about 1½ miles from the head of the bay. The country rock is graywacke and a little argillite. About 75 feet of underground work has been done on the claim on a curving lead that outcrops on the shore. This lead is traceable about 25 feet across the beach and for about 50 feet in the tunnel. The outer end strikes N. 6° W. and dips 70° W. From 1 to 10 inches of quartz is visible in the lead, and this in places shows secondary banding parallel to well-defined walls. Arsenopyrite, pyrrhotite, and quartz were the only minerals observed in the ore.

Other gold quartz prospects.—A well-defined quartz vein, 6 inches to 3 feet in thickness, was observed at an elevation of 2,500 feet in the west wall of a small cirque the drainage from which is tributary from the south to the stream that enters the head of the south fork of Jack Bay, about 1½ miles east of the head of the bay. The vein strikes N. 40° E. and dips 60° W., crosscutting the bedding of massive fine-grained graywackes, and is traceable several hundred feet by local outcrops. The walls break free. The lead does not appear to be very well mineralized. Quartz, arsenopyrite, and limonite were the only minerals seen in the ore. The presence of traces of gold, however, is reported to have been shown by assays. The quartz shows secondary banding parallel to the walls in some places.

A smaller quartz vein, only a few inches wide but traceable for a considerable distance, crops out near the divide on the side of the ridge that fronts on Galena Bay.

A small quartz vein 2 inches thick cuts the thick black slate series on the north side of the flat at the head of the south fork of Jack Bay. The vein crops out in the west wall of the canyon of a stream at an elevation of 100 feet and at a distance of 1¼ miles from the head of the bay. The bedding and cleavage of the slates here strike S. 75° E. and dip 60° N. The vein strikes north and dips 55° W. Chalcopyrite and pyrrhotite were the only metallic minerals observed in the ore.

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MINING IN CENTRAL AND NORTHERN KENAI PENINSULA.

By BERTRAND L. JOHNSON.

INTRODUCTION.

The mineral production of central and northern Kenai Peninsula comes entirely from gold quartz lodes and placers. Very little gold quartz mining was in progress during 1917, and placer operations were restricted to a few streams.

GOLD QUARTZ MINING.

The producing gold lodes in 1917 were in the Moose Pass district, on Porcupine Creek, and in the Hope district. The Kenai Alaska, one of the large producers of former years, did not operate; both the mine and the mill were closed down. In the Moose Pass district a small mill, operated by water power, was installed on the Ronan & James property on Summit Creek, and several tons of ore were milled. The installation of this mill was started June 15, and all operations ceased on the property for the year on October 26. Underground operations consisted in the driving of 100 feet of tunnel and the removal of the ore, which was later milled. Surface improvements also included the erection of an aerial tramway between the mine and the mill. Present underground developments on the property consist of a 137-foot crosscut to the lead, a 210-foot drift on the vein, an 85-foot raise to the surface at the point where the lead was struck, and a 30-foot shaft on the outcrop of the ore body.

On the Gilpatrick property, in Moose Pass, two men were at work, and some ore was milled in an arrastre which had been erected in previous years on this property.

On the Columbia and Ophir claims, also in the Moose Pass district, only 12 feet of tunnel was driven during the year, and the mill on this property was not operated. Only assessment work is reported on the Beatrice and Sampson claims.

On Porcupine Creek two or three men were said to have been at work on the Bluebell and Primrose claims in 1917, and a few tons of ore are reported to have been mined and milled at the small mills on this creek.

Some underground work was done on a gold lode property on Grant Lake, and the ore mined was milled in the arrastre on this property.

The mill on the Lucky Strike property on Palmer Creek, near Hope, was operated from July 1 to October 1, one shift a day. The mine also was operated from June 1 to October 1.

GOLD PLACER OPERATIONS.

Placer operations were in progress on Resurrection, Crow, Mills, Winner, Canyon, Cooper, and Stetson creeks. Large mining operations were in progress only on Resurrection and Crow creeks.

On Resurrection Creek several hydraulic outfits are said to have been operating. The Mathison Mining Co. operated from June 6 to September 18 with a crew of nine men. E. E. Carson hydraulicked stream gravels from May 10 to July 2 with a crew of two men. The Pearsons and the St. Louis Mining & Milling Co. are also reported to have worked, but no data are available regarding their operations. Practically all these placer camps suffered greater or less damage during a heavy rain and wind storm which passed over the Kenai Peninsula early in September, 1917.

A large crew was at work on the Crow Creek placer property during the summer, and considerable work was done. This property is said to have suffered extensively also in the September storm. On Winner Creek, a tributary of Glacier Creek, Axel Lindblad operated from June 1 to September 28.

On Mills Creek Robert Michaelson worked alone throughout the year, driving a tunnel, now 96 feet in length, in an old channel of Mills Creek. Fred Matz, on this same creek, groundsluiced on his placer claim from June 1 to October 1.

The Dunfranwald Gold Mines carried on extensive development work near the junction of Canyon Creek and East Fork preparatory to actual mining operations. This work is said to have consisted of the construction of ditches, dams, and flumes. Some development work was also done on the Lynx Creek gravels.

The major operation on Canyon Creek was at the property of the Kenai Peninsula Placer Mines, where the installation of a hydraulic plant is said to have been completed in September. The crew employed at this property during the season comprised 30 to 40 men, and they were engaged in opening up bench gravels on the left limit of the creek.

Small hydraulic operations are reported on Cooper and Stetson creeks. The property of the Kenai Mining & Milling Co. at the mouth of Cooper Creek was not in operation.

Two men were at work on the Getchell claims on Gulch Creek, mining the old creek channel gravels by hydraulic methods.