

## **MINING ON PRINCE WILLIAM SOUND.**

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By **BERTRAND L. JOHNSON.**

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### **GENERAL FEATURES.**

The lode-mining districts of Prince William Sound may in a general way be grouped into two concentric belts, concave southward, the outer one including the gold quartz districts and the inner one including the copper camps. The copper mines produce also large amounts of gold or silver, or both; and the gold mines produce also some silver. The ores of the gold quartz districts are free milling. The copper ores are smelted at Tacoma, Wash., and their content of valuable metals is recovered during this process. The metallurgic treatment of the gold quartz ores is performed locally in small stamp or roller mills, with amalgamation; the concentrates are shipped to the Tacoma smelter. A much larger tonnage of copper ore than of gold quartz ore is mined and treated, and the total value of the metals produced from the copper ores is about five times that obtained from the gold quartz ores. The only placer deposits in the region are gold placers, and these are found only in the gold quartz districts and have been little developed.

The productive mines of the Prince William Sound region in 1914 included two copper mines and eight gold mines. Most of the gold mines were in the Port Valdez district. Besides these properties, a prospect on Knight Island made a small shipment of copper ore to Tacoma, and the Golden Eagle stamp mill, at Golden, is said to have been in operation a few days in the fall.

### **COPPER MINING.**

#### **GENERAL CONDITIONS.**

Copper mining and prospecting in the Prince William Sound region was curtailed somewhat in 1914 compared with the previous year, chiefly owing to the low price of copper. The Beatson Copper Co. and the Ellamar Mining Co. made regular shipments as usual, but the other properties which in previous years had shipped copper ore to the smelters in the United States were either idle or had only a little development work done on them, except that a small

shipment of ore is reported from one property on Knight Island. Development work was done on a few of the nonproducing prospects, and assessment work on many others. All the copper ore shipped consisted of crude sulphide ore in which the copper-bearing mineral was chalcopyrite. So far as known the ores all went to the Tacoma smelter. Extensive preparations were made by the Granby Consolidated Mining, Smelting & Power Co. (Ltd.) to put the Midas mine, on Solomon Gulch in the Port Valdez district, on a producing basis, but the European war caused a cessation of all development work at that property late in the summer.

The producing copper properties on Prince William Sound appear to have been only slightly affected by the confusion in the financial and copper markets resulting from the war. An increased quantity of copper ore was mined in 1914, but the average grade of the ore mined was much lower than in the preceding year. The value of the metals recovered from these copper ores in 1914 was also less than in 1913. This decrease was due largely to the lower grade of the ore mined, although the lower price received for the copper content of the ores contributed slightly to the decline in the total value of the production. It appears probable that the future position of Prince William Sound as a copper producer depends on the successful treatment of the lower-grade copper ores by concentration or by a marked lowering of mining and metallurgic costs through some radical change from present methods, possibly the erection of a local smelter. The only change in either mining or metallurgic treatment of the copper ores of Prince William Sound that is known to have taken place in 1914 was the introduction at the Beatson-Bonanza mine, on Latouche Island, of a mechanical concentration process for the recovery of the valuable metals in the ore. Previous to this innovation hand-sorting only had been used at the producing properties of the region.

#### LATOCHE AND KNIGHT ISLANDS.

The Beatson Copper Co., operating the Beatson-Bonanza mine, on Latouche Island (Pl. VII, p. 138), continued to ship crude chalcopyrite ore to the Tacoma smelter. During the year a large plant for the concentration of the lower-grade ores, chiefly by a flotation process, was nearly completed at this mine. Development work at the mine was continued as usual by open cuts, tunnels, and drifts.

A few tons of copper ore is said to have been shipped from Knight Island to the Tacoma smelter by the Seattle Alaska Copper Co., which also reports driving 140 feet of tunnel in an ore zone 9 to 10 feet wide on its claims. The Blackbird group of the Latouche Copper Mining Co. was not operated in 1914. This property is said to be developed by a crosscut tunnel 736 feet long, a 280-foot drift on

the vein, a 242-foot raise to the surface, and several short drifts. The Knight Island Copper Mining Co. reports 25 feet of drifting, some open-cut work, and prospecting in 1914. Assessment work was done on the Una group, which is now developed by 65 feet of tunnel.

#### ELLAMAR DISTRICT.

The Ellamar Mining Co. operated its mine and plant throughout the year, making regular shipments of crude sulphide ore to the Tacoma smelter. The entire sulphide body is now being mined as ore, and the mine is a large producer of both copper and gold, with smaller amounts of silver. The underground development work in 1914 lay between the 400-foot level and the surface, and some raises, drifts, and crosscuts were run in the slate country rock. The filling system is used, the change to this system having been made in 1913. A maximum force of 72 men was employed on the property during the year. This was reduced to 60 men in October. A station for loading ore on large steamers was erected on the bar at the entrance to Virgin Bay, and an aerial tramway with several towers was installed, connecting this station with the mine buildings. An illustrated description of this new tram line has recently been published.<sup>1</sup> New 1,200-ton ore bunkers were in process of erection in the fall, close to the old ore bunkers at the landward end of the wharf.

No ore shipments were made from any of the Landlocked Bay properties. Two men were at work on the Montezuma claim of the Threeman Mining Co., and ore is reported to have been found on both the Montezuma and the old Alaska Commercial Co. claims. The Landlock Bay Copper Mining Co. had two or three men engaged in development work, and a little development work was also done on the property of the Hemple Copper Mining Co. in the spring. No mining was done in 1914 at the Standard property. At Galena Bay the claims of the Galena Bay Mining Co., at the head of Vesuvius Valley, were surveyed for patent.

#### PORT VALDEZ DISTRICT.

The developments and ore deposit at the Midas mine, the property of the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), and the only copper property in the Port Valdez district, are described in a preliminary report on that district (pp. 140-188).

#### PORT FIDALGO.

Development work is reported on two of the Port Fidalgo copper properties (Pl. VII). On the Dickey Copper Co.'s ground (formerly

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<sup>1</sup> Aerial ship-loading system at Ellamar, Alaska: Eng. and Min. Jour., vol. 99, pp. 230, 249, 1915.

the Mason and Gleason claims) three men were engaged in development work, and ore is said to have been found during the year on a new lower level. The Fidalgo Mining Co. made no shipments in 1914. Development work was actively prosecuted in the early part of the year, but the working force was decreased to two men early in the spring, and no work was done after June 1. The developments since the writer visited the property in 1913 consist of stopping operations between the two levels and between the upper level and the surface, the extension of the main tunnel to a length of 650 feet, and the opening of a 20-foot raise between the main level and the overlying ore shoot. A new ore shoot was also encountered about 600 feet from the portal of the main tunnel.

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

Assessment work was done on several properties on Unakwik Inlet, Wells Bay, and Glacier Island. New copper prospects are reported to have been discovered in the vicinity of Wells and Long bays.

### GOLD MINING.

#### GENERAL CONDITIONS.

Both gold quartz lodes and gold placers occur within the Prince William Sound region, but the placer deposits are few, small, and spotted and have been worked only intermittently and on a small scale. The annual placer production is probably only a few hundred dollars. The interest in gold quartz mining in 1914 centered in the Port Valdez, Tiekel, and Port Wells districts, as in the preceding year. The mining developments in the Port Valdez district are discussed in the preliminary report on that district (pp. 140-188). In the Tiekel district considerable development work is reported on several prospects. No data are available as to developments on gold quartz prospects along the Prince William Sound shore of Kenai Peninsula and in the McKinley Lake district. A short trip was made in the fall of 1914 to the Port Wells district, and the data then obtained are given here.

#### PORT WELLS DISTRICT.

##### GENERAL FEATURES.

The distribution, geologic relations, characteristics, and economic features of the gold deposits of the Port Wells district, together with the developments up to and including 1913, were briefly described in a recent report.<sup>1</sup> Since that report was written the Port

<sup>1</sup> Johnson, B. L., Mining on Prince William Sound: U. S. Geol. Survey Bull. 592, pp. 237-243, 1914.

Wells district has increased considerably in importance as a gold quartz camp. Two mills were erected in 1914, one of which was in operation the greater part of the year. The Granite mine, formerly known as the Tatum property, is now the most productive property in the Port Wells district and has become, since the closing of the Cliff mine at Valdez, the largest producer among the gold quartz mines of the Prince William Sound region. Considerable underground development work was done in 1914 on a few properties, and assessment work was done on many claims. A few new discoveries have been made, principally on the west side of Port Wells between Portage Bay and the Granite mine. Business at Golden is said to have been a little slacker than in 1913 but to have lasted longer. In the fall of 1914 there was reported to be a permanent population of about 150 men in the district. Transportation facilities have improved, and several ocean steamers touched in the Port Wells district during the summer. Regular mail and passenger service was also maintained between Valdez and several points on Port Wells. The only post office in the district is at Golden.

The following notes regarding recent developments on the several prospects are grouped by separate fiords and bays, so far as possible. With the exception of the Granite mine none of the properties in the district were visited in 1914, but the data presented were procured from what are believed to be reliable sources. There are many other prospects in this district on which assessment or development work may have been done, but no data are available regarding them.

#### AVERY RIVER.

A milling plant consisting of a rock crusher and a single-stamp Moyle mill having a capacity of 3 tons in 24 hours was erected on the Consolidated claim, on Avery River, in 1914. The mill was run intermittently during the season and several tons of ore was milled.

The property is developed by two shafts, 61 and 21 feet deep. Ten feet of work is reported to have been done on the Avery River property of the Sweepstake Mining Co. in 1914.

#### GOLDEN AND VICINITY.

A few new discoveries have been reported in the vicinity of Golden, including a new lead in a new tunnel on the Nugget claim and a lead discovered by H. C. and H. R. Johnson. On the Golden Eagle claim a 5-stamp mill was erected close to the lagoon below the tunnels and is reported to have been in operation a few days in the fall. The mill is connected with the underground workings by a short aerial tram. Only a little underground work is reported. Fifteen men

are said to have been at work on this property in October. The arrastre erected on the Tolson & Stanton property in 1913 was not in operation during the year. Several feet of tunnel was driven on the Golden Wonder No. 9, and 90 feet of tunnel was driven on the Gold Queen prospect of Hanson, Gustafson & Berklund, and camps were established.

#### SHORE OF PORT WELLS BETWEEN HOBO BAY AND HARRISON LAGOON.

The present importance of the Granite mine justifies a rather extended description. It is situated on the west side of Port Wells, on an eastward-facing timbered slope bordering a small bight in the coast between Hobo Bay and Harrison Lagoon. The original discovery, at an elevation between 500 and 600 feet, is on the end line between the Port Wells No. 1 and the Port Wells No. 2 claims. A good road extends from the shore to the mine camp and workings.

The vein was discovered July 19, 1912, by M. L. Tatum and Jonathan Erving, and a shaft was sunk on the vein. A shipment of 5 tons of ore taken from this shaft is said to have been made in the following December. In 1913 the property was bonded to B. F. Millard, who later organized and incorporated the Granite Gold Mining Co., the present owner of the property. Development work was actively carried on in 1913 and 1914, and the property was raised to its present position as the largest producer among the gold quartz mines of the Prince William Sound region. The underground developments on August 22, 1913, included a 30-foot inclined shaft, a 170-foot crosscut tunnel with two drifts on the vein, 75 and 60 feet long, 150 feet from the mouth of the tunnel, and some surface stripping. On October 5, 1914, the underground workings consisted of the original 30-foot inclined shaft; a main level reached by a 170-foot crosscut tunnel, which cuts the vein 150 feet from the portal of the tunnel, with about 450 feet of additional crosscuts and drifts, about 250 feet of which are along the vein; an 85-foot raise extending upward from the main level toward the inclined shaft on the surface; a 154-foot raise from the main level to the surface; a 130-foot inclined shaft,  $7\frac{1}{2}$  by 11 feet, extending down from the main level; a 50-foot level, 44 feet vertically below the main level, with 330 feet of drifts along the vein; a station cut 70 feet vertically below this level, with a short crosscut to the lead, and stopes between the 50-foot level and the main level and between the main level and the surface.

The surface improvements on the property include a well-graded wagon road from the shore to the mine; mill buildings at an elevation of about 200 feet housing a 7-foot Chilean mill, a breaker, rolls, a No. 4 concentrator, and another concentrator, all driven by gasoline

engines; an aerial tram from the mill to the ore bunkers, near the mine workings; and several buildings. The entire plant and mine are electrically lighted. Machinery on the property includes an air compressor, hoist, triplex sinking pump, gasoline engines, and drills.

Milling operations are said to have started March 14, 1914, and the mill had been running continuously, except for clean-ups and a short stop in August for repairs, at the time the property was visited. The tailings from the mill are ponded. From 30 to 45 men were employed during the season. Two shifts were worked underground, and three shifts in the mill and power house.

The country rock of the ore body consists of interbedded slates, graywackes, and argillites cut by large masses of medium-grained biotite granite, hydrothermally altered near the veins to a light-gray to greenish-gray rock. The granite contacts are said to be irregular.

The developments suggest the presence of more than one lead on the property, but are not sufficiently advanced to prove it. The vein showing in the shaft occupies a fissure striking S. 75° W. and dipping 60° N. In the underground workings considerable variation in the strike and dip of the vein is noticeable in the several drifts. In 1913 observations seemed to show that the vein had a general strike between N. 50° W. and N. 70° W. and a dip of 43°–55° N., and it is reported to be offset in many places by small faults. The fissure ranges from 3 inches to 14 feet in width and averages perhaps from 3 to 3½ feet. The fissure filling varies with the character of the country rock. In the sedimentary rocks it consists of shattered slate, graywacke, and argillite, with quartz veins or a quartz network cementing the shattered rocks and inclosing angular fragments in a network of porous white crystalline quartz. In the granite the vein is stronger and better defined, although its widest part includes numerous shattered masses of altered granite cemented by gold-bearing quartz veinlets.

The original shaft was all in slate and graywacke. The lead now under development cuts both sediments and granite, but most of the development work has been in the granite. In the main level the hanging wall of the vein is granite. Between the main level and the 50-foot level the lead lies along the contact of the granite and the sedimentary rocks, and the shaft was sunk along the vein, which here had a dip of 45°. On this level everything in beyond the shaft is said to have granite on both walls, and below this level both shaft and vein are reported in granite but the dip of the vein has changed to 35° N. Between the 50-foot level and the next lower level several parallel quartz veins with a maximum width of 14 inches cut across the shaft toward the main vein. In the station and crosscut on the lower level some of these leads join the main vein, increasing its width to 4 feet.

There are good walls to the veins in the granite on the 50-foot level, but little gouge, although the quartz breaks free from the walls. The same is true in the crosscut on the lower level. In the lead in the original surface shaft gouge shows on both walls of the fissure.

The gangue minerals of the Granite mine ore include quartz, calcite, and a brownish-weathering carbonate. The metallic ore minerals are gold, pyrite, sphalerite, stibnite, galena, arsenopyrite, and chalcopyrite. In one specimen both light-colored and medium-colored gold were seen, so it is probable that the grade of the gold varies considerably in different parts of the vein. Stibnite is in places very closely associated with the richer gold ore. The sulphides are not particularly abundant in the ore, forming, according to report, but 2 per cent by weight of it.

A new lead is said to have been discovered in 1914 about 700 feet from the Granite mine, on the contact of the same granite intrusion.

#### MISCELLANEOUS LOCALITIES IN THE PORT WELLS DISTRICT.

Considerable development work is reported on the prospect of Everson, Gauthier & Cooper, on Hobo Bay. The crosscut tunnel is said to have been lengthened to 172 feet, the lead crosscut, and some drifting done on the lead. Surface strippings are said to expose the lead for about 1,500 feet. The prospect is reported by the owners to be developed by a 25-foot shaft and 300 feet of drifts.

On the Mineral King claim of Hermann & Eaton about 90 feet of drifting is reported to have been done on the lead on the 100-foot level between November, 1913, and March 1, 1914, and the developments are now said to include a 110-foot inclined shaft and 150 feet of drifts on the 100-foot level. The tunnel on the Yakima ledge is said to have been extended to 50 feet.

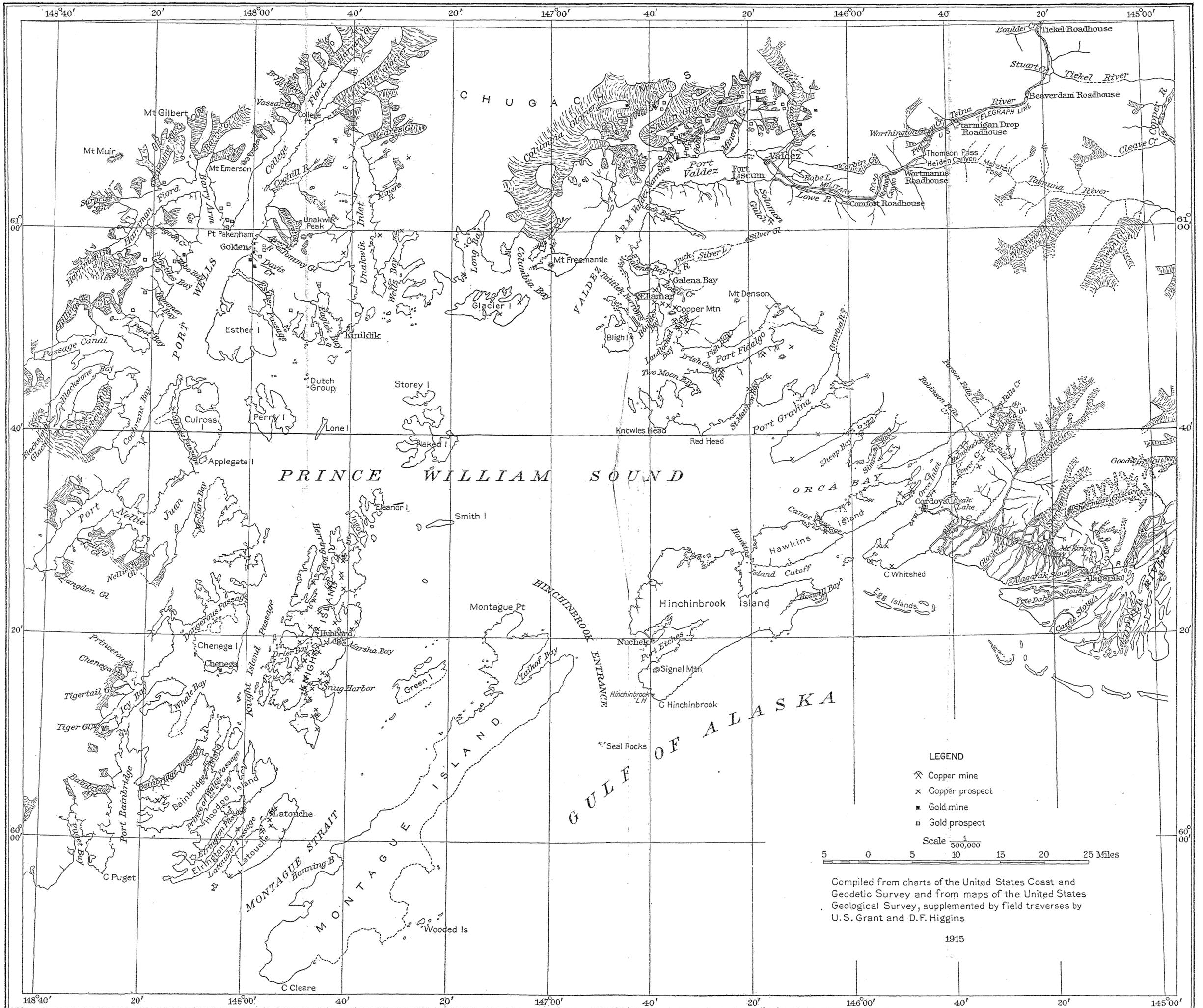
The developments on the Tomboy group, on Pigot Bay, now include a 40-foot adit and a 20-foot winze on the vein on the Tomboy No. 2, and a 35-foot tunnel on Tomboy No. 3, on a vein discovered in 1914. Twelve men were employed on the property until December 22, 1914. Several tons of ore from the new vein was milled in Valdez.

Several veins are said to have been discovered on different parts of Pigot Bay during the summer.

A gold quartz vein is reported to have been discovered on Passage Canal, late in the fall, by Guy Banta and Harvey Sullivan.

The Hummer Bay prospect of Everson, Harris & Parker is said to be developed by two tunnels, 30 and 138 feet long, and by a 15-foot shaft.

Assessment work only is reported on the Barry Arm prospects.



MAP OF PRINCE WILLIAM SOUND, SHOWING MINERAL RESOURCES.

On the Black & Hogan claims, on Harriman Fiord, the Tar Flat group, 250 feet of tunnels and two shallow shafts are said to have been driven on the vein at an elevation of about 100 feet above sea level. Ten feet of underground work is reported to have been done on the Harriman Fiord property of the Sweepstake Mining Co.

The Eldorado claims of White & Pedersen on Eaglek Bay were under development by the Alaska-Washington Gold Mining Co., and at the close of 1914 the total length of drifts and crosscuts was reported to be 375 feet.

Two new discoveries of gold quartz were made on the east side of Eaglek Bay, thus extending the known gold-bearing area of the Port Wells district a little farther eastward.

The Thomas-Culross Mining Co. did considerable development work on the Bugaboo and Chelan claims on Thomas Bay, Culross Island, during the first 10 months of 1914. The developments now include a 140-foot crosscut tunnel to the fissure, a 175-foot drift on the vein from this crosscut tunnel, and a 28-foot vertical shaft sunk on the vein. All this work except the crosscut tunnel was done in 1914. A shipment of several tons of ore from these workings was made to the smelter.

# THE GOLD AND COPPER DEPOSITS OF THE PORT VALDEZ DISTRICT.

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 Port Valdez district (Pl. VIII, p. 186). A brief presentation of the geographic factors bearing on the economic development of the mineral deposits of the district precedes a discussion of the geology. The general description of the mineral deposits is followed by detailed descriptions of many of the ore bodies.

Detailed geologic mapping was begun in the Port Valdez district in 1914 by the writer, assisted by G. L. Harrington. Mr. Harrington also assisted in the preparation of this report, which is only preliminary. A more complete account of the geology and mineral resources will be prepared when the final mapping and studies have been completed.

## GEOGRAPHY.

The Port Valdez district lies in the northeastern part of the Prince William Sound region and comprises the area immediately tributary to Port Valdez. (See Pl. VIII.)

The district is one of strong relief. The mountains inclosing the fiord rise abruptly from sea level and in parts of the district attain elevations of 4,000 feet within a mile of the coast. The main range, which has a maximum elevation of 6,970 feet, lies north of Port Valdez. A well-defined but less rugged range, with peaks from 2,000 to 5,425 feet above sea level, forms the mountainous spur south of Port Valdez. The continuity of the main range is broken only by the high pass (4,800 feet) occupied by the Valdez Glacier. A few lower passes, 2,000 to 2,500 feet above sea level, cross the spur range between Port Valdez and Columbia Glacier.

The entire Port Valdez district has been intensely glaciated in recent times, and, as in other districts of alpine glaciation, two distinct types of topography have resulted—one shaped by frost action above

the surface of the glaciers, with sharp peaks, cirques, and narrow, steep-walled, comblike ridges, and the other with the rounded features of an area overridden and smoothed beneath glacial ice. The characteristic sharp, angular forms developed by high-level erosion appear at elevations above 4,000 feet. Practically all of the district below this elevation is characterized by the rounded summits, slopes, and U-shaped valleys produced by glacial abrasion.

In pleasing contrast to the rugged relief of most of the district are the broad, gravel-covered, timbered lowlands that border the head of Port Valdez. These plains, which slope gently seaward, all lie below an elevation of 250 feet above sea level. The Valdez and Mineral Creek plains have a slope of only 50 feet to the mile, and the gradient of the Lowe River flats is even less.

The glaciers that cover much of the area north of Port Valdez are, with the exception of Anderson Glacier, of the alpine type. Columbia Glacier, the largest in the Prince William Sound region, borders the northwestern part of the district. The long ice tongue of Valdez Glacier debouches on the gravel plain at the head of Port Valdez. Shoup Glacier discharges into Shoup Bay. Mineral Creek heads in a valley glacier, and numerous hanging glaciers occur in this and other valleys. Anderson Glacier caps the mountainous area between Sawmill and Shoup bays and occupies a pass between Shoup Bay and Columbia Glacier. South of Port Valdez only a few small glaciers remain.

The shore line is remarkably even. The shores are mostly steep, in places precipitous, and rocky, with a few small rock peninsulas and islands. The head of Port Valdez is fringed by a wide mud flat, and smaller flats adjoin the mouths of many of the streams. The otherwise even shore is dented by three small bays—Jack, Sawmill, and Shoup bays.

Most of the drainage of the district enters Port Valdez. The streams drain small areas, and are mostly short, and as they derive a considerable part of their water supply from melting snow and ice, the stream flow is subject to wide variations during the year.<sup>1</sup> Two power plants are in operation on Solomon Gulch, and some smaller plants are utilized during the summer. There are also some undeveloped water powers in the district.

### COMMERCIAL CONDITIONS.

Valdez, the supply point of the district, with a population of about 1,500, lies at the head of Port Valdez, which is open to navigation throughout the year. It is the coastal terminus of the Valdez-

<sup>1</sup> Ellsworth, C. E., and Davenport, R. W., Preliminary report on a water-power reconnaissance in south-central Alaska: U. S. Geol. Survey Bull. 592, pp. 178-179, 1914.

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. Valdez can be reached in six days by steamer from Seattle. Two companies operate steamers to Valdez, giving a service in summer of eight times a month and in winter of four to six times a month. Freight charges from Seattle to Valdez (1915) vary from \$3 to \$40 a ton according to classification. Transportation for passengers (1915) costs \$45 for first class and \$25 for second class.

Valdez is provided with wharves, banks, 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. Gasoline in 1914 cost 45 cents a gallon in 10-gallon cases, and British Columbia coal retailed at \$12.50 a ton delivered. The town has in the past been subjected to occasional disastrous floods of the streams from Valdez Glacier, but it is now protected by a dike built in 1913-14.

On the south side of Port Valdez wharves have been built at Solomon Gulch, forming the coastal terminal for the aerial tram of the Midas mine, and at Fort Liscum, an army post. Wharves have also been built at the mouth of Mineral Creek and at the Cliff mine. A wagon road has been built from the Mineral Creek wharf to a point 5 miles up Mineral Creek, and one up Solomon Gulch to the Midas mine. The other properties have been connected with tide-water by trails, some of which traverse the glaciers.

Transportation along the coast is effected largely by the use of gasoline launches, some of which give a regular service to the Port Wells district. Launches can be chartered at a cost of \$10 to \$30 a day. Wages in the district are about \$3 to \$4 a day and board. At the height of the mining season in summer it is not always possible to obtain the services of experienced lode miners, though there are a number of them in the district.

The climate of the Port Valdez district is somewhat colder and drier than that of neighboring districts on Prince William Sound, which are more directly exposed to the influence of the Pacific Ocean. Records at Valdez show a total annual precipitation of about 56 inches; at Fort Liscum, on the south side of the bay, it is 74 inches. The average annual snowfall is about 30 feet. The average temperature for the three summer months is about 52° F. and for the three winter months about 21° F. At higher elevations the climate is more severe. The steep slopes and heavy snowfall lead to numerous snowslides, and this is one of the elements the miner has to contend with in winter work in the district.

Timber is scarce in the Valdez district, but there is some in the Lowe River valley and at Sawmill Bay. Trees 5 feet in diameter

may be found, but the average size is very much smaller. Spruce and hemlock predominate, although on the Valdez and Lowe River flats cottonwoods are more abundant. The upper limit of timber is irregular, extending from sea level to 1,500 feet. Timber is also obtainable from Port Fidalgo, 20 miles to the south. The local timber is suitable for mine workings and rough lumber, but the better grades of lumber are brought from Seattle. The Port Valdez district is included in the Chugach National Forest.

In the lowlands, which are not extensive, there is some good grass, but most of the horse feed is brought from Seattle. Small local gardens supply the hardier vegetables and these, with fish and small game, are the only local sources of food supply.

To summarize the commercial conditions: Equipment and supplies can be landed at tidewater on Port Valdez at no great cost. Transportation to inland properties, however, is usually rather expensive. Fuel is costly, but other supplies are comparatively cheap, and wages are not high. Timber, though not locally plentiful, can be brought from points near by. Underground operations can be carried on throughout the year, and mills can also be operated the entire year where a permanent water supply is available. Water-powers available throughout the year are not abundant.<sup>1</sup> The opening of the Bering River and Matanuska coal fields should give comparatively cheap fuel. The strong relief is favorable to the undercutting of lodes, where good evidence of their persistence at depth is shown, doing away with the necessity of pumping. Lodes located at tidewater, like that of the Cliff mine, necessitate the sinking of shafts and pumping of water.

## GEOLOGY.

### OUTLINE.

The Port Valdez district lies in the southern part of the Chugach Mountains, which so far as known consist of metamorphosed sedimentary rocks, chiefly slates, argillites, graywackes, and conglomerates with minor amounts of greenstones and limestones, altered in many places to schistose rocks by dynamic and contact metamorphism. The age of these rocks is unknown, but is probably either late Paleozoic or early Mesozoic. The intrusives which cut these sedimentary rocks are believed to be of Mesozoic and later age.

Earlier workers in this part of the Prince William Sound region and the Chugach Mountains have subdivided the rocks of this area

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<sup>1</sup> Ellsworth, C. E., and Davenport, R. W., op. cit., pp. 170-180.

into two great divisions—the Valdez and Orca groups.<sup>1</sup> The Valdez group was presumed to be the older and more metamorphosed and was described as consisting principally of slates and graywackes. These Valdez rocks were believed to be unconformably overlain by another great series of less altered sediments of similar lithologic types, named the Orca group. The Orca rocks consist of interbedded slates and graywackes with extensive greenstone flows and agglomerates as well as thick conglomerate beds. Granitic rocks were reported to intrude both Orca and Valdez groups.

The major part of the Port Valdez district as mapped by Grant and Higgins<sup>2</sup> lies within the Valdez group of these writers. The

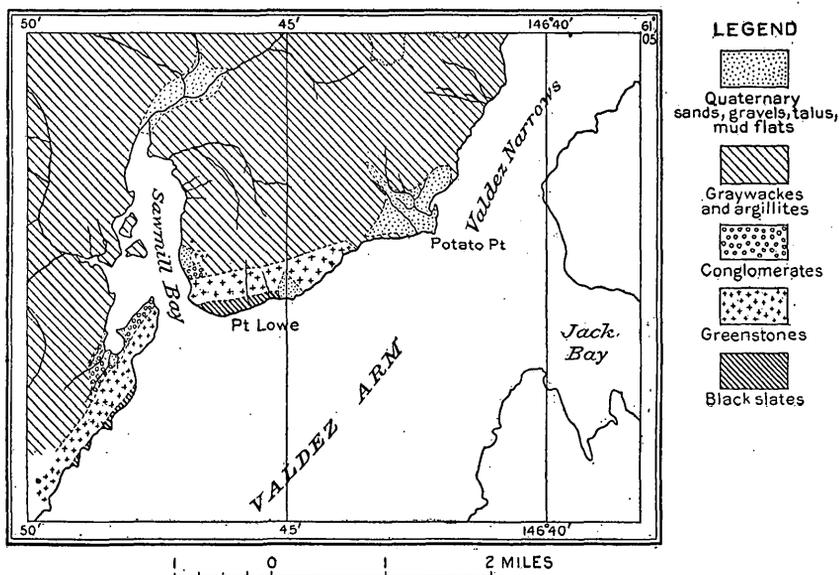


FIGURE 4.—Geologic sketch map of the vicinity of Sawmill Bay.

boundary of the Valdez and Orca groups is placed by them at the entrance to Valdez Narrows, and a large part of the area between this locality and Point Fremantle is mapped as the Orca.

The conclusions reached as a result of the 1914 field work are tentative, but the evidence collected suggests a stratigraphic succession markedly different from that outlined above. The geologic section as now understood appears comparatively simple and consists of

<sup>1</sup> 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., pt. 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 Pub., pp. 32-40, 53, 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. 20-33, 51-52, 1910.

<sup>2</sup> Idem, pl. 2.

slate, greenstone, conglomerate, graywacke, and argillite, deposited in the order named. No conclusive evidence was seen for the existence of an unconformity between any two of these formations. The Sawmill Bay area, although closely folded and faulted, was found to offer the best clue to the stratigraphic succession in this district, and the small geologic sketch map (fig. 4) shows the distribution of the formations in this vicinity. North of this area, however, the rocks have undergone greater dynamic metamorphism and present an intricately folded complex which, so far as the present field work shows, includes slightly altered as well as schistose types of all members of the stratigraphic succession named above. This complex borders the shores of Port Valdez and covers most of the district. Less deformed beds occur, however, in the extreme northeastern part of the district, in the valley occupied by Valdez Glacier. The use of the term "Valdez group" as at present commonly understood does not seem justified by recent work. This question will be discussed in full in the final report on this district.

#### SEDIMENTARY ROCKS.

The pre-Quaternary rocks are almost entirely of regionally metamorphosed types. The variety of sedimentary rocks is not great. Four lithologic subdivisions may be made—(1) black slates, (2) greenstones, (3) conglomerates, (4) graywackes and argillites. The stratigraphic sequence is apparently that in which they are mentioned here. Other metamorphic varieties are found which have resulted from the regional metamorphism of these units. Rocks altered by the contact metamorphism produced by granitic intrusions also occur within the district but cover only very small areas.

#### BLACK SLATES.

The black slates occupy an inconsiderable part of the area. The largest and most typical exposure is a strip lying east of the greenstone band at the mouth of Sawmill Bay. The slates are predominantly dark-gray to black, very fine grained rocks, with a well-developed slaty cleavage. This division, in contrast with the other sedimentary rock groups of the district, is characterized by a relatively small percentage of graywacke. Within the metamorphic complex that covers most of the Port Valdez district are small in-folded areas of these slates, locally in intimate association with sheared greenstones or green schists. Examples of these occurrences are to be seen on the east side of Valdez Glacier at the Rose Johnson property, on Mineral Creek below Brevier Creek, on the south side of Port Valdez near Jackson Point, on the west side of the Valdez

Narrows near the lighthouse, near the head of Clear Creek, on Twin Falls Creek, and between Anderson and Columbia glaciers. A slaty or schistose structure has been developed by dynamometamorphic processes in many of the other rock groups of the district, but rocks having this structure must be carefully distinguished from the typical black slates, which have distinct lithologic characters and considerable thickness. The belt at the mouth of Sawmill Bay is about 800 feet wide, and much larger exposures occur in the Ellamar district.

#### GREENSTONES AND GREEN SCHISTS.

The greenstones and green schists are derivatives of a series of basic lava flows, which locally display pillow structure. The maximum thickness of these rocks exposed within the Port Valdez district may be seen at the entrance to Sawmill Bay, where a steeply dipping band of greenstones 1,000 feet wide extends southwestward along the coast. Much smaller areas of greenstone occur in the west side of the Valdez Narrows, at the head of Solomon Gulch, between Anderson and Columbia glaciers, on Mineral Creek, within the valleys occupied by Valdez and Shoup glaciers, and on some of the northerly tributaries of Sawmill Bay. The least-altered greenstones are dark-greenish, heavy, fine to medium grained rocks, which on weathered surfaces have a characteristic brownish appearance when seen from a distance. Those at Solomon Gulch and Sawmill Bay are the least altered, and in the exposures at the mouth of Sawmill Bay the ellipsoidal structure is still evident. In other exposures, as on Shoup Bay, the west side of the Valdez Narrows, Mineral Creek, and in the Valdez Glacier drainage area, the original structure and texture have been almost completely masked by the later schistosity, so that the rocks now appear in many places as rather light green bands of chlorite schist or as thin chloritic bands complexly inter-sheared with black slates.

#### CONGLOMERATES.

The small area covered by the conglomerate in this district is not a clue to the stratigraphic significance of the formation, whose existence and situation are indicative of a pronounced change in conditions—a transition from the period of volcanic activity in which the basic lava flows occurred to the period of sedimentary deposition in which the thick graywacke and argillite series was laid down. The largest body of conglomerate is that lying above the greenstone on the peninsula at the entrance to Sawmill Bay, where it is 800 feet thick. This body is apparently continuous with the conglomerate area lying to the southwest, where scattered outcrops of conglomerate are visible over a width of about 1,500 feet, but it is questionable

whether the thickness exposed is the original thickness or whether there may not have been duplication of the beds through faulting. The contact of the conglomerate with the underlying greenstone is not exposed within the district, but because of the presence of numerous greenstone pebbles in the conglomerate, especially near the contact, the sequence may be safely assumed. This conglomerate has been tentatively correlated with a similar conglomerate at the entrance to Galena Bay, where the relations of the greenstone and conglomerate are more apparent. At that point the conglomerate "lies conformably upon the underlying greenstones, and although the conditions of sedimentation were greatly changed, coarser materials being carried into the sea and volcanic activity having ceased, it is believed that no time elapsed between the deposition of the greenstones and that of the conglomerate, but that deposition was continuous."<sup>1</sup> Other exposures of this conglomerate are on the east side of Sawmill Bay north of the greenstone, where its extent is limited by faulting, and on the Sawmill Bay and Cape Freemantle shore. Present indications also point to an exposure of conglomerate on the steep eastern slope of Point Lowe, but its stratigraphic relations are not definitely known.

In the type locality the texture of the conglomerate varies markedly. Near the greenstone contact there are many large boulders, but farther away the pebbles are much smaller. They are mainly angular to subangular in shape; few are well rounded. The pebbles consist of greenstones, graywacke, argillite, and slate. The matrix is usually a dark-gray fine to medium grained graywacke material closely resembling in appearance the overlying graywackes.

A few conglomerate boulders are found in the wash from Valdez Glacier. They are of essentially the same type of rock as those from the vicinity of Sawmill Bay. A small conglomerate boulder found in the beach gravel on the east side of Valdez Narrows appears much less metamorphosed than any conglomerates known in place in this district. It also differed from the other conglomerates in having a very light colored sandy matrix with numerous embedded rounded pebbles of black argillite. It seems doubtful at present if this boulder had its source within the Port Valdez district.

#### GRAYWACKES AND ARGILLITES.

The graywackes and argillites cover large areas within the Port Valdez district. They are especially well developed on Sawmill Bay and Valdez Narrows, on the south side of Port Valdez, and along the upper reaches of the Valdez Glacier. This graywacke and argil-

<sup>1</sup> Capps, S. R., and Johnson, B. L., The Ellamar district, Alaska: U. S. Geol. Survey Bull. 605, p. 42, 1915.

lite series covers a much larger area than any of the other sedimentary rock groups of the Port Valdez district. Its rocks grade from the conglomeratic graywackes at the bottom through gray to dark-gray coarse-grained graywackes containing feldspathic material, small slate fragments, and pebbles of older rocks of similar nature, to the darker, finer-grained argillites. The graywackes are the predominant members of the series. In places there are alternating beds of characteristic dark argillites and equally distinct graywacke, the individual beds being but a few inches thick. The contrasting colors of the argillites and graywackes in these occurrences give, at a little distance, a distinctly banded or ribbon-like appearance to the rock. Elsewhere the graywackes are in massive beds several hundred feet thick, with only an occasional thin bed of the argillite. The graywackes are composed of subangular fragments of quartz and plagioclase feldspar, comparatively little decomposed, and a few grains of epidote, in a carbonaceous, calcareous, and argillaceous matrix. Small fragments of earlier graywackes and cherts are also found in these graywackes.

#### QUATERNARY DEPOSITS.

The Quaternary deposits are the youngest sediments of the district. They consist of unconsolidated material resting unconformably on the glaciated surfaces of the metamorphic rocks and include glacial deposits, fluvioglacial deposits, the sands and gravels of the present nonglacial streams, lake deposits, beach deposits, talus cones and fans, and landslide material. These deposits have been formed by the erosion, principally glacial, of the metamorphic bedrock of the district and consist chiefly of graywacke and argillite, with minor amounts of slate, greenstone, green schist, aplite, and quartz. The district has been one of glacial erosion rather than of deposition, and the Quaternary deposits mask relatively small areas. Glacial till forms a thin patchy mantle over all the low-lying parts of the district. Fluvioglacial deposits have their best development in the united outwash plains of the Valdez Glacier streams and Lowe River, and glacially excavated rock basins filled with fluvioglacial gravels occur on Solomon Gulch and Mineral Creek. A concentric series of gravel terraces lies on the outer side of the big bend in Shoup Glacier between Shoup and Anderson glaciers. Landslide *débris* covers many acres between Solomon Gulch and Fort Lisicum.

#### STRUCTURE.

The structure of the Port Valdez district has not been worked out, but certain general statements may be made regarding its broader features. The stratigraphic succession as at present understood has

been given above, and the areal distribution of the different formations is due largely to their deformation since they were laid down. The least-deformed beds are at the entrance to Sawmill Bay, bordering the upper reaches of Valdez Glacier, and at the head of Solomon Gulch. The Valdez Glacier area lies north of the second glacial tributary to Valdez Glacier from the east. Here a thick succession of graywackes and argillites strike approximately east and dip rather gently to the north. At the head of Solomon Gulch the folding has exposed a large mass of greenstone beneath the overlying graywackes. At Sawmill Bay the entire sedimentary series has been closely folded and faulted. The beds strike N. 40°-70° E. and dip 70° N. to vertical. Over the rest of the Port Valdez district a marked uniformity in the strike and dip of bedding and schistosity prevails. The strikes are between S. 70° E. and N. 75° E. and the dips are from 45° to 80° N. Minor folds observed at several localities indicate that the monoclinical dips are the result of closely compressed folds overturned to the south. In the western part of the district some of these folds were observed with axes having a westward pitch.

Subsequent to the folding, but before the mineralization of the rocks, a set of fissures was developed in which the gold-bearing quartz was later deposited. These fissures trend between N. 25° W. and S. 50° W., but most of them lie between N. 55° W. and west. This set of fissures dip between 65° and 90°, mostly to the north and east. Pronounced jointing trending from N. 45° W. to N. 30° E. is noticeable along the shores of Port Valdez but does not seem to occur around the mouth of Sawmill Bay.

### INTRUSIVE IGNEOUS ROCKS.

#### GENERAL FEATURES.

Intrusive igneous rocks are not abundant in the Port Valdez district. A few small, widely scattered stocks or bosses of granitic rocks and a few dikes, of aplitic and diabasic types, are found. The relations of the diabasic dike rocks to the aplites and granites of the district are not known. The aplites and granites are probably genetically related to each other, and on the Giant Rocks, between the mouth of Mineral Creek and Valdez, a gradation can be seen from medium-grained granitic rocks to dense, finely porphyritic aplitic dikes.

These intrusives are the youngest pre-Quaternary rocks of the district and intrude both the unaltered and the schistose phases of the sedimentary rocks. Their age is not known, but the granites and related dike rocks are probably of the same age as the other granitic intrusives of the Prince William Sound region, which in recent years

have been tentatively assigned to the Mesozoic. The igneous intrusions of the Port Valdez district apparently took place after the major deformations of the country rocks. In certain places, however, as in the Valdez Narrows, these igneous rocks have suffered later shattering and faulting. The granitic and aplitic rocks were intruded previous to the mineralization of the district and in many places show the effects of the hydrothermal alteration caused by the mineralizing solutions. Quartz stringers, with some calcite, occur in some of the diabase dikes, and in one place calcite and pyrite were seen along fracture and shearing planes in one of these dikes. As there is reason to believe that there was but one general period of mineralization in this district, it appears possible that some of the diabasic dike rocks were intruded previous to the mineralization, and it may be that some of them are complementary offshoots of the granitic magma.

#### GRANITIC AND RELATED ROCKS.

The granitic and related rocks of the Port Valdez district occur in small stocks or dikes on the Giant Rocks, between the mouth of Mineral Creek and Valdez; on the north shore of Port Valdez just west of the mouth of Gold Creek; on the east side of the entrance to Valdez Narrows; at the head of Solomon Gulch; on Mineral Creek; and within the valley occupied by Shoup Glacier. Abundant float is also found on the west lateral moraine of Valdez Glacier, and a granitic intrusive is reported in the west end of the Gold King nunatak. The rocks are all of light-grayish to light-greenish color and have fine-grained, porphyritic, or aphanitic texture. Surficial alteration of the mineralized phases gives the rocks a brownish cast. These light-colored rocks are intrusive into the dark-gray, green, and black metamorphic rocks of the district, to which they offer a marked contrast.

A boss of granitic rock with aphanitic to slightly porphyritic offshoots, 4 to 20 feet thick, occurs on the Giant Rocks, between Valdez and Mineral Creek. The dikes are intruded parallel to the schistosity of the surrounding metamorphic rocks, which here strikes about east and dips  $55^{\circ}$  N. The laminæ of the schists have in places been deformed by the intrusion of the molten rock, and the dikes show series of lenses of igneous rock varying in width from a quarter of an inch to 4 feet, around which the laminæ of the schistose rocks bend. Locally the dikes are badly sheeted and jointed. A little contact metamorphism, developing biotite in some of the surrounding graywackes, has taken place but is not common. The intrusives are medium-grained, finely porphyritic to aphanitic rocks of a light-gray to greenish-gray color. They are composed largely of plagioclase feldspar, with minor amounts of orthoclase, quartz, apatite, sericite, and ferromagnesian minerals. Biotite and chlorite are abundant in

some parts of the rocks. Sulphide mineralization of the intrusions is indicated by the scattered rusty spots in the weathered rock. Quartz seams, slightly iron stained, lie along some of the joints in the granite. Small quartz veins also cut the adjoining metamorphosed graywackes. The medium-grained, uniform-textured phases of this granite are used in the local rock-drilling contests at Valdez.

A badly shattered aplitic dike or stock is exposed for 125 feet along the eastern shore of Valdez Narrows, near the outer entrance. The rock is a light-gray dense aplite composed chiefly of quartz and albite. Ferromagnesian minerals are scarce. Pyrrhotite and chalcopyrite occur as impregnations in the aplite. Assays show the presence of a trace of gold. The adjoining graywackes appear slightly metamorphosed by the intrusion. A rock of similar appearance, mineralized by pyrrhotite, occurs at the head of Solomon Gulch, near the Midas mine.

A fine-grained light greenish-gray aplite dike crops out on the north shore of Port Valdez west of the mouth of Gold Creek. It is intrusive into the sediments parallel to the schistosity, which has a strike of N. 88° E. and dips 56° N. The dike is 4 feet wide and is traceable for about 150 feet along the shore. The dike exposure is much weathered and shattered. Small quartz veins are abundant in the graywacke near the dike.

The diabasic intrusive rocks are not as abundant as those of the other types and have been found only in the southwestern part of the district, on both sides of Valdez Narrows and in the mountains to the west. The rocks are dark colored and consequently are not conspicuous. They are dense, finely porphyritic or fine-grained diabases, some of which weather dark brown. Their width varies from 1 foot to as much as 25 feet, although the smaller dikes are the most abundant. They are usually vertical or nearly so. In some localities the dikes are shattered and slightly faulted. One diabase dike in the Valdez Narrows is impregnated with pyrite.

## MINERAL RESOURCES.

### INTRODUCTION.

The mineral resources of the Port Valdez district comprise deposits of gold, silver, and copper. At present gold and silver are the only metals recovered from the ores, but recent developments indicate that the Midas mine, on Solomon Gulch, will soon become a copper producer. A shipment of several tons of copper ore is said to have been made from this property in 1912 or 1913. The gold now produced in the district comes chiefly from gold quartz lodes, although a small amount of placer gold is obtained each year. These

placer operations are intermittent and on a small scale, and the output is very small. The silver occurs alloyed with the native gold of both lodes and placers. The copper ore of the Midas mine also carries both gold and silver. The gold ores are free milling, but the copper ores must be melted. Some of the gold quartz lodes contain chalcopyrite, but the amount is small and it is of no value. The concentrates from the gold-milling plants have been in the past and are at present shipped to smelters.

In the following discussions of the relations of the ore deposits, two types of ores, gold quartz ores and copper-bearing sulphide ores, are recognized. There is reason for believing that in the Valdez district, as in the Ellamar district, both types of ore had a common origin in the mineralizing solutions and were deposited in the same epoch of metallization. Differences in physical and chemical conditions existing at the place of deposition of the ores are believed to account for the present diversity in the types of deposit, inasmuch as the mineral associations at both gold and copper deposits are practically identical, only the relative amounts of the different minerals in the ores varying.

Auriferous gravels were known to occur in the streams of the Port Valdez district many years before any workable gold-bearing quartz was discovered. By 1898 Schrader<sup>1</sup> reported that pay gravels had been found on several of the streams and that some work had been done on them. Quartz veins were staked as early as 1897 in some parts of the district, and in 1901 the Midas copper deposit, at the head of Solomon Gulch, was located by H. E. Ellis. Valdez was, however, for a number of years after its settlement looked upon merely as a starting point for the interior, and it was not until after the Cliff mine, which had been located in 1906, became productive in 1910 that the mineral possibilities of this region began to be realized. As Brooks has stated,<sup>2</sup> the success of the Cliff mine—

very greatly stimulated prospecting by local miners and attracted the attention of nonresidents, who quickly recognized the possibility of developing here a new auriferous lode district. As a result, several hundred lode claims were staked and considerable development work was undertaken during 1910 and 1911. These activities first centered in the region immediately adjacent to Port Valdez, but later both the eastern and western extension of what was believed to be an auriferous belt received attention. The search for auriferous lodes was carried westward to Columbia Glacier and later to Port Wells and eastward along the Valdez-Fairbanks road.

The Ellis Imperial had been located in 1909 by the discoverer of the Cliff. In 1910 the Ibex, Silver Gem, Gold King, Alice, Sealey-Davis, Millionaire, and Black Diamond claims and those of the

<sup>1</sup> 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., pt. 7, pp. 421-422, 1900.

<sup>2</sup> Brooks, A. H., Gold deposits near Valdez: U. S. Geol. Survey Bull. 520, p. 108, 1912.

Valdez Mining Co. were among those located. The next year (1911) some of the properties located were the Ramsay-Rutherford, Bald Mountain, Pinocle, Bessie Williams, Cameron-Johnson, Mountain King, Rambler, Big Four (on Mineral Creek), Mayfield, and Bunker Hill. The mining developments up to and including 1912 have been summarized by Brooks,<sup>1</sup> and those in 1913 by the writer.<sup>2</sup> Milling plants have been erected at properties on the east side of Valdez Glacier, on Mineral Creek, at the Cliff mine, on the west side of Shoup Glacier, and on a barren rocky island in Columbia Glacier, and a considerable output of gold now comes annually from these lodes. The extensive developments made on the Midas copper property by its present owners justify the assumption that it will soon not only add materially to the gold production of the Port Valdez district but also place the district among the copper-producing districts of Alaska.

In 1914 nine mills of various types were in operation in the Port Valdez district, and it is estimated that between 250 and 300 men were engaged in mining at one time or another during the year. The value of the total mineral production to January 1, 1915, has been about \$900,000.

The valuable metal content of the gold quartz thus far mined in the Port Valdez district has averaged about \$37 a ton. It has ranged from \$18 to \$85 in ores milled at the several prospects during an entire season, and still higher averages have been obtained on lots of a few tons sent to custom mills or smelters. The thickness of the veins thus far mined in this district has ranged from a few inches to more than 5 feet, but the average thickness of the ore bodies developed on producing properties appears to be between 1 and 2 feet. The greatest depth to which an ore body has been mined is about 500 feet, at the Cliff mine.

#### GEOGRAPHIC DISTRIBUTION OF ORE DEPOSITS.

The Port Valdez district is one of several scattered gold quartz districts on the mainland bordering Prince William Sound from McKinley Lake to Seward. These districts form a broad mineralized belt, concave southward, encircling the copper deposits of Prince William Sound, one of which (the Midas mine) is included within the Port Valdez district.

The area in which ore deposits have been found in the Port Valdez district lies in an east-west belt paralleling Port Valdez and extending from Columbia Glacier on the west to and beyond Valdez Glacier on

<sup>1</sup> Brooks, A. H., Gold deposits near Valdez: U. S. Geol. Survey Bull. 520, pp. 108-130, 1912; The mining industry in 1912: U. S. Geol. Survey Bull. 542, pp. 35-36, 1913.

<sup>2</sup> Johnson, B. L., Mining on Prince William Sound: U. S. Geol. Survey Bull. 592, pp. 237-239, 240, 1914.

the east, a distance of about 25 miles between the most easterly and most westerly known deposits. (See Pl. VIII.) Prospects have also been found in the vicinity of Thompson Pass and Ptarmigan Drop, 12 to 15 miles to the east, in what is apparently the eastward extension of the Port Valdez mineralized belt. Evidences of mineralization are also reported west of Columbia Glacier. The most northerly prospects within the area are those at the head of Mineral Creek, which are 8 miles from tidewater. The most southerly ore deposit is that of the Midas mine. The geologic limits of the gold-bearing area have not yet been definitely located. As Brooks<sup>1</sup> has shown, the inland limit of the occurrence of the ores seems to be determined by their accessibility, and the area outlined above and covered in this report "must in the light of present knowledge therefore be regarded as a topographic province in which ores have been found rather than as a geologic province within which the conditions for the occurrence of mineral deposits are more favorable than they are elsewhere." The actual limits of the mineralized area yet remain to be discovered, as it appears at present that they lie beyond the arbitrarily chosen limits of the Port Valdez district, which is only a part of a larger similarly mineralized geologic province.

Considerable prospecting has been done throughout the district, but as certain areas, such as the south side of Port Valdez, the area adjacent to Sawmill Bay, the lower part of Mineral Creek, and the upper reaches of Valdez Glacier, have shown little of promise, most of the development work has been confined to the area north of Port Valdez. Within that area there are several scattered areas in which promising ore bodies have been discovered. These are (1) on both sides of Valdez Glacier between Camicia Glacier and the next large eastern glacier tributary to Valdez Glacier; (2) the upper part of the Mineral Creek valley; (3) Shoup Bay and vicinity; and (4) the mountainous ridge between the upper reaches of Shoup and Columbia glaciers. To these should be added the area at the head of Solomon Gulch.

Gold-bearing quartz veins occur both north and south of Port Valdez, although, as pointed out above, those of economic importance thus far have been on the north of the bay. The only copper deposit occupies an isolated position near the head of Solomon Gulch on the south side of Port Valdez.

#### VERTICAL RANGE.

The known vertical range of mineralization is over 5,600 feet, extending from 300 feet below sea level in the Cliff mine to an elevation of 5,350 feet at the Big Four property on Mineral Creek. Gold

<sup>1</sup> Brooks, A. H., Gold deposits near Valdez: U. S. Geol. Survey Bull. 520, p. 119, 1912.

quartz deposits have been found throughout the vertical range of mineralization. The Midas mine is at an elevation of about 800 feet above sea level.

#### DISTRIBUTION OF PRODUCTIVE MINES.

The gold quartz producing properties all lie north of Port Valdez and Lowe River. The Gold King, the Cameron-Johnson, the mines at the head of Mineral Creek, and the Ramsay-Rutherford lie near the northern border. The Gold King is the westernmost producer, the Ramsay-Rutherford the easternmost, and the Cliff mine the southernmost. The Midas mine, a prospective producer of gold-copper ore, is south of Port Valdez. The Cliff mine, the earliest and largest producer of the district, is at sea level, but not all the producing properties are located on or near the coast. The Gold King, at an elevation of 3,750 feet on a nunatak in Columbia Glacier, is  $6\frac{1}{4}$  miles in an air line from tidewater. The Mineral Creek properties are over 7 miles from the bay and range in elevation from 300 to more than 5,000 feet above sea level. The Ramsay-Rutherford property, 8 miles from the coast, is at an elevation of about 3,500 feet. The Rose Johnson mill, on Valdez Glacier, 6 miles from Valdez, is at an elevation of 1,200 feet. The Midas ore will have to be transported  $4\frac{1}{2}$  miles from the mine to ocean-going steamers. These productive properties may be grouped as follows: Valdez Glacier valley, 2; Mineral Creek valley, 4; Shoup Bay and vicinity, including the Cliff mine, 2; Columbia Glacier valley, 1; Solomon Gulch, 1.

#### GEOLOGIC RELATIONS OF THE ORE DEPOSITS.

##### STRUCTURE.

The determination of the limits of the mineralization of the Port Valdez district is largely a structural problem. Both the gold quartz and the copper deposits occur only in the more intensely disturbed areas. The distribution of the gold quartz deposits appears to depend largely on the occurrence of the thick series of fractured graywacke and argillite which, as previously pointed out, overlies the greenstones and black slates of this district. The folded and faulted beds of this series cover a large part of the Port Valdez district, interspersed with small infolded bodies of the greenstones and black slates. The gold quartz deposits occupy fissures in this disturbed series and in the metamorphic complex of which it forms so large a part. Certain areas appear to have been more favorable to the deposition of the gold quartz ores than others. There appears to have been an area of this character on Valdez Glacier near the Ibex and Ramsay-Rutherford properties, where this brittle series fractured on

the upper limb of an overturned fold. The deposits on Mineral Creek, which have not yet been carefully studied, appear to occupy a somewhat similar situation. Another highly fractured mineralized belt extends from Shoup Bay westward through the Anderson Glacier pass.

The Midas copper deposit is in a shear zone that traverses a portion of the area in which all the rocks of the local geologic section—black slates, greenstones, and graywackes—are involved in the deformation.

The strikes of the greater majority of the ore-bearing fissures of the district lie within the 105° included between N. 25° W. and S. 50° W. Within this arc there is a little closer grouping between N. 55° W. and west. The dips range from 65° to 90° and are mostly to the north and east.

The fissures are as a rule narrow. Some are sharp, clean-cut, and filled with quartz. Others are shattered zones largely filled with fragments of the country rock between well-defined walls, with lenses or irregular networks of quartz cementing the fractures. In still others the filling is pulverized and shattered country rock with little or no quartz.

Some postmineral movement has occurred within the mineralized district, resulting in the shattering of some of the quartz and the slight faulting of some of the veins.

No marked changes are to be expected in depth either in the mineral association of the ores or in the value of the lodes as a whole. It appears probable that gold quartz veins are distributed throughout the rocks to considerable depths in much the manner and form shown by the present known ore deposits. The persistence of the general mineralization with depth, however, is no criterion as to the persistence of the mineralization in individual deposits. The vein matter is usually not continuous along either strike or dip, even in fissures that are traceable for long distances. The ore occurs in narrow shoots that are lenticular in both plan and section, and the distribution of the shoots within many of the fissures is very irregular. The average width of the ore shoots thus far mined is between 12 and 24 inches. Their length has varied, attaining a maximum perhaps in the Cliff mine, where the ore has been followed from a point 200 feet above sea level to a point 300 feet below.

#### RELATIONS TO COUNTRY ROCK OTHER THAN STRUCTURAL RELATIONS.

The character of the country rock appears to have had little if any chemical effect on the deposition of the gold-bearing quartz lodes of the district, which have the appearance of simple fissure fillings and show no evidence of chemical action. The country rock of these veins, however, is in places impregnated with pyrite and

arsenopyrite. The copper deposits are impregnations and replacements of sheared rocks. In the Midas mine the rocks most closely associated with the ore are the black slates. In the Ellamar district the black slates include some impure dark limestones, and it is not at all improbable that much of the sulphide impregnation and replacement evident at the Midas mine are the result of the action of the calcareous sediments involved in the shearing of the black slate and greenstone series upon the mineralizing solutions.

#### CHARACTER OF THE LODE ORES.

As pointed out previously the mineral association in both gold and copper deposits is practically the same, the relative proportions of the different minerals alone varying. Both types of ores are composed of primary minerals. Classified on the basis of the dominant valuable metals, the ores may be grouped into gold-silver and copper-gold-silver ores. From a metallurgist's point of view the ores are classifiable into free-milling gold ores and base smelting sulphide ores with a high copper content. This also agrees with a classification based on the predominant minerals, which in one kind of ores are native gold and quartz and in the other are the sulphides chalcopyrite, pyrite, and pyrrhotite.

The mineralogy of the ores is fairly simple. The economically important minerals are native gold and chalcopyrite, the former being the source of the gold and silver and the latter the source of the copper. Quartz is the dominant gangue mineral of the gold quartz ores; calcite and a brown-weathering light-colored carbonate occur in less abundance, and albite and chlorite are present in some of the ores. The gangue of the copper ores is the crushed and altered country rock, with a very small amount of quartz and carbonates. The metallic ore minerals comprise gold, silver, pyrite, and stibnite. Pyrite is the most common and universally distributed sulphide, with galena a close second. Sphalerite and chalcopyrite are the next most widely distributed minerals, and some of the ores contain pyrrhotite and arsenopyrite. Stibnite was noted in ore from the Gold King and the Silver Gem. Limonite is the most common alteration product from the oxidation of both gold and copper ores, but malachite staining was also noted at the Midas. Surficial alteration products of arsenopyrite and stibnite are usually visible on surface exposures of ores carrying those minerals. In the gold quartz ores the amount of sulphides present is usually small.

In most of the ore deposits of the district the primary sulphides of the ores are exposed at the surface, although the outcrops of the ore bodies have in many places been modified slightly by the postglacial oxidation of the sulphides in the veins, and in the more favorable

places a slight partial oxidation of the sulphides has taken place to depths of at least 100 feet. A part of the gold formerly contained in the eroded parts of the veins appears to have been left behind in the partly oxidized outcrops, which in places show marked surface enrichment.<sup>1</sup> Brooks has placed the thickness of this enriched zone as less than 20 feet.

#### GENESIS OF THE LODE ORE DEPOSITS.

Genetically classified the Port Valdez gold quartz lodes are fissure fillings of hydrothermal origin formed at moderate temperatures. The copper lodes are due to the impregnation and replacement of sheared sedimentary strata by hydrothermal solutions at moderate temperatures. The mineral association in the copper and gold quartz deposits is similar. This is true also of the other copper and gold districts of Prince William Sound, where a gradation from a gold quartz vein to a chalcopyrite-bearing shear zone has been noted. A common origin from the same mineralizing solutions is therefore assumed for the copper and gold quartz ores of the Port Valdez district. The evidence indicates but one period of mineralization. The ores were deposited later than the deformation of the sedimentary rocks of the area and the consequent development of the schistosity around Port Valdez. The mineralization was also later than the intrusion of the granitic and related igneous rocks of the area, inasmuch as the granites on the Giant Rocks, between Mineral Creek and Valdez, and the aplites of Solomon Gulch and Valdez Narrows were mineralized subsequent to their intrusion. A more definite determination of the age at which the mineralization took place is not obtainable from this district. The granitic intrusions of Prince William Sound and presumably those of the Port Valdez district also are probably of Mesozoic age. In most Alaskan metalliferous districts an intimate relation has been shown to exist between the ore deposits and intrusions of granitic character. In the Port Valdez district the presence of albite in the gold quartz veins indicates that the vein-forming waters had a magmatic source from granitic igneous rocks. These waters circulated subsequent to the granitic intrusions, to which, therefore, they were most probably genetically related. The ore deposits of the Port Valdez district, if these conclusions are justified, are all of Mesozoic age and belong in the late Mesozoic metallogenetic epoch of the Pacific coast.

#### GOLD PLACER DEPOSITS.

The unconsolidated deposits of the Port Valdez district, being derived from the erosion of an auriferous series of rocks, are slightly gold bearing, and colors of gold are reported in the gravels on

<sup>1</sup> Brooks, A. H., Gold deposits near Valdez: U. S. Geol. Survey Bull. 520, p. 129, 1912.

streams entering Shoup Bay, Mineral and Gold creeks, Solomon Gulch, and Lowe River. Small amounts of gold have been recovered by intermittent operations on these streams. The unconsolidated deposits cover a comparatively small part of the district and are predominantly of glacial and fluvioglacial origin. Morainic material, talus deposits, and outwash fans or deltas from aggrading glacial streams present in general decidedly unfavorable conditions for paying placer ground, although exceptional cases undoubtedly exist. The processes involved in the deposition of these materials are such as would tend to disseminate widely any contained gold. Most of the streams of the Port Valdez district are still aggrading glacial streams, and while their gravels are auriferous in places they are probably of low grade and the gold is widely disseminated. Very little postglacial erosion of these glacial and fluvioglacial materials, which would tend to concentrate their gold content, has taken place, except in a few scattered localities on Gold, Mineral, and McAllister creeks. Postglacial erosion of bedrock in box canyons is a possible source of a small amount of the gold on some of the creeks. No large areas of commercial placers are known within the district, and the general conditions appear unfavorable for large workable placer deposits.

#### MINES AND PROSPECTS.

##### GENERAL ORDER OF STATEMENT.

The mine and prospect descriptions are grouped by drainage areas so far as this is possible, and these areas are treated in geographic order from east to west. (See Pl. VIII.) The properties near Valdez Glacier, on the east, are described first, and the properties near Columbia Glacier, the westernmost in this district, are described last. The arrangement of treatment within a given area has no significance as to the relative importance of the separate mines or prospects, nor is the amount of space devoted to a prospect any measure of its economic value. All the prospects in the Port Valdez district have not yet been visited, but information about some of the properties not examined has been procured from reliable sources and is here included. Several properties which were not visited in 1913 or 1914, and regarding which no recent information is available, were described by Brooks<sup>1</sup> after a visit to the claims in 1911.

##### VALDEZ GLACIER AREA.

###### MINE OF RAMSAY-RUTHERFORD GOLD MINING CO.

The Ramsay-Rutherford property is about 8 miles in an air line northeast of Valdez, on the ridge east of Valdez Glacier, between

<sup>1</sup> Brooks, A. H., op. cit., pp. 122-123.

Camicia Glacier and the next higher large glacier tributary to Valdez Glacier from the east. It is far above timber line, at an elevation of about 3,500 feet, in the west wall of a cirque tributary from the south to the large Valdez Glacier tributary above mentioned. The property is reached from Valdez by way of Valdez Glacier to a point 4 miles from the foot of the glacier and thence over a well-marked trail which angles up the east wall of the Valdez Glacier valley to the cirque in which the mine is located. The distance from Valdez to the mine by the traveled route is about 10 miles. The present workings are on the Lost Hopes Nos. 1 and 2 claims. Development was in progress in 1912-1914, and in October, 1914, the underground workings comprised a 162-foot shaft, 300 feet of drifts, 190 feet of crosscuts, and stopes between the 50-foot level and the surface. A small shipment of ore is reported to have been made during 1912 or early in 1913. In September, 1913, the Ramsay-Rutherford Gold Mining Co. was formed, and in the spring and summer of 1914 a 7 by 9 inch Blake crusher, a 5-stamp mill, and a concentrator were installed in a mill building near the mine and the mine and mill were connected by short ground and aerial trams. The mill, air compressor, machine drills, and pump were operated by five gasoline engines. The plant was also electrically lighted during the operation of the mill. The stamps are reported to have dropped first on August 4, 1914. Milling operations stopped September 16, 1914, because the canvas water pipes supplying the mill froze. Besides the mill building a cookhouse and a bunk house were erected at the mine. A maximum of 27 men were employed during the operation of the mill. After the mill was shut down this force was decreased to 10 men, and during the winter of 1914-15 the mine force is said to have been reduced to 3 or 4.

The country rock, chiefly graywacke with a little argillite, strikes about east and dips  $75^{\circ}$  N. To the north the dips are gentler, and across the large tributary to Valdez Glacier north of the Ramsay-Rutherford property the graywackes appear to dip north at a low angle.

The ore bodies on the Ramsay-Rutherford property are fissure veins. On the 50-foot level the vein upon which the underground development work has been done ranges in width from 1 inch to 72 inches, in strike from  $S. 1^{\circ} E.$  to  $S. 25^{\circ} E.$ , and in dip from  $82^{\circ} E.$  to  $70^{\circ} W.$  On the 100-foot level the strike is  $S. 35^{\circ}-45^{\circ} E.$ , the dip is  $82^{\circ} E.$ , and a maximum width of 6 feet of quartz is exposed. The vein here varies in width from  $1\frac{1}{4}$  to 5 feet, with an average width of  $2\frac{1}{2}$  to 3 feet. This lead is stripped for over 50 feet on the surface, where it strikes  $S. 30^{\circ}-40^{\circ} E.$  and dips  $80^{\circ} E.$  In some places the vein is solid quartz; in others it contains considerable brecciated country rock. Bunches of solid sulphides, chiefly pyrrhotite, are

reported in the solid quartz on the 100-foot level. A fault that cuts off the vein in the north end of the 50-foot level has a strike of S. 80° E. and a dip of 80° N. About 5 inches of gouge occurs on the fault plane, and gouge also shows in places on the walls of the vein. Post-mineral movement along the vein is indicated by the badly shattered and crushed quartz in some parts of the vein.

A surface open cut on what is considered a second vein exposes a reported maximum width of 11 feet of ore. This vein is said to be traceable for 60 feet and to average 3½ feet in width.

The ore is a free-milling gold quartz accompanied by sulphides in very subordinate amounts. The ore milled in 1914 averaged less than 1 per cent of concentrates. In portions of the vein, however, the sulphides are much more abundant, and in some places bunches of nearly solid sulphides, chiefly pyrrhotite, occur in the white quartz. The minerals present in these sulphide masses are the same as those disseminated in the rest of the vein. The principal gangue mineral is quartz; calcite and probably siderite occur sparingly. The gold is native and was observed most abundantly in the sulphide bunches. Silver is also present in the ore, probably alloyed with the gold. Pyrrhotite, pyrite, chalcopyrite, sphalerite, and galena are the sulphides present. Arsenopyrite is reported, but none was seen by the writer. Limonite occurs as a surficial oxidation product of the iron-bearing sulphides.

#### PINOCHLE CLAIM.

The Pinochle claim, on the westward-facing slope of the same mountain as the Ramsey-Rutherford mine but a little nearer Valdez, is reached by the same route. The claim is above timber line, at an elevation of about 3,100 feet. The development work in September, 1914, consisted of a short tunnel on the vein, a 115-foot crosscut tunnel driven to tap the lode at about 90 feet in depth, a 10-foot shaft on the supposed extension of the ore fissure, and some stripping along the vein. Three men were at work on the property in the later part of September, 1914.

The country rock of the ore deposit consists of closely folded graywacke and argillite, striking, at the mouth of the adit, N. 67° W. and dipping 86° N. The ore body occupies a well-defined fissure reported to be traceable on the surface a distance of 110 feet. The lead strikes N. 30°-60° W. and is practically vertical. The width of the fissure ranges from 4 to 36 inches. The quartz content of the fissure also varies widely, very little being evident at some places, while at others 3 feet of solid quartz fills the fissure. One large quartz lens 3 feet thick and traceable along the roof of the tunnel for 15 feet was observed. In the face of the crosscut tunnel in September, 1914, there was a small vertical shear zone, 4 to 12 inches

wide, striking N. 85° W., which in the floor showed a width of 12 inches of quartz. The gangue of the ore from this property is a white quartz. Pyrite was the only sulphide recognized in the ore.

#### CLAIMS OF VALDEZ MINING CO. AND IBEX GROUP.

Brooks<sup>1</sup> in 1911 visited the claims of the Valdez Mining Co. and also the Ibex group. His descriptions follow:

The Valdez Mining Co. owns a group of claims on the west side of Valdez Glacier about 8 miles from tidewater, at an altitude of about 2,700 feet. It can be reached from Valdez by a horse trail which traverses the glacier for some distance. The country rock consists of interbedded schistose graywacke and slate, which strike about N. 75° E. and dip about 75° N. The vein, which at the outcrop is about 5 to 6 feet wide, strikes about N. 60° W. and dips 70° S. An adit, which reaches the vein at a depth of about 60 feet, has been driven 110 feet. A winze has been sunk 50 feet below this level, at which depth a drift has been run on the vein for some 40 feet. The vein at this depth is well defined, having good walls and a gouge on the hanging wall. The vein is from 3 to 8 feet wide in the underground workings. It is made up of ribbon quartz, which carries the gold in high values and measures from 2 to 4 feet in thickness, and of massive white quartz. On the lower level the ribbon quartz is from 24 to 50 inches wide. The white quartz also carries some gold. The ribbon quartz includes coarse pyrite masses and crystals. The vein includes druses containing well-developed quartz crystals. Another adit, which has been driven about 115 feet, is intended to crosscut the vein at a depth of 330 feet in a distance of 300 to 325 feet.

The Ibex group of claims lies about one-fourth mile northwest of the Valdez tunnel, where a 4-foot vein outcrops at an altitude of about 2,600 feet. Both walls of this vein are well defined. Banded quartz in this vein is said to carry gold in high values. A tunnel has been driven about 200 feet, but the vein was lost at a distance of 100 feet. The Ibex vein is believed to lie on an extension of the Valdez.

The Valdez Mining Co. in 1913 continued its crosscut tunnel to a length of about 230 feet.

#### ROSE JOHNSON PROPERTY.

The Rose Johnson claims are on the east side of Valdez Glacier about midway between Camicia Glacier and the next large tributary to Valdez Glacier from the east. A 1-stamp mill was erected in 1914 on one of the claims, at an elevation of about 1,200 feet. The milling equipment is said to include also a small crusher and a water wheel. The mill was run only a short time in 1914. The underground developments on this group of claims are reported to consist of several short tunnels, a 20-foot shaft, some open cuts, and stripping.

The country rock at the mill consists chiefly of crinkled and sheared black slate associated with considerable greenstone. The schistosity in the slate strikes about S. 85° E. and is vertical.

<sup>1</sup> Brooks, A. H., Gold deposits near Valdez: U. S. Geol. Survey Bull. 520, pp. 127-128, 1912.

Operations had stopped and there was no one on the property at the time it was visited. A vein in slate in one tunnel strikes S. 85° E., has a vertical dip, and shows a width of 2 to 7 inches of quartz. The other ore bodies were not seen, but they are reported to range from 6 inches to 3 feet in width. Specimens of ore said to come from this property show free gold, pyrite, galena, chalcopyrite, and sphalerite (?) in a quartz gangue. Some limonite has been formed by the surficial oxidation of the iron-bearing sulphides.

#### MINERAL CREEK.

The mines and prospects on Mineral Creek were visited by George L. Harrington, who wrote the following descriptions:

#### MOUNTAIN KING PROPERTY.

The Mountain King property of W. L. Smith is on the east side of Mineral Creek, a mile east of the mouth of Brevier Creek, at an elevation of about 3,000 feet. There are four tunnels on the property. The upper one, about 10 feet long, was driven till it cut the vein, when the ore shoot was stoped out. This tunnel has now caved in. About 40 feet below it are the workings from which ore is now being taken, consisting of a 100-foot tunnel, and at the end of it a 45-foot drift and a stope above the drift, along the vein. The vein is irregular in width, ranging from 1 inch to 18 inches, and consists of somewhat lenticular masses of quartz, joined by quartz stringers. The tunnel is driven N. 50° W. through sheared and platy graywacke, which strikes approximately east and dips steeply to the north. The metallic minerals are pyrite, galena, chalcopyrite, sphalerite, and free gold. The pyrite has weathered and oxidized, staining the quartz with iron oxides.

A third tunnel about 50 feet below this opening has been driven 85 feet N. 2° E., cutting the vein, along which a drift has been run for 40 feet. This drift exposes the vein for about 15 feet, where it shows a width of as much as 18 inches of iron-stained quartz that contains some sulphides. The bunk house and blacksmith shop are at the mouth of this tunnel. A fourth tunnel driven 135 feet below the bunk house to intersect the vein is said to be in 260 feet.

During the summer of 1914 the mill, on Mineral Creek just below the mouth of Brevier Creek, has been in operation, putting through over 120 tons. This mill was built during the previous summer and winter and consists of a 10 by 12 inch crusher, a stamp mill of two 1,200-pound stamps with plates, a table, a Pelton wheel operating under a 160-foot head, and a small generator. The ore was brought about halfway down the slope to the mills by go-devils and the rest of the way by double-ended sleds lowered by a donkey engine, with

a short length of aerial tram at the mill. A survey has been made for the installation of an aerial tram from the mill to the lowest tunnel.

Development work, consisting of about 200 feet of tunnels, is said to have been done on other claims under the same ownership, lying north and east of the Mountain King claim and farther up the ridge, but these were not visited. Essentially the same minerals are reported, with the addition of arsenopyrite from the claim lying to the north.

#### WILLIAMS-GENTZLER PROSPECT.

The Williams-Gentzler prospect is on the north side of the East Fork of Mineral Creek, at an elevation of about 4,000 feet. It was not visited. The work done is reported to consist of an upper tunnel about 30 feet long, a lower crosscut tunnel to the vein about 25 feet long, and a drift on the vein about 30 feet long. There is a shaft 12 feet deep in the lower tunnel. During the summer of 1914 a raise was driven to connect the two tunnels. The ore was treated in an arrastre, 10 feet in inside diameter, four drags of 200 pounds weight being used, running at 5 to 6 revolutions a minute. The power used was furnished by a  $2\frac{1}{2}$ -horsepower gasoline engine. The ore was crushed by hand to a size suitable for the arrastre. The capacity was about 2 tons in 24 hours. A portion of the concentrates was saved by riffles.

The ore shoot pitches to the southeast and extends about 25 to 30 feet, though the vein is traceable much farther. Minerals reported in the ore are pyrrhotite, pyrite, and galena.

#### BIG FOUR CLAIM.<sup>1</sup>

The upper workings on the Big Four claim lie at an elevation of over 5,000 feet. It is reported that the tunnels on this claim aggregated about 200 feet in September, 1914, but the claim was not visited.

Some work has also been done on a second vein, at an elevation of 3,900 feet, consisting of 135 feet of tunnel and about 25 feet of stripping along the vein. This vein shows a maximum width of 3 feet of shattered iron-stained quartz, containing considerable amounts of pyrite, some galena, sphalerite, and free gold. The vein is exposed for about 20 feet in the tunnel, where it strikes N. 75° W. It shows at least one offset along a plane parallel to the principal joint system (N. 15°-20° E.), and the two portions of the vein are apparently connected by barren quartz stringers along this line of offset.

During the spring and summer of 1914 a mill and a bunk house were erected and machinery installed in the mill, the equipment consisting of a small crusher, a 10-stamp mill, with amalgamating

<sup>1</sup> Brooks, A. H., *op. cit.*, p. 125.

plates, and a 12-horsepower distillate engine. The mill was in operation during September and October, 1914, test runs being made on ore from both the upper and lower veins. The ore is brought down by sleds or go-devils from the upper tunnel to the lower tunnel, and a 650-foot aerial tram handles it from this point down to the mill.

#### PROSPECTS OF MINERAL CREEK MINING CO.

The prospects on which work has been done by the Mineral Creek Mining Co. include the Buster, Chesna, Hercules, Millionaire, and Sunshine claims, all of which lie on the west side of Mineral Creek.

The work done on the Buster vein consists of a tunnel 200 feet long which follows the vein for 25 feet, to a point where it pinches. It is encountered again farther in, and a shallow winze is sunk on it. At the portal of the tunnel there is a shattered zone about 3 feet wide containing about 18 inches of quartz, in a country rock of sheared argillite and graywacke. Pyrite was the only sulphide seen.

There are three tunnels at the Chesna with a total length of about 750 feet. Only the upper and lower tunnels were examined. The lower tunnel is about 180 feet long and is driven N. 40° W. on a few quartz stringers 2 to 3 inches wide, separated by 6 to 8 inches of graywacke. The quartz is iron stained and shows a small amount of pyrite and carbonate. The upper tunnel has about 200 feet of drift and 20 feet of crosscuts. It is driven on a 4-foot shear zone carrying as much as 2 feet of quartz. This zone pinches within about 50 feet but widens out (or a new lead is encountered) farther along in the tunnel. The only metallic mineral seen was pyrite. The country rock at the mouth of the tunnel is a much-sheared slate. In the tunnel the rock is a slaty graywacke. The middle tunnel is said to include about 350 feet of drifts and crosscuts.

On the Hercules claims 120 feet of tunnel with 115 feet of crosscuts and two shallow winzes sunk on the vein constituted the development work up to 1914. The assessment work for 1914 was being done by driving a tunnel about 100 feet lower down, to intersect the vein at an estimated distance of 250 feet. About 10 feet of this tunnel had been driven early in October. The strike of the schistosity of the graywacke is N. 80° W. and the dip 65°-70° N. The vein follows the country rock closely in dip and strike. It has a maximum width of 20 inches in the main tunnel, but as indicated on the roofs of the crosscuts it seems to pinch in both directions. The minerals of the vein include quartz, gold, pyrite, galena, sphalerite, chlorite, carbonate (mostly lime), pyrrhotite, and chalcopyrite(?).

There are two tunnels on the Millionaire claim. The upper tunnel was driven about 60 feet to cut the vein and about 20 feet along it. In addition a winze was sunk on the vein about 50 feet, and the vein

was stoped out above to a height of about 15 feet. The ore taken out contains pyrite, pyrrhotite, chalcopyrite, and galena and shows also some thin plates and flakes of free gold. The vein, as exposed in the workings, strikes N. 60° W. and dips 70° N. It has a width of 6 to 20 inches. The lower tunnel, 100 feet below, was driven on a shear zone containing numerous quartz stringers with a small amount of pyrite, but only a little gold is reported from this zone. This tunnel is about 450 feet long.

#### HIGH GRADE PROSPECT.

The High Grade prospect lies in the canyon of Mineral Creek about a mile above McIntosh's road house. Two tunnels have been driven on the property. The one on the west side, which was not visited, is said to be 140 feet long; the tunnel on the east side is in 60 feet. A fair trail to the mouth of the canyon connects the prospect with the wagon road down Mineral Creek.

The country rock is a schistose graywacke, and the tunnel on the east side is driven on a 3-foot shear zone made up of this rock and shattered quartz, the quartz in places amounting to 6 or 8 inches. At the face the shear zone is about 1 foot wide. The metallic minerals are pyrite and galena, with quartz and a brown-weathering carbonate as the gangue. Much of the gold is said to lie in the sulphides.

The opening on the west side of the creek is driven on a quartz vein said to be 8 inches wide in places, and it is asserted that the vein and fissure are traceable for half a mile or more. The minerals are essentially the same on both sides of the canyon.

#### " 45 " PROSPECT.

The prospect known as the " 45 " is on the south side of Brevier Creek, at an elevation of about 2,500 feet. The work on the claim was done in 1913 and consisted of about 20 feet of tunnel and an open cut of about 20 feet, with a 16-foot face. The tunnel is driven on joint fractures striking S. 45° E. and dipping about 70° E. The principal fracture is from 1 inch to 6 inches wide, averaging about 4 inches, filled with crystalline quartz, generally iron stained, in some places containing lenses of pyrite as much as 6 inches in diameter and half an inch or more in thickness. In the face of the tunnel is a 6-inch seam of slaty gouge which carries very little quartz. The metallic minerals present are pyrite, galena, sphalerite, chalcopyrite, and free gold. Quartz is the dominant gangue mineral.

The country rock is graywacke, whose schistosity strikes N. 80° E. and dips about 70° N. Numerous joint fractures parallel to that on which the tunnel has been driven occur, many of these showing 2 inches or less of porous iron-stained crystallized quartz.

The assessment work for 1914 was done by the construction of a trail from the mouth of Brevier Creek to an elevation of about 1,700 feet, above which, on account of the gentle slope, free from brush, no trail is necessary.

#### VON GUNTHER PROSPECT.

The prospect of Dr. O. von Gunther lies on the west side of Mineral Creek near the end of Mineral Creek Glacier, at an approximate elevation of 1,320 feet. The development in September, 1914, consisted of 18 feet of tunnel driven along the fissure, which trends N. 47° W. At the portal of the tunnel about 2 feet of quartz shows along the wall. At the working face no quartz shows along the graywacke wall rock, but there are a few 2-inch clear-white quartz stringers cutting across the face. The vein is nearly vertical as seen along the outcrop and appears for about 20 feet both vertically and horizontally, being covered by talus below the mouth of the tunnel. The ore minerals consist of pyrite and its oxidation products. The gangue minerals are quartz and calcite. Claims have been staked on a wider vein in the creek bottom that is believed to be an extension of this vein.

#### QUITSCH PROSPECT.

The prospect of William Quitsch consists of one claim on Mineral Creek Glacier about  $2\frac{1}{2}$  miles from the front of the glacier. It was not visited. In 1913 a trail was built to the property, and it is reported that in 1914 about 12 feet of tunnel was driven. Specimens of ore said to come from this prospect show quartz, galena, pyrite, some of the products of oxidation of the pyrite, and a small amount of free gold. The vein occurs in graywacke.

#### HICKEY PROPERTY.

In August, 1914, the property on the east side of Mineral Creek half a mile east of Brevier Creek, formerly known as the Mountain View claim<sup>1</sup> of the Mineral Creek Mining Co., was restaked by Ross Hickey, but no development work had been done October 1, 1914. The previous owners had stripped the quartz ledge upon which discovery was made for about 30 feet. At one place on the ledge as then exposed numerous specks of free gold were discernible. On this face there was also a considerable amount of pyrite and a little galena, the pyrite oxidized and staining the quartz. The vein is from 8 inches to 3 feet wide, and some 2 to 3 inch quartz stringers extend into the hanging wall to the north. The vein crosses the east-west schistosity of the graywacke country rock at an angle of about 45°. The graywacke is platy, cleaving with irregular, rounded surfaces.

<sup>1</sup> Brooks, A. H., Gold deposits near Valdez: U. S. Geol. Survey Bull. 520, p. 126, 1912.

In the workings below the point of discovery the vein is exposed for about 150 feet, varying in width from 1 to 20 inches. The quartz carries very few sulphides.

#### MINERAL KING CLAIM.

The Mineral King is one of the claims formerly owned by the Mineral Creek Mining Co. The tunnel is on the south side of Brevier Creek, about a quarter of a mile from its mouth.<sup>1</sup> In September, 1914, the tunnel mouth had been covered by a slide. No work had been done during the current year.

#### MONTE CARLO PROSPECT.

The Monte Carlo prospect, better known as the Cook & Barrett property, lies on the west side of Mineral Creek at an elevation of 3,600 feet, about 1½ miles northwest of the mouth of Brevier Creek. The property is reached by a trail from the mouth of Brevier Creek by way of Millard's upper camp.

The earliest work done here was on a tunnel that was driven 110 feet in to cut the vein, and then an incline was driven about 36 feet farther without reaching the vein.

During the summer of 1914 a second crosscut tunnel was driven 36 feet at an elevation about 70 feet above the lower tunnel. This tunnel has reached the vein but has not been driven through it. The country rock is a schistose graywacke striking N. 70° E. and dipping about 70° N., and the vein upon which work is being done is approximately parallel to this in strike but has an irregular dip, there being some indication of a fold or roll in it. This vein has a maximum thickness of 5 feet. It is an offshoot of a larger vein that is exposed in a small gully for about 200 feet and has a maximum width of 15 feet. The larger vein contains a small amount of pyrite. From surface cuts on the small vein, which shows pyrite, galena, and free gold, 4 tons of ore was taken to Valdez in 1913.

#### CLAIMS OF H. L. JAYNES.

A group of claims was staked in 1913 and 1914 by H. L. Jaynes on the east side of Mineral Creek opposite the mouth of Brevier Creek, at an elevation of about 2,800 feet. The claims include the Rose, July, and Little Giant. The work done on the Rose and July claims consists of stripping and the building of trails. On the Little Giant some surface stripping has been done and in addition 46 feet of tunneling and 75 feet of crosscutting. The country rock is a graywacke with slaty cleavage that strikes about east and has a steep but varying dip to the north.

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<sup>1</sup> Brooks, A. H., op. cit.

A quartz vein at the east end of the Rose claim is said to have been stripped for 40 feet to a depth of 8 feet, showing a width of 1 to 18 inches of quartz. The strike of this vein is N. 85° W. About 200 feet below, to the west, what is apparently the same ledge is exposed for about 200 feet and has a width of 4 to 12 inches. A crosscut tunnel 36 feet long is said to tap the vein at a depth of 40 feet. About a ton of ore was milled in Valdez in 1914 from this vein. It shows considerable pyrite and some galena and free gold. At the west end there is less sulphide and no free gold was seen, and lower assays are reported from this part of the vein.

On the July claim the vein has been stripped for about 25 feet, exposing from 6 to 10 inches of porous crystallized iron-stained quartz, showing pyrite, galena, sphalerite, and free gold. The vein strikes about N. 45° W. on the west end but swings to an approximate easterly direction on the east end.

There are two veins about 30 feet apart on the Little Giant, striking east, with the country rock, but apparently running together toward the east, the junction on the surface being in a small stream passing across the claim. These veins range from 6 inches to 4 feet in thickness and show varying amounts of the sulphides pyrite, galena, sphalerite, and pyrrhotite, as well as some free gold. Some carbonates are also present. The southern vein of the two is exposed on the surface for 40 feet and is 2 to 3 feet wide. About 200 feet to the west another vein or a continuation of one of the two mentioned crops out for 30 feet and shows from 1 inch to 8 inches of quartz, with pyrite, galena, and free gold. Several tons of ore from the surface croppings of the two veins on this property was milled in Valdez in 1914.

#### OTHER CLAIMS.

A large number of claims lie on the east side of Mineral Creek, mostly to the south of Wood Creek. These include the Alaskan, Hecla, Queen of Sheba, Tiger, the property formerly known as the Olsen & Wood, and several other claims.

On the Alaskan claim there is a 17-foot shaft, now nearly filled with water. This shaft is sunk on the vein, which is from 6 inches to 5 feet wide along 150 feet of outcrop. The general strike is about S. 77° E., and the dip ranges from vertical to 60° N. A small Z-shaped fold appears in the outcrop of this vein. The country rock is a sheared graywacke, and the vein minerals are quartz, pyrite, galena, sphalerite, chalcopyrite, and free gold. A second vein which crops out on this strike about 200 feet to the east may be a continuation of the first vein. A tunnel is being driven to cut this vein at an estimated distance of 500 feet from the portal. The tunnel is now said to be in 200 feet.

The Queen of Sheba tunnel is driven N. 58° W. for 36 feet on a vein which ranges in width from 1 foot to 6½ feet. The dip of the vein is vertical in general but wavy. The walls are well defined and free. The vein matter is shattered iron-stained quartz containing only a small amount of pyrite. The vein is exposed on the surface for about 60 feet.

In Wood Canyon on the Hecla claim there are two tunnels said to be 76 and 65 feet in length. The upper tunnel is driven on a quartz ledge which shows a maximum width of 6 feet and a vertical exposure of 150 feet. Both tunnels are driven on well-defined breaks about 300 feet apart, and in the shattered zone between the two veins are numerous stringers of quartz that widen out in many places to lenticular masses 2 feet across. In this zone are some black graphitic slates. A large part of the zone contains pyrite in the shattered graywacke and slate.

The Tiger claim lies down Wood Creek from the Hecla, and a 10-foot tunnel has been driven on it. There are numerous shear zones carrying as much as 2 feet of pyritized black slaty gouge, which contains many stringers of quartz. The more massive beds of graywacke show plication. The tunnel on the Olsen & Wood claim<sup>1</sup> is reported to be 200 feet in length. It is being driven to intersect a 4-foot shear zone containing many quartz stringers irregularly distributed through the zone. A trail was constructed in 1914 from McIntosh's road house to the cabin, which is at an elevation of about 1,600 feet.

#### VICINITY OF SHOUP BAY.

##### CLIFF MINE.

The Cliff mine is at sea level on the north side of Port Valdez, 10 miles from Valdez. It is at the base of a steep bluff at the east end of the gravel flat, half a mile east of Shoup Bay. A long wharf extending into deep water was formerly a stopping point for ocean steamers. The mine is reached from Valdez by gasoline launches.

The Mystic No. 1 claim, upon which the development work has been done, was located by H. E. Ellis August 15, 1906. In August, 1909, it was leased to the Cliff Mining Co., a local organization. The property has been systematically developed since that date. In the spring of 1910 a 3-stamp mill was installed and the mine became the first gold quartz producer of the Port Valdez district. In August, 1910, the underground developments consisted of two adits at a vertical interval of 54 feet, connected by raises, and one intermediate drift. The lower adit was about 200 feet long. There was also a short prospect tunnel about 200 feet above the beach. In 1911 the

<sup>1</sup>This claim was visited by Mr. Brooks in 1911. See Brooks, A. H., op. cit.

3-stamp mill was burned, but a new stamp mill was erected and in operation before the end of the year. Meantime mining operations were continued and the ore was shipped to Tacoma. The mine workings had reached a depth of 100 feet below sea level and extended for about 600 feet along the vein. In 1912 the 500-foot level, which is about 300 feet below sea level, was reached and some drifting was done on it. The Cliff mine was in 1913, as before, the largest producer in the Valdez district. The mill, with six stamps, was operated, except for short stops of some of the stamps, throughout the year. About 45 men were employed. The underground developments were reported to amount to at least 8,000 feet, of which over 900 feet was said to be on the 500-foot level. Development work was carried forward on this level until it was stopped by an influx of sea water. The pumps were then pulled and the water allowed to rise within a few feet of the 300-foot level. In the fall of 1913 mining and development work was in progress on the 100, 200, and 300 foot levels and in the stopes between them. The plant at that time included a jaw crusher, six stamps, three tables, boilers, an air compressor, drills, and hoists. Coal was used as fuel. In 1914 all operations at the Cliff ceased on July 6, and in August the property was turned over to the original owners. In the fall the water in the mine stood just below the 200-foot level.

The country rock of the ore deposit appears to be chiefly a dark-gray schistose graywacke, the schistosity of which in this vicinity strikes east and dips  $65^{\circ}$  N. Adjacent to the vein this schistose rock is highly impregnated with pyrite and small acicular crystals of arsenopyrite and cut by small mineralized quartz veins.

The Cliff ore body occupies a linked vein system which cuts across the foliation of the schistose graywacke. Present developments indicate that within the fractured zone of the mine there are several persistent fissures which fork, inclose large lenticular masses of country rock, and reunite along the strike without crossing one another. So far as present developments have gone these veins appear to diverge in depth. The general strike of this fissure system is N.  $30^{\circ}$ - $40^{\circ}$  W., although individual strikes range from N.  $28^{\circ}$  W. to N.  $47^{\circ}$  W. The dips of the fissures range from  $65^{\circ}$  E. to  $48^{\circ}$  W. in the upper levels of the mine. Below the 300-foot level the dip of the veins developed steepens to  $85^{\circ}$  W. On the outcrop and on the 100-foot level but one simple fissure occurs, and it has a dip of about  $70^{\circ}$  W. Between the 100 and 200 foot levels, north of the shaft, this vein splits. On the 200-foot level the two veins thus formed are 44 feet apart at the cross-cut which connects them 160 feet north of the shaft, but they approach each other southward along the level. They dip in opposite directions. On the 300-foot level three veins are reported, the third

vein splitting off from the main fissure at the shaft about 25 feet below the 200-foot level. No data are available at present regarding the number of veins on the lower levels.

The fissure system has been traced underground along the strike for a distance of about 900 feet. The fissures are usually well defined. Their width is generally from 6 to 36 inches but locally increases to 5 feet. On the 300-foot level an average width of 1 foot of ore is reported. In some places there is only an inch or so of gouge in the fissure; in others the entire fissure is filled with quartz, or the sheared and shattered fissure filling may contain but a few quartz stringers. In the wider places a network of quartz stringers may occur, separated by masses of country rock. On some of the fissures barren stretches of many feet occurred between the ore shoots. Most of the ore came from the bayward end of the fissure system, and this shoot is said to have pitched to the southeast under the waters of Port Valdez.

The ore from the Cliff mine is a peculiar bluish-white quartz with minor amounts of calcite, albite, chlorite, and a brownish-weathering carbonate. The metallic minerals in the ore include gold, arsenopyrite, pyrite, sphalerite, and galena. The sulphides are mostly fine and do not appear abundant, but from milling operations the ore is estimated to contain from 3 to 5 per cent of sulphides. The ore is free milling. Gold was found on all the levels and is a primary constituent of the ore, occurring native in the quartz in association with the above-named sulphides. Pyrite and arsenopyrite appear most abundantly as impregnations of the graywacke country rock. A rather conspicuous characteristic of the Cliff ore, besides its bluish-white color, is the abundance of small acicular crystals of arsenopyrite sprinkled through the graywacke adjacent to the veins. Limonite occurs as a surficial oxidation product of the iron-bearing sulphides.

#### CLAIMS OF CAMERON-JOHNSON GOLD MINING CO.

The claims of the Cameron-Johnson Gold Mining Co. are on the right side of Shoup Glacier, on the mountain ridge between Shoup and Columbia glaciers. The mill and lower camp stand at an elevation of about 2,400 feet, or 900 feet above Shoup Glacier. They are about 4 miles in an air line from Shoup Bay and about 7 miles by trail from the head of the bay by way of Shoup Glacier. One of the ore bodies under development is close to the lower camp and at approximately the same elevation. The others lie at elevations between 4,250 and 4,500 feet above sea level on Mount Cameron, about a mile from the lower camp. A pack train is used for the summer transportation of supplies from the bay to the lower camp.

The Mazuma, Treasury Note, and several other claims, seventeen in all, originally located by Cameron & Johnson, were deeded to the Cameron-Johnson Gold Mining Co. A small amount of development work was reported in 1911. The property was leased to Henry Hewitt from March 26, 1912, to February 8, 1913, and considerable development work is said to have been done during this interval, mostly on the Treasury Note claim. A shipment of ore is also said to have been made. Six to eight men were at work there in September, 1912. The next year a mill building, sheathed in corrugated iron and housing a 5-stamp mill and a concentrator, was erected. Power was furnished by a No. 3 Pelton water wheel operating under a 240-foot head with water from a glacial stream carried through 1,500 feet of pipe that decreased in diameter from 11 to 8 inches from the intake to the wheel. Milling began July 20, 1913, and stopped about October 1. An average of 30 men were employed on the property during the working season, but at times as many as 36 were at work. A temporary aerial tram was erected between the mine and the mill during the summer; it was later dismantled. Mining was in progress until the middle of September.

In 1914 mining operations are reported to have begun August 17, and at the close of the season the underground work is said to have aggregated a little over 700 feet. The mill was in operation but a short time. An average of 30 men were employed during the season, which closed about the middle of September. Most of the season was spent in surface improvement of the property. An 1,800-foot temporary aerial tram was erected during the summer, and all the ore mined in 1914 was brought down over it. Later a 3,850-foot aerial tram was completed between the mill and a point on Mount Cameron at an elevation of about 3,700 feet, about 1,300 feet above the mill camp. This replaced the temporary tram. A new dam was also erected. A 7-foot Lane mill and another concentrator were added to the equipment. A bunk house was erected at the mill camp and additions were put on the mill and cookhouse. Two small wooden buildings, a bunk house and a cookhouse, were erected near the upper terminal of the aerial tram.

The country rock in the vicinity of the Cameron-Johnson claims appears to be entirely graywacke and argillite. At the upper terminal of the aerial tram the bedding and schistosity in these rocks has a strike of N. 85° E. and a dip of 80° N.

Of the numerous veins reported as occurring on this property only the lower vein, near the mill camp, has been visited. The data regarding the other veins have been furnished by the present owners.

The vein on the Mazuma claim near the mill is said to be the largest on the property, as well as the lowest in grade. This vein lies on the west bank of Johnson Creek about 40 feet above the mill

camp. A crosscut tunnel 110 feet long is driven N. 20° W. from the bank of the creek and taps the vein at its east end, where it has a strike of N. 65° W. and a dip of 55° N. A 60-foot raise extends to the surface from this point. This vein has been traced along the outcrop about 100 feet and varies in width, the maximum being 11½ feet. The average width in the raise is reported to be about 3 feet. The strike is N. 62°-72° W., and the dip 55°-72° N. The fissure is quartz filled and shows a little secondary banding parallel to the walls.

At the upper workings most of the development work is reported on the Treasury Note vein, which is said to have an easterly strike, to show from 3 to 36 inches of ore, and to be traceable for over 300 feet. The remaining veins are narrower and shorter.

The ore is a free-milling gold quartz ore of which the gangue is dominantly quartz with a minor amount of a brown-weathering carbonate. Gold, pyrite, galena, sphalerite, and arsenopyrite were recognized in specimens of the ore. Limonite forms as a surficial oxidation product of the iron-bearing sulphides. About 3 per cent of the ore is said to be sulphides.

#### CLAIMS OF SEALEY-DAVIS MINING CO.

The property of the Sealey-Davis Mining Co. is on the east side of Shoup Bay about half a mile north of the Cliff mine and on the opposite side of the ridge. The underground workings are between 200 and 615 feet above sea level. Several wooden buildings, including office, bunk house, cookhouse, and blacksmith shop, are located at tidewater on Shoup Bay. At the lower tunnel a blacksmith shop has been erected, and at the entrance to one of the other tunnels there is a 3-horsepower gasoline engine and blower. Developments in 1914 included four tunnels with about 1,500 feet of drifts and crosscuts, a winze, a short raise, stopes above the upper tunnel, some stripping, and open cuts. One shipment of ore is said to have been made to the Tacoma smelter and another to the custom mill at Valdez.

The country rock of the ore body is a dark-gray fine-grained schistose graywacke with a small amount of argillite. The schistosity has a nearly west strike and a dip of 55° N. The ore deposit occupies a well-defined fissure which strikes N. 23°-35° W. and dips 75° E. to 85° W. The highest definitely located point on the vein is in an open cut at an elevation of 650 feet. The first 50 feet of the lower tunnel, at an elevation of 200 feet, is driven on a narrow iron-stained shear zone; the remainder of this tunnel shows no vein. The other tunnels, at elevations of 425, 560, and 615 feet, are driven on the vein, which varies in width, being in some places

a narrow seam and in others  $5\frac{1}{2}$  feet wide. The maximum width of quartz observed was 2 feet. In the upper tunnel the quartz occurs as long, narrow masses from 3 to 15 inches thick, parallel to the walls of the fissure. In the next lower tunnel the quartz in the fissure is fairly continuous and there is from 1 to 15 inches of solid quartz. The maximum thickness of 2 feet of quartz was seen in the next lower tunnel, where the quartz occurs as long, narrow stringers or lenticular iron-stained masses, sheeted parallel to the wall and having a usual width of 1 inch to 15 inches.

The primary ore minerals include quartz, chlorite, calcite, gold, pyrite, arsenopyrite, chalcopyrite, sphalerite, galena, and pyrrhotite. The development of acicular crystals of arsenopyrite in the impregnated graywacke country rock of this vein is not so pronounced as at the Cliff mine. Limonite is present in weathered exposures of the ore body.

#### ALICE MINE.

The Alice mine is situated at sea level on the west side of Shoup Bay a short distance north of the mouth of McAllister Creek,  $1\frac{1}{2}$  miles northwest of the Cliff mine. During 1913 and 1914 a regular boat service was maintained by a gasoline launch between Valdez and the mine.

The vein was located March 15, 1910. In September, 1911, only a small amount of development work had been done. In 1912 an air compressor and pump were installed and a two-compartment shaft sunk to a depth of more than 100 feet below high-tide level. Ten to twelve men were employed, several frame buildings constructed, and 30 tons of ore shipped to Valdez and milled. Development work stopped early in February, 1913, when 15 men were employed on the property.

In 1914 the underground developments comprised an adit 247 feet long, a 170-foot two-compartment timbered shaft crossing the tunnel level 60 feet from the portal of the tunnel, and 100 feet of drifts along the lead at the bottom of the shaft. There was also considerable surface stripping and several shallow shafts (6 to 10 feet deep) along the outcrop of the vein. The buildings included mess house, blacksmith shop, boiler, engine and compressor house, shaft house, and three bunk houses. The plant was electrically lighted and the machinery on the property in 1914 included a 100-horsepower boiler, a 3-drill air compressor, drills, a 50-light dynamo, a 5-horsepower steam engine for the dynamo, a steam hoist, and pumps. Only assessment work is reported on this property in 1914.

The country rock in the vicinity of the ore body comprises schistose graywackes, slates, and a very small amount of green schists. The schistosity has a strike of N.  $70^{\circ}$ - $80^{\circ}$  E. and a dip of  $50^{\circ}$ - $70^{\circ}$  N.

The Alice claim is located on a well-defined fissure, striking N.  $60^{\circ}$ - $65^{\circ}$  W. and dipping  $70^{\circ}$  S. to vertical, cutting the schistose country rock in both strike and dip. This fissure is traceable as a shallow trough from tidewater to tidewater across a low ridge, a distance of about 1,100 feet, with a maximum elevation of about 120 feet above sea level. The width of the fissure ranges from a few inches to  $2\frac{1}{2}$  feet. At one point in the tunnel the fissure filling is about 6 feet wide and shows wide-spaced joints parallel to the walls occupied by long, narrow quartz veinlets. The fissure filling on the tunnel level is usually from half an inch to 8 inches wide but in places is as much as 15 inches wide, most of which is quartz. The ledge matter, consisting of brecciated and sheared country rock, has in some places a width of 6 feet, but the quartz is not abundant in those places.

The gangue minerals are quartz, calcite, chlorite, and a light-colored, brown-weathering carbonate. The metallic ore minerals include gold, pyrite, chalcopyrite, arsenopyrite, and sphalerite. Galena is also reported in the ore. The presence of silver alloyed with the native gold is shown by assays. Limonite is present in the weathered parts of the vein.

#### THREE IN ONE GROUP.

The Three in One group is situated on the southward-facing slope of the mountain between Gold Creek and Shoup Bay, at an elevation of approximately 1,500 feet. The property is reached by a trail which leaves the shore of Port Valdez at the mouth of a small stream about a mile west of the mouth of Gold Creek.

The underground development work in 1914 consisted of a 500-foot adit, a 160-foot raise, a 50-foot adit at the upper end of the raise, open cuts, and strippings on the vein. The surface improvements include a cabin southeast of the mine at an elevation of about 850 feet and trails to the mine and to the shore from the cabin. Three men were employed on the property in the fall of 1914.

The country rock is schistose graywacke and argillite, the schistosity of which at the mouth of the lower tunnel strikes N.  $77^{\circ}$  E. and dips  $60^{\circ}$  N. Only one vein is reported on the property. The lowest outcrop of this vein is at the lower tunnel, at an elevation of about 1,450 feet. The lead is reported to continue up the slope of the hill for about two claim lengths to the crest of the ridge, at an elevation of over 2,500 feet. In the lower tunnel the lead strikes N.  $27^{\circ}$ - $35^{\circ}$  W. and dips  $50^{\circ}$ - $80^{\circ}$  W. In the upper tunnel it strikes N.  $15^{\circ}$  W. and dips from  $80^{\circ}$  W. to vertical. The width of the fissure varies from 3 to 10 feet. The width of the contained quartz is from a few inches to 8 feet, but it averages about 2 feet. The quartz lies in long, narrow lenses. The ore minerals include gold, chalcopyrite, sphalerite, galena, and arsenopyrite. Three kinds of quartz are

reported—a bluish quartz, a massive white quartz, some of which is coarsely crystalline, and a banded quartz.

#### CLAIMS OF THOMPSON-FORD MINING CO.

The property of the Thompson-Ford Mining Co. is on the east side of Uno Basin about 2 miles from the head of Shoup Bay. The workings are at an elevation of about 2,500 feet above sea level. The claims are reached by a trail from the east side of Shoup Bay about half a mile south of the mouth of Uno Creek.

The present underground workings are on the end line between the Silver Falls and Foaming Falls claims. Nearly continuous development of the property is reported by the owners up to 1914. In 1913 four men were employed during the first half of the year and one man during the remainder of the season. A shipment of ore was also made to the Tacoma smelter during the summer. Two men were at work on the property in the fall of 1914.

The underground developments include a lower tunnel 325 feet long, with two drifts 100 and 25 feet in length; a 150-foot raise from the lower tunnel to the surface; a 20-foot shaft and a 15-foot drift from the bottom of this shaft to the raise; and about 100 feet of drifts on a level 60 feet below the collar of the raise.

The country rock of the Thompson-Ford ore body consists of sheared graywackes and argillites. The strike of the schistosity of these beds is N. 75°–80° E. and the dip 65°–75° N. The strike of the vein on the surface is from N. 50°–60° W. and the dip 50°–85° N. At the shaft the vein has split and includes a 10-foot horse of sheared country rock. This vein ranges in width from 1 inch to 18 inches, but has an average width of about 8 inches, and the surface showing is 115 feet long. The walls of the vein are free. On the 60-foot level a vein 6 to 12 inches wide strikes N. 35°–45° W. and dips 85° SW. It is exposed for about 15 feet. Numerous small quartz stringers also occur in the workings on this level. On the lower level a poorly delimited sheared zone with a general northwesterly strike is cut diagonally by a long tunnel. Within this zone the schistose rocks are much contorted and crumpled and in places contain numerous quartz stringers, some of which are several inches thick. The first 20 feet of the crosscut at the end of the long tunnel lies in this zone, which is also exposed in this tunnel for over 50 feet from the crosscut. A shear zone 8 to 15 inches wide with a strike of N. 75° W. is reported at the end of this crosscut. The gangue minerals, as in most of the other ores of this district, consist chiefly of quartz, with a little calcite. Pyrite is the most abundant sulphide, but galena, sphalerite, and chalcopyrite are also present. The ore is a free-milling gold ore, the gold occurring native. Limonite is present in the weathered ore.

## CLAIMS OF SEACOAST MINING CO.

The claims of the Seacoast Mining Co. are on the southwestward-facing slope of Mount Shasta about a mile northeast of the mouth of Uno Creek. Several veins are reported to occur on the property at elevations from 1,750 to 2,600 feet above sea level. The mine workings are reached by a trail from the lower camp at the mouth of Uno Creek.

The total underground development work in 1914 comprised a 265-foot crosscut tunnel with a 4-foot winze and a 10-foot raise, a 50-foot crosscut tunnel, a shallow shaft, open cuts, and stripping. The surface improvements consisted of an upper camp (one wooden building) at an elevation of 1,800 feet, a small wooden building part way up the trail, four buildings at the mouth of Uno Creek, and the trail from the shore to the upper camp. An average of 15 men are reported to have been employed on the property in the summer of 1913. In 1914 two men were employed during the early part of the summer and seven men were at work in September. A small shipment of ore has been made to Seattle for a sample mill test.

The country rock of the veins is the schistose graywacke and argillite prevalent in the Shoup Bay area. The strike of the schistosity is N. 60°-80° E. and the dip is 60° N.

Several veins are reported on the claims owned by this company. At the upper camp a vein that is traceable for about 150 feet strikes N. 25° W. and dips eastward. Irregular lenses of quartz occur in the fissure, and above the long tunnel a width of 28 inches of solid quartz shows in the vein. Just east of the tunnel a spur vein 12 inches wide leaves the main vein on the uphill side and has a strike of N. 55° E. and a dip of 55° N. Within the tunnel a large mass of quartz was cut 30 feet from the portal and a winze was started on it. In the winze this lens had a maximum width of 10 feet, but the vein narrowed upward to a few inches. The hanging wall of this vein in the east wall of the tunnel is well defined and strikes N. 10° W. and dips 55° E. The continuation of this vein in the northwest wall of the tunnel has a width of 2 feet. At 25 feet beyond the winze a vein 3 to 24 inches in width crosses the tunnel with a strike of N. 33° W. and a dip of 47° W. At an elevation of 1,850 feet an inclined shaft is being sunk on a vein reported to be traceable for 250 feet. This fissure varies in width from a fraction of an inch to 11 feet. The maximum width of solid quartz exposed is 2 feet. The strike of the vein ranges from S. 80° E. to N. 10° E. and the dip from 40° to 60° N. A lead on the Portland claim is said to range from 6 inches to 6 feet in width and to be traceable for several hundred feet.

The minerals present in the ores of the Seacoast Mining Co.'s veins include quartz, chlorite, calcite, a brown-weathering carbonate, pyrite, galena, gold, pyrrhotite, chalcopyrite, and sphalerite. Large masses of pyrite occur in the vein opened by the inclined shaft. Oxidation products present are limonite and malachite.

#### SILVER GEM CLAIM.

The Silver Gem claim is at tidewater on the southwest side of Shoup Bay about a quarter of a mile from the front of Shoup Glacier and half a mile northwest of the Alice mine. The underground developments consist of an adit about 500 feet in length, 10 feet above sea level. It is reported that a shipment of ore from this claim was made to the custom mill at Valdez and milled there.

The country rock of the ore deposit is a schistose gray graywacke, in places impregnated with pyrite. The schistosity strikes N. 68°-88° E. and dips 62°-66° N.

The Silver Gem claim is staked on the north end of a well-defined fissure<sup>1</sup> traceable about half a mile southwestward from tidewater at the tunnel mouth. This fissure forms a pronounced trough on the hillside and across the ridge. At the tunnel mouth it strikes N. 10° W. and dips 70°-80° W. Within the tunnel the fissure curves, and near the face of the tunnel the strike is N. 35° E. and the dip 55° W. The width of the fissure filling is from 6 inches to 9 feet, but the average width is about 2½ feet. The hanging wall is well defined and slickensided. The fissure filling consists of crushed and shattered country rock with varying amounts of quartz. Many small stringers and lenses of quartz occur in the vein filling. The largest mass of quartz observed was a short lens 28 inches thick. In places the shattered graywacke of the vein material is cemented by mineralized quartz. Most of the quartz is badly shattered.

Quartz, calcite, and chlorite are the gangue minerals. Pyrite, arsenopyrite, sphalerite, and stibnite have been observed in the ore, and galena and free gold are reported. There is also a pyritic impregnation of the schistose graywackes adjoining the vein. Limonite is present in the weathered outcrops.

#### BALD MOUNTAIN GROUP.

The Bald Mountain group, better known locally as the Olson property, is on the right margin of Shoup Glacier at an elevation of about 3,100 feet above sea level. It is about three-fourths of a mile northeast of the Cameron-Johnson mill camp and about 650 feet higher.

<sup>1</sup> Brooks, A. H., Gold deposits near Valdez: U. S. Geol. Survey Bull. 520, p. 123, 1912.

It is reached from Shoup Bay,  $7\frac{1}{4}$  miles distant, by way of the Cameron-Johnson trail.

The surface improvements on the property comprise stripping and open cuts on the veins and a small wooden cabin. The underground developments consist of two tunnels 180 and 36 feet in length, at elevations of 3,050 and 3,250 feet respectively, and a shallow shaft on one of the veins. The longer tunnel comprises a 120-foot crosscut and 60 feet of drift, 50 feet of which was opened in 1914. The country rock of the veins is schistose graywacke and argillite, the schistosity and bedding of which strike N.  $60^{\circ}$ - $80^{\circ}$  E. and dip  $70^{\circ}$ - $77^{\circ}$  N.

Development work has been done on two veins, each of which is reported traceable for several hundred feet. The upper vein has a strike of N.  $75^{\circ}$  W. and a dip of  $65^{\circ}$  N. Its width varies from 4 to 18 inches. The other and larger lead has a maximum width of 7 feet and about the same strike as the upper vein. Other leads occur on the property but have not yet been prospected. One of them is 4 to 5 inches wide and is traceable for over 100 feet. The gangue of the ore is chiefly quartz with a small amount of light-colored, brown-weathering carbonate. The sulphide minerals observed in specimens of ore from this property are pyrite, sphalerite, and galena.

#### MINNIE CLAIM.

The Minnie claim is on the right margin of Shoup Glacier at an elevation of about 3,000 feet, a short distance northeast of the Bald Mountain group. The claim was located in July, 1911. The developments in 1913 included a 35-foot tunnel, a 20-foot tunnel, one or two shorter tunnels, some surface stripping of the veins, and a small wooden cabin. Several attempts to ship ore to custom mills were stopped by accidents, and in 1913 a 1-stamp mill operated by water power was placed on the claim and run for about 25 days in the fall by two men.

Several small veins are reported to occur on this property. The vein on which the two longer tunnels are driven and which supplied the ore for the mill has been stripped for about 150 feet. The fissure strikes N.  $70^{\circ}$  W. and dips  $55^{\circ}$  S. The country rock is the usual graywacke and argillite, the bedding and schistosity of which strike N.  $84^{\circ}$  E. and dip  $75^{\circ}$  N. This lead contains from 4 to 24 inches of quartz, but the average width is only 9 inches. The ore minerals are quartz, pyrite, galena, and gold.

#### OWL PROSPECT.

The Owl prospect is in Uno Basin, about half a mile southwest of the Thompson-Ford workings, at an elevation of about 2,400 feet. It is about  $1\frac{1}{2}$  miles from Shoup Bay and is reached by the same trail as

the Thompson-Ford claims. This prospect, formerly the property of the Owl Mining Co., was restaked January 6, 1914, by George Pulver and E. J. Baker as the Oregon and Washington claims. The underground developments total about 190 feet. The country rock is graywacke and argillite, the schistosity of which strikes N. 85° E. and dips 55° N. The ore deposit consists of a sheeted or sheared zone several feet wide which carries several large stringers and lenses of quartz that have a maximum thickness of 18 inches. The quartz outcrops are traceable for a distance of about 150 feet along the strike, which is approximately N. 45° W. The dip is 30° E. The tunnel is driven along the fissuring. The gangue minerals are quartz, calcite, and chlorite. Pyrite, chalcopyrite, galena, and sphalerite are the sulphides present. Limonite and a little malachite occur in the weathered outcrops of the ore body.

#### GUTHRIE & BELLOLI PROPERTY.

The Guthrie & Belloli tunnel lies at the entrance to Uno Basin, at an elevation of 1,300 feet. It is just north of the trail to the Thompson-Ford and Owl prospects and three-fourths of a mile from the east shore of Shoup Bay. The tunnel is about 150 feet in length. The country rock is sheared graywacke and argillite, the schistosity of which strikes N. 87° E. and dips 63° N. The vein on the surface strikes about N. 25° W. and dips 60° E. The outcrop is traceable for about 100 feet, and the width ranges from 1 foot to 10 feet. Within the tunnel the vein strikes N. 58°-73° W. and shows a maximum width of 6 feet of quartz. The gangue minerals are quartz, calcite, and chlorite. The metallic ore minerals include pyrite, chalcopyrite, arsenopyrite, sphalerite, and galena. Limonite is present as a surficial oxidation product of the iron-bearing sulphides.

#### BUNKER HILL CLAIM.

The Bunker Hill claim is on the southwest slope of Mount Shasta, three-fourths of a mile northeast of the head of Shoup Bay, at an elevation of 1,800 feet. It is reached by a trail from the mouth of Uno Creek. The underground development in 1914 consisted of a 100-foot adit. The country rock is the usual schistose graywacke.

The vein on which the tunnel is driven ranges in strike from north to N. 70° E. and dips 63° W. The quartz filling of the fissure is somewhat lenticular and ranges in thickness from 4 to 25 inches. A small fold, the axis of which pitches 70° NE., exposed in the tunnel about 35 feet from the portal, is occupied by the vein. In some places the quartz is shattered; in others the vein shows secondary banding parallel to the walls of the fissure, which are free and in places marked by gouge. The ore minerals are quartz, calcite, chlorite, arsenopyrite, galena, pyrite, sphalerite, and limonite.

## GOLD BLUFF CLAIM.

The Gold Bluff claim is at sea level on the east side of the entrance to Shoup Bay. It is on the northwestward-facing slope of the same ridge as the Cliff mine and the Sealey-Davis properties, but about half a mile northwest of the Cliff and half a mile southwest of the Sealey-Davis.

The present developments consist of a 200-foot adit, a 5-foot cross-cut, and a small building at the tunnel mouth. The country rock is schistose graywacke, the schistosity of which strikes N. 85° E. and dips 52° N. The tunnel is driven along a shear zone which very nearly parallels the schistosity of the country rock. The shear zone strikes N. 80° E. to S. 88° E. and dips 55°-63° N. at different places in the tunnel. The width of the shear zone is from 2½ to 4 feet. It contains a few short lenses of white quartz with a maximum thickness of 4 inches. In places no quartz was visible in the tunnel. At the face of the tunnel narrow stringers of quartz with a maximum thickness of half an inch show in the shear zone, which is here 3 feet wide. The minerals recognized in hand specimens of ore collected on the property in 1914 are quartz, calcite, chlorite, pyrite, pyrrhotite, and chalcopyrite.

## BLUEBIRD GROUP.

The Bluebird group is on the southeastward-facing slope of the mountain west of the entrance to Shoup Bay, at an elevation of about 650 feet. The improvements on the property include a cross-cut tunnel 100 feet in length, with a 10-foot drift at the face of the tunnel, a 10-foot tunnel near the west end of the vein, open cuts on the vein, a trail from the shore to the prospect, and three buildings on the beach.

The country rock is a schistose graywacke, the schistosity of which has an easterly strike and a dip of 40°-60° N. The long tunnel is driven about 30 feet below the outcrop of the lead, which is traceable southwestward along the hillside for about 200 feet and appears to have about the same strike and dip as the schistosity of the country rock. The wall followed in the drift at the end of this tunnel strikes N. 75° E. and has a vertical dip. The ore body on the surface consists of a poorly defined mineralized shear zone 4 to 10 feet in width. The fissure filling is made up largely of lenticular masses of a much-shattered mineralized fine-grained to dense, heavy dark greenish-black basic dike rock. The shattered portions are in many places cemented by an irregular network of mineralized quartz. The shear is indistinct in the tunnel, although at the face bunches and irregular masses of quartz occur in the shattered country rock. The ore minerals are quartz, calcite, chlorite, pyrrhotite, chalcopyrite, galena, and pyrite.

**OTHER PROSPECTS.**

There are several other prospects in the Shoup Glacier valley and vicinity, which have not yet been studied but upon which considerable development work has been reported. On the property of the Rambler Gold Mining Co. a 230-foot tunnel and two shafts, 18 and 20 feet deep, were reported in 1913. A 130-foot adit has also been driven on the Bence-McDonald ground, and short tunnels are reported on the Ivanhoe property, near the head of Shoup Glacier; on some claims near the Minnie claim, on the right margin of Shoup Glacier; and on a claim near those of the Seacoast Mining Co., belonging to Henry Stevens.

Along the north shore of Port Valdez between the Cliff mine and Gold Creek several hundred feet of tunnels are reported on the Ellis Imperial, Black Diamond, and other properties, none of which have yet been visited.

**COLUMBIA GLACIER PROPERTIES.****GOLD KING MINE.**

The Gold King mine is at an elevation of 3,750 feet on the east end of an ice-surrounded mountain rising out of Columbia Glacier. It is about  $6\frac{1}{2}$  miles in an air line from Shoup Bay and 18 miles from the foot of Columbia Glacier. It is reached by a trail about 8 miles in length which leaves tidewater at the head of Shoup Bay, traverses Shoup Glacier to the Midway camp, at an elevation of 1,300 feet, and then crosses the high mountain range between Shoup and Columbia glaciers through a pass about 4,400 feet in elevation.

The Gold King ore body was located July 26, 1911, by Olaf Olsen, Frank Gustafson, and Hans Andersen, and several hundred pounds of high-grade ore was brought to Valdez in that and the following year. In October, 1912, after the locators had tapped the vein in a crosscut tunnel at the upper workings, the property was taken over by the Gold King Mining Co., which started development work on its own account in December, 1912. During the winter of 1912-13 machinery and supplies were taken in over Shoup Glacier, with the aid of gasoline hoists. In September, 1913, the surface improvements included a mill building, housing a crusher, feeder,  $3\frac{1}{2}$ -foot Huntington mill, amalgamating plates, and a concentrator, all operated by gasoline engines, besides several camp buildings. The camp was built on the terminal moraine of a small hillside glacier. The mill was at a slightly lower elevation. This company also owned the Midway camp, on Shoup Glacier, and two small wooden buildings on Shoup Bay. A telephone line connected the mine with Shoup Bay. A pack train and a dog team were used for the transportation

of supplies during the summer of 1913. In the winter of 1913-14 the bunk house was carried away by a snowslide.

Milling operations began August 13, 1913, and the mill ran for about 40 days that season. In 1914 the mill was started June 16 and ran until August 27.

The underground development work in September, 1913, when the property was visited,<sup>1</sup> consisted of No. 1 tunnel, with several hundred feet of drifts and crosscuts, a 60-foot winze, and 90 feet of drifts from the bottom of the winze; No. 2 crosscut tunnel, about 400 feet long, with 15 feet of drifts on a small fissure crosscut 260 feet from the portal; No. 3 crosscut tunnel, 60 feet long, with 40 feet of drifts; and some open cuts and stripping. The underground development in 1914 is said to have consisted in drifting west on a crosscut on the lower level and in stoping in the east vein and in the No. 1 vein. The long crosscut tunnel was also continued to a length of 669 feet, but the vein had not been encountered. Development work was in progress from early in March until September, and from 16 to 22 men were employed.

The country rock is chiefly graywacke but contains some zones of banded argillite, one of which has a width of about 50 feet. The bedding strikes N. 65°-72° E. and dips 62° N. to 90°. A granite outcrop, about 50 by 100 feet, intrusive into the graywackes and argillites and cut by mineralized quartz veins and stringers, is reported in the west end of Gold King Mountain.

Two veins are being developed on the Gold King claims—the upper or saddle vein (No. 1), on which most of the work has been done, and the lower vein (No. 3), east of the camp buildings. The saddle vein strikes N. 60° W. and dips 50°-60° S. Its width ranges from 2 to 18 inches, but the average width is probably under 1 foot. At one point the quartz occurs as narrow stringers in a belt of shattered mineralized graywacke 5 feet wide. The vein in many places shows secondary banding parallel to the walls. On the surface the vein has a good footwall but a less well defined hanging wall. Underground the footwall of the vein is well defined, the quartz usually breaking free but showing no gouge. On the hanging wall about an inch of gouge is present. This vein is cut by a fault which strikes N. 74° E. The filling of the fault fissure is from 2 to 18 inches thick and contains a little quartz. On the west side of this fault, about 120 feet southwest of No. 1 vein, a small vein 1 to 6 inches wide, striking nearly parallel to the fault, has been found.

No. 3 vein is tapped by a crosscut tunnel 60 feet long and is followed by drifts in both directions. This vein strikes N. 70°-77° W.

<sup>1</sup> Johnson, B. L., *Mining on Prince William Sound*: U. S. Geol. Survey Bull. 592, pp. 237-238, 1914.

and dips  $65^{\circ}$ – $70^{\circ}$  N. It shows a width of 8 to 36 inches of solid quartz, and in one place a width of 5 feet is reported. The vein shows considerable secondary banding parallel to the walls of the fissure, the hanging wall of which breaks free. The hanging wall carries from 4 to 8 inches of gouge, and in places the gouge is visible on both walls.

In the long crosscut tunnel (No. 2) a fissure striking N.  $85^{\circ}$  E. and dipping  $70^{\circ}$  N. was cut 260 feet from the portal. The fissure has well-defined walls and the fissure filling ranges from 15 to 30 inches in width. Quartz occurs as small stringers in the soft iron-stained fissure filling.

The ore is free milling. Quartz is the dominant gangue mineral, although calcite and a cream-colored, brown-weathering carbonate are also present. The metallic minerals in the ore are gold, pyrite, galena, sphalerite, chalcopyrite, and stibnite. The ore contains about 3 per cent of sulphides. Pyrite cubes impregnate the graywacke adjacent to the veins. Limonite and the red and yellow alteration products of stibnite are found in the weathered outcrops of the veins.

#### CLAIMS OF MAYFIELD GOLD MINING CO.

The claims of the Mayfield Gold Mining Co. are on the steep southward-facing slope of a mountain jutting westward into Columbia Glacier in the extreme western part of the Port Valdez district, about  $7\frac{1}{2}$  miles from tidewater on Shoup Bay. The ore body lies at an elevation of nearly 3,000 feet above sea level and is reached from Shoup Bay by a trail through the Anderson Glacier pass. Assessment work only has been done on these claims since July, 1912. The underground developments in August, 1914, consisted of two tunnels—an upper crosscut tunnel 105 feet in length and a lower tunnel with nearly 350 feet of drifts and crosscuts.

The country rock of the ore deposit consists of closely folded graywackes and argillites, the bedding and schistosity of which strike N.  $70^{\circ}$ – $80^{\circ}$  E. and dip  $50^{\circ}$ – $60^{\circ}$  N. West of the lower tunnel parallel jointing, striking N.  $20^{\circ}$ – $30^{\circ}$  W. and having a vertical dip, is rather conspicuous.

About 50 feet above the upper tunnel a poorly defined fissure is traceable S.  $70^{\circ}$  E. along the hillside for a distance of several hundred feet, cutting the schistosity of the interbedded graywackes and argillites at a slight angle. At intervals along this fissure there are stringers, bunches, and lenses of quartz in the fissure filling. This break is also traceable for a considerable distance west of the ore body now developed. Practically no quartz is visible in this portion of the outcrop of the fissure, however, but the adjacent country rock is markedly iron-stained. The ore body under development lies at

the intersection of the fissure above mentioned with a spur break, striking N. 20°-30° W. and dipping 50° E. The spur lead has been stripped for about 50 feet from the mouth of the upper tunnel to its junction with the other fissure, which it does not appear to cross. Above the upper tunnel the main fissure contains about 10 feet of ledge matter, a large part of which is quartz. From this point considerable quartz shows in this fissure for a distance of about 200 feet westward to a point just beyond the junction of the main and spur leads. At the junction of the two leads a maximum width of 8 feet of solid quartz is visible. The spur lead shows on the outcrop from 1 to 6 feet of quartz. The fissure cut at the face of the upper tunnel has a strike of N. 30° W. and a dip of 45° E. In the lower tunnel, which is about 100 feet below the outcrop of the main vein, a fissure was cut 200 feet from the portal of the tunnel. A drift was driven 90 feet westward along this fissure, which has a strike of S. 70° E. and a dip of 60° N. where crosscut. It ranges from 1 foot to 5 feet in width. The fissure filling is composed of sheared and shattered graywackes and argillites with a comparatively small amount of quartz. At the end of the drift on this fissure a large quartz vein, probably the spur lead, was encountered. A 30-foot drift has been driven along this vein, which has a strike of N. 30° W., the same as that of the spur lead on the surface.

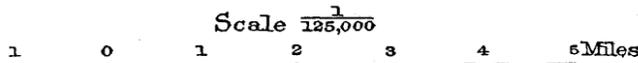
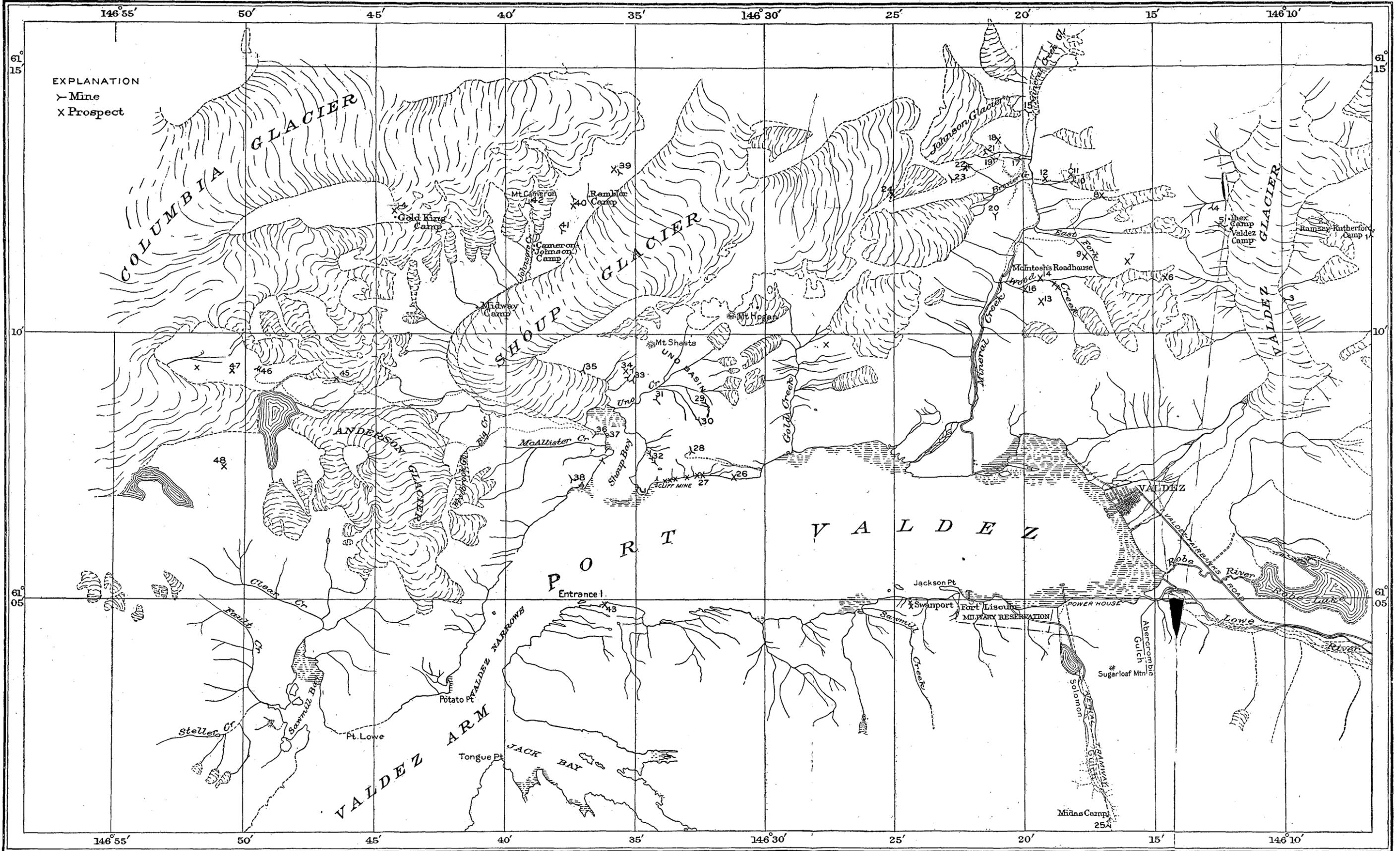
Quartz was the only nonmetallic gangue mineral observed in the Mayfield ore. The metallic minerals include gold, pyrite, chalcopyrite, galena, sphalerite, and arsenopyrite. Limonite and the greenish oxidation products of arsenopyrite are visible on the weathered outcrop of the veins.

#### OTHER PROSPECTS.

A small amount of development, chiefly the result of assessment work, has been done on a few other prospects near Columbia Glacier, which have not yet been visited by Geological Survey parties. One of these properties, originally located as the Bessie Williams, was restaked in 1914, and preparations for its development were being made during the summer by the Mammoth Mining Co.

#### GOLD PLACERS.

Placer operations have never created a great deal of interest in the Port Valdez district. The gravel areas are small, and much of the gravel has a low gold content. In 1914 a small amount of placer gold was obtained from the upper reaches of Lowe River and from sluicing operations on the upper end of Mineral Creek. Some of the gravel flats on Mineral Creek were tested also by drilling.



MAP OF THE PORT VALDEZ DISTRICT, SHOWING MINES AND PROSPECTS.

On Gold Creek the Budd Mining Co. continued preparations to work gold placers in the basin above the lower falls. Commencing April 22 six men were employed in clearing the trail and freighting supplies and construction materials from the beach to the Gold Creek basin. The force was increased in two weeks to eight men, and that number was employed until June 16, when the work was stopped for the season owing to a proposed change of ownership. During this time a false dam was built for the diversion of water to permit the laying of bed pieces for the true dam. At the time of stopping the mudsills for the true dam had been laid in concrete on bedrock. About 200 feet of 3 by 6 foot flume had also been built, which will give a head of 120 to 150 feet for hydraulicking.

#### SOLOMON GULCH.

##### MIDAS MINE.

The Midas copper mine, now the property of the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), of Canada, is situated at an elevation of about 800 feet above sea level, at the base of the mountain ridge bordering the west side of Solomon Gulch, about  $4\frac{1}{2}$  miles from Port Valdez.

The surface developments on the property in the fall of 1914 comprised a wagon road from the shore to the mine; an aerial tram,  $4\frac{1}{2}$  miles long, nearly completed from the bay to the mine workings; wharf and ore bunkers at the coast terminal of the aerial tram; several buildings on shore near the wharf; ore bunkers, bunk house, three cottages, and foundations for two more, at the mine. The principal underground developments consist of two adits, each several hundred feet in length, with a vertical interval between them of 92 feet, and three raises, two of which connect these two levels. The total underground developments are reported to include over 1,600 feet of tunnels, drifts, and raises. About 150 feet of this work is said to have been done during July and August, 1914. There are also some shallow shafts and strippings on the outcrop of an ore body upstream from the mine camp. The number of men employed on the property varied from 15 to 75 during the year. The property was closed August 31, 1914, after the outbreak of the European war.

The country rock of the ore deposits is composed of black slates, argillites, graywackes, cherts, light-gray and greenish schists, and greenstones, with some associated light-colored aphanitic silicic intrusive rocks. Most of the rocks exposed in the immediate vicinity of the mine are sedimentary. A large mass of greenstone, coarsely crystalline in some places and sheared in others, crops out near the head of the valley. Heavy-bedded graywackes occur above the mine.

The present developments show two apparently distinct ore bodies, one on the west side of the valley, where the present extensive developments are being made, and the other about half a mile upstream from this locality, in the middle of the valley bottom. Both deposits occur in mineralized shear zones. The lead now under development has been traced for several hundred feet into the hill by the tunnels. On the surface the highest showing of ore is about 650 feet above the lower long tunnel. The strike of the shear zone lies between N. 75° W. and S. 62° W. and the dip is 40°-70° N. The width ranges from 1 foot to 14 feet but the average width of ore is between 3 and 4 feet. The other ore deposit appears as a sulphide-impregnated, closely folded, shattered, and sheared series of sedimentary rocks; the mineralized zone is wider and the ore in this zone is said to be of lower grade than in the developed ore body at the mine camp. The bedding and schistosity at this deposit strike N. 57° W. and dip 60° N.

The ores are partly replacements 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, and pyrrhotite. It was thought that sphalerite was detected in some of the specimens, but it was too fine grained for macroscopic determination. Numerous tests for zinc with negative results are reported by local assayers, so that it is believed that sphalerite is scarce or lacking in this ore. A little quartz is associated with the sulphides. Some limonite has resulted from the surficial oxidation of the iron-bearing sulphides, and malachite stains from the carbonation of copper minerals. Gold and silver are reported in assays of the ores, but neither metal has been observed in specimens. With the exception of galena and arsenopyrite, which have not been observed in the specimens examined, the association of metallic minerals is the same as that of the other copper deposits and the gold quartz deposits of the Prince William Sound region.