# THE PORT WELLS GOLD-LODE DISTRICT.

By B. L. Johnson.

## INTRODUCTION.

### SCOPE OF REPORT.

The object of this report is to describe briefly the distribution, geologic relations, and characteristics of the gold deposits of the Port Wells district. Before the geology and mineral resources of the district are considered a concise description of the principal factors bearing on the economic development of the mineral deposits of the district will be given. This will be followed by a description of the geology, sufficiently complete to permit an understanding of the occurrence of the mineral deposits, the general discussion of which is followed by detailed descriptions of many of the ore deposits.

### PREVIOUS WORK IN THE DISTRICT.

The earliest recorded exploration of the Port Wells district was made in June, 1794, by Whidbey, of Vancouver's[1] expedition. While Vancouver's ships lay in Port Chalmers, on Montague Island, a boat party in charge of Joseph Whidbey, in a yawl and a small cutter, examined and mapped the west shore of Prince William Sound from the southwest entrance to Bligh Island. Whidbey entered Port Wells, passing between Culross and Esther islands, visited Passage Canal and College Fiord, and left through Esther Passage. Ninety-three years later, in 1887, Capt. S. Applegate [2] in the schooner yacht *Nellie Juan*, explored and charted Port Wells. In 1898 an expedition under Capt. E. F. Glenn, of the United States Army, visited Port Wells. The reports of this expedition [3] contain much geographic information concerning this part of Alaska; that of W. C. Mendenhall,[4] who was attached to this expedition as geologist, furnished the first geologic information regarding the Port Wells

[1] Vancouver, George, Voyage of discovery to the North Pacific Ocean [etc.] in the years 1790-1795, 3 vols., maps, London, 1798; new ed., with corrections, 19 views and charts, 6 vols. (see vol. 5, pp. 269-320), 1801.

[2] Davidson, George, The glaciers of Alaska: Geog. Soc. Pacific Trans. and Proc., 2d ser., vol. 3, pp. 1-98, maps, 1904.

[3] Glenn, E. F., and Abercrombie, W. R., Reports of explorations in the Territory of Alaska (Cooks Inlet, Sushitna, Copper, and Tanana rivers), 1898, War Dept., Adjt. General's Office, No. 25, 1899.

[4] Mendenhall, W. C., A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898; U. S. Geol. Survey Twentieth Ann. Rept., pt. 7, pp. 265-340, 1900.

district. In the following year (1899) the Harriman Alaska Expedition [1] spent several days in Port Wells, and the reports of the members of this expedition furnish much information regarding this district, especially on the glaciers and glaciation. In 1904 Davidson [2] compiled the existing data regarding the coastal glaciers of Alaska and described some of the Port Wells glaciers. Grant and Paige, in 1905, and Grant and Higgins, in 1908 and 1909, visited Port Wells on geologic reconnaissances for the United States Geological Survey. Certain of their reports [3] contain considerable data regarding the geography and geology of the Port Wells district. The National Geographic Society's expedition of 1910, under Lawrence Martin,[4] studied the glaciers and glaciation of College and Harriman fiords. Notes on the fluctuations of the glaciers of Port Wells have been published by Reid [5] from data obtained from Grant and Martin.

## PRESENT INVESTIGATION.

The present investigation was undertaken as a result of numerous discoveries of gold-quartz deposits in the Port Wells district. Field work in this district was begun August 9, 1913, and brought to a close September 15, 1913. The use of the launch *Prospector*, of Cordova, Capt. George E. Scott, greatly facilitated the work. The base of the accompanying map (Pl. IX) was the reconnaissance map published as Plate II in Bulletin 443, United States Geological Survey, corrected by later surveys made by the United States Geological Survey and the United States Coast and Geodetic Survey, as shown on chart 8550.

For information furnished and assistance rendered during the course of the investigation the writer wishes to express his obligations to Messrs. George E. Scott, W. B. Harris, W. C. L. Beyers, Stephen Roe, Axel Frodenburg, W. L. Taylor, and many others.

[1] Burroughs, John, Narrative of the expedition: Alaska, vol. 1, Harriman Alaska Expedition, pp. 1–118, 1902. Emerson, B. K., General geology; Notes on the stratigraphy and igneous rocks: Alaska, vol. 4, Harriman Alaska Expedition, pp. 11–56, 1904. Gannett, Henry, General geography: Idem, vol. 2, pp. 257–277, 1902. Gannett, Henry, Harriman Alaska Expedition: Nat. Geog. Mag., vol. 10, pp. 507–512, 1899; Am. Geog. Soc. Bull., vol. 31, pp. 344–355, 1899. Gilbert, G. K., Glaciers and glaciation: Alaska, vol. 3, Harriman Alaska Expedition, 231 pp., 27 pls., 11 figs., 1904. Muir, John, Notes on the Pacific coast glaciers: Idem, vol. 1, pp. 119–135, illus., 1902.

[2] Davidson, George, The glaciers of Alaska: Geog. Soc. Pacific Trans. and Proc., 2d ser., vol. 3, pp. 1–98, maps, 1904.

[3] 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, 1910. Grant, U. S., and Higgins, D. F., (1) Glaciers of Prince William Sound and the southern part of the Kenai Peninsula, Alaska; (2) Glaciers of Port Wells, Prince William Sound: Am. Geog. Soc. Bull., vol. 43, pp. 321–338, 13 figs., 1911. Grant, U. S., and Higgins, D. F., Coastal glaciers of Prince William Sound and Kenai Peninsula, Alaska: U. S. Geol. Survey Bull. 526, 1913.

[4] Martin, Lawrence, The National Geographic Society's researches in Alaska: Nat. Geog. Mag., vol. 22, pp. 551–554, 556–560, 1911. Martin, Lawrence, Gletscheruntersuchungen längs der Küste von Alaska: Petermann's Mitt., Jahrg. 58, pp. 78–81, 3 pls., 1 map, 1912. Martin, Lawrence, Some features of glaciers and glaciation in College Fiord, Prince William Sound, Alaska: Zeitschr. für Gletscherkunde, Bd. 7, Heft 5, pp. 289–333, 1913. Martin, Lawrence, Alaskan glacier studies (in press).

[5] Reid, H. F., The variations of glaciers: Jour. Geology, vol. 17, pp. 667–671, 1909; vol. 19, pp. 454–461, 1911. Reid, H. F., Les variations périodiques des glaciers: XVIme rapport, 1910; Amérique du Nord: Zeitschr. für Gletscherkunde, Bd. 6, Heft 2, pp. 100–103, 1911.


MAP OF THE PORT WELLS GOLD-LODE DISTRICT.

**Key to Mines and Prospects.**

1. Cann & Minor.
2. Conley & McChesney.
3. Sweepstake Mining Co.
4. Morning Star; North Star: Consolidated.
5. Nugget claim.
6. Mayflower claim.
7. Golden Wonder No. 9 claim.
8. Frodenburg & Bloom.
9. Mountain claim.
10. Lucky Swede claim.
11. Golden Wonder No. 1 claim.
12. Arrowhead (Johnson & Johnson) claim.
13. Edwin Grieet.
14. Golden Eagle claim.
15. H. M. Carter.
16. Tobson & Stainton.
17. Paymaster (Peter Black) claim.
18. Hammel & Howell.
19. Walters, Brandin & Atkinson.
20. Stanaton & Mills.
21, 22. Charles Cameron.
23. Edwin Grieet and O. T. Benson.
24. Mitchell & Myers.
25. Sheehan & Morgan.
26. Black & Hogan.
27. Halter & Olson.
28. Sweepstake Mining Co.
29. White & Jones.
30. Michael Vincent.
31. Olsen & Vlatis.
32. A. P. Yannes.
33. Anderson & Yannes.
34. Joseph Harris.
35. Granite Gold Mining Co.
36. Reed, Gauthier & Cooper.
37. Yakima claim.
38. Hermann & Eaton.
39. George & McFarland.
40. Everson, Harris & Parker.
41. Westburg & Dorsonnet.
42. Dunklee & Reilly.
43. Kavanaugh & Boom.
44. Collins, Fish & Stewart.
45. Collins, Fish & Berry.
46. Bullion lodge.
47. Hillside claim.
48. Ernest King.
49. Gray Bros.
50. Stewart & Fish.
51. White & Pedersen.
52. Thomas-Cutrose Mining Co.
53. John Sells.

## GEOGRAPHY.

### LOCATION.

The Port Wells gold-quartz district lies in the northwest part of Prince William Sound and as here considered comprises the area adjacent to Port Wells and its tributary fiords. (See Pl. IX.) It includes Esther and Culross islands and the shores of the mainland bordering Esther and Culross passages and Eaglek Bay and also a small part of Kenai Peninsula lying farther southwest. As thus defined the district lies between parallels 60° 30′ and 61° 20′ north latitude and meridians 147° 40′ and 148° 50′ west longitude, and includes a total land, ice, and water area of about 750 square miles. The Port Wells district is within the Valdez recording district of the third judicial division of the Territory of Alaska. The recorder's office is at Valdez.

### TOPOGRAPHY.

The Port Wells district lies within the Pacific Mountain province of Alaska and includes parts of the Chugach and Kenai mountains.[1] A low gap, occupied by the Portage Glacier, separates the Kenai and Chugach mountains.

The district has been intensely glaciated and includes two distinct types of glacial topography, one the result of high-level erosion, with sharp peaks, cirques, and comb ridges shaped by frost action above the surface of the glacier ice; the other the result of low-level erosion, with the rounded features of an area overridden and smoothed beneath glacial ice, which left rounded hills and spurs and U-shaped valleys.

The forms due to high-level erosion are found only in the higher mountains. High, sharp ranges border Port Wells and its tributary fiords on the west and north, and also occur in the northeast Kenai Mountains. The highest peaks are in the main range of the Chugach Mountains west and north of Port Wells. The maximum relief is found west of Harriman Fiord, where Mounts Gilbert and Muir rise to heights of 10,194[2] and 8,207[2] feet above sea level, respectively, within distances of 5¼ and 2 miles, respectively, from the fiord. Mount Gannett,[2] west of Barry Glacier, has an elevation of 9,240 feet. Higher peaks occur north of College Fiord, but the relief is less. The peaks on the outlying ridges of the main ranges, such as the ridge between College Fiord and Unakwik Inlet and the range between Passage Canal and Harriman Fiord, are from 4,000 to 8,000 feet high.

The rounded features produced by overriding glaciers are found on the lower slopes of the high, sharp ranges on Harriman and College fiords, Blackstone Bay, Passage Canal, Portage Passage, and on the borders and around the southern end of the sharp ridge between Col-

[1] Brooks, A. H., The geography and geology of Alaska: U. S. Geol. Survey Prof. Paper 45, pp. 16–17, 27–36, 1906.

[2] Martin, Lawrence, The National Geographic Society's researches in Alaska: Nat. Geog. Mag., vol. 22, p. 540, 1911; Alaskan glacier studies, p. 319 (in press).

lege Fiord and Unakwik Inlet. The foothills of these ranges on Point Pakenham, on the peninsula between Harriman Fiord and Port Wells, and between Cochrane Bay and Port Nellie Juan, also exhibit rounded features, and Esther and Culross islands are covered by rounded glaciated summits and slopes. Other characteristic low-level sculptured forms are everywhere seen within these areas. Practically all of this rounded topography lies below an elevation of 5,000 feet above sea level.

The shore line of the Port Wells district is very irregular, deeply indented, and fiorded like the rest of Prince William Sound. No part of the district is over 6 miles from tidewater.

The streams of the district are short, none being over 3 to 4 miles long. The principal streams are Coghill and Avery rivers. Coghill River is reported to drain a rather large lake. Members of the United States Geological Survey measured the discharge of some of the streams of the Port Wells district in 1913, and the results are presented elsewhere in this volume. The discharge of most of the streams varies greatly from season to season, the streams deriving a considerable part of their water from melting snow and glaciers. The steep gradients of some of the streams and numerous waterfalls offer possible sources of power for use in mining and other industries. A sawmill, driven by an overshot water wheel, was erected at the mouth of Avery River in 1913, and an arrastre near Golden was also driven by an overshot water wheel.

The present glaciers of the Port Wells district are principally of the alpine type. Rather extensive ice and snow fields, however, lie in the northern part of the peninsula between Harriman Fiord, Port Wells, and Passage Canal, in the mountainous country north of College Fiord, and in the area southwest of Blackstone Bay. Cap Glacier, south of the Crescent Glacier, between College Fiord and Unakwik Inlet, is reported to be a thin névé field, intermediate in character between the snow fields and the valley glaciers. The main centers of glaciation are in northeastern Kenai Peninsula and in the areas southwest, west, and north of Harriman Fiord and west and north of College Fiord. A few glaciers originate in the high parts of the peninsula between College Fiord and Unakwik Inlet. The most numerous glaciers of the Prince William Sound region are about the two northern arms of Port Wells—College and Harriman fiords. Most of these glaciers reach tidewater and are constantly discharging icebergs. Detailed descriptions of many of these glaciers have been published.

The submarine topography of the district does not differ greatly from that produced by the low-level sculpturing above sea level.[1] It appears to be chiefly the result of glacial erosion, as it shows little

[1] Martin, Lawrence, Some features of glaciers and glaciation in College Fiord, Prince William Sound, Alaska: Zeitschr. für Gletscherkunde, Bd. 7, Heft 5, pp. 32, 34–41, 1913. Martin, Lawrence, The National Geographic Society's researches in Alaska: Nat. Geog. Mag., vol. 22, 1911. Martin, Lawrence, Alaskan glacier studies (in press). U. S. Coast and Geodetic Survey chart No. 8550.

deposition of sediments. Below sea level, the fiords, which were widened and deepened by glacial erosion, have the characteristic U-shaped cross sections, submarine hanging valleys, rock basins, confluence steps, and terminal moraines. These features are believed to have been caused by submarine glacial scouring. The depth of water along the axis of College Fiord ranges from 174 to 804 feet. In Harriman Fiord the maximum depth of water is 510 feet, in Pigot Bay 408 feet, in Barry Arm 588 feet, in Passage Canal 1,176 feet, in Blackstone Bay 1,188 feet, and in Port Wells, 1,518 feet. In the pocket between Culross, Esther, and Perry islands a sounding of 1,584 feet has been made. Typical submarine hanging valleys are the Yale Arm of College Fiord, which hangs 500 feet above the main fiord, Bettles Bay, and the cove of Serpentine Glacier, in Harriman Fiord. College Fiord and Barry Arm unite to form Port Wells, above which their mouths hang 350 to 400 feet. A submarine rock basin is shown by soundings in Pigot Bay. Submarine terminal moraines cross the mouths of Barry Arm and College Fiord.

## CLIMATE.

No weather records have been kept within the area described in this report, but some are available for adjacent districts, at Seward, Sunrise, Valdez, and Cordova. The Port Wells district lies within the Pacific coast climatic province, the climate of which is essentially temperate and humid, being characterized by heavy precipitation and a comparatively high mean annual temperature.

The precipitation is about 132 inches at Cordova, 74 inches at Valdez, and 54 inches at Seward. In 1912 the total annual precipitation at Cordova was about 191 inches, but the rainfall in that year was exceptionally heavy in all parts of Prince William Sound. The records show further an average at different localities of 90 to 240 days in which some precipitation takes place. The total annual snowfall is 5 to 8 feet at Seward, 6 feet on Trail Creek, on the Alaska Northern Railroad, and 12 feet at Valdez.

The mean annual temperature of this province is 40° to 48° F. The lowest temperature recorded from this region is −14° F.; the highest is 82° F. The summers are cool, the average for the three summer months being about 51° F. The average temperature for the three winter months is 20° to 30° F.

Within the Port Wells district climatic conditions vary, but probably within the above limits. That lower temperatures prevail near the heads of the fiords than in other parts of the district is shown by the fact that the timber line descends to sea level at those points, whereas in the southeast part of the district, for example, in favorable situations, the conifers extend about 1,500 feet above sea level. Severe seaward-blowing winds are reported at the heads of the fiords in the winter.

## TIMBER AND VEGETATION.

Only a small part of the total area of the district is forested, as is shown on the accompanying map (fig. 3), timber line being taken as the upper limit of coniferous trees. Timber line ranges from sea level at the upper ends of College and Harriman fiords, where the timber is small, grows in scattered groups, and is accompanied by

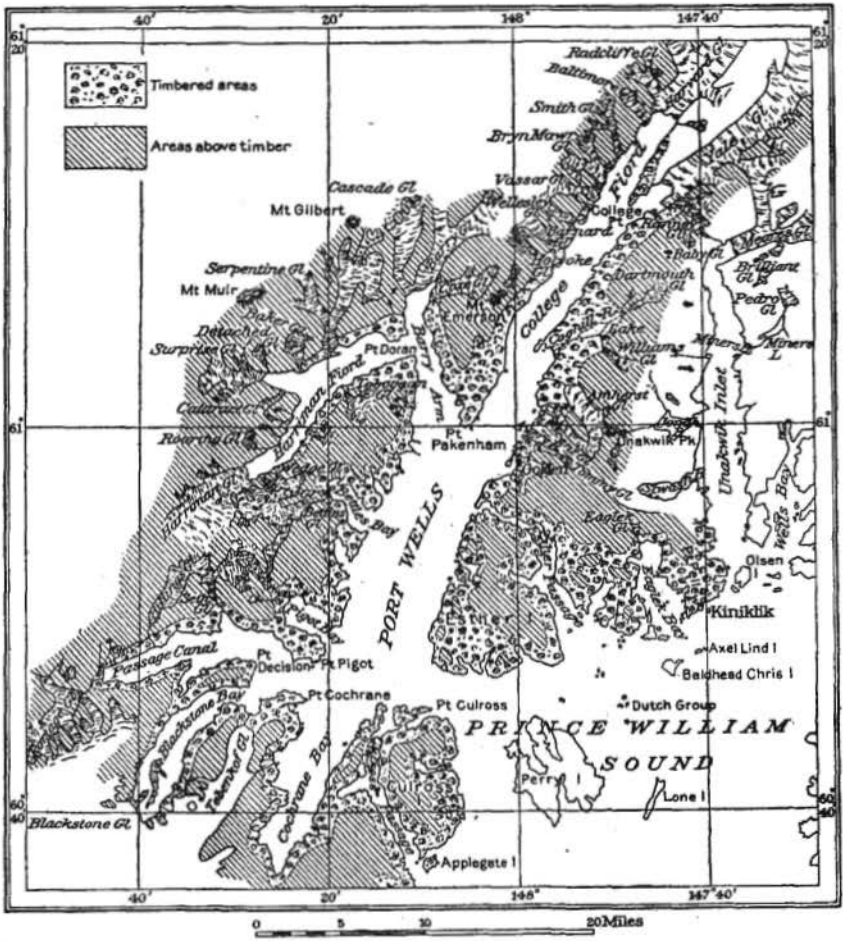


FIGURE 3.—Sketch map showing distribution of timber in the Port Wells district.

little underbrush, to an elevation of about 1,500 feet in favorable situations in the southeastern part of the district, where heavy growths are found on the lower slopes. The forest trees are chiefly conifers, including spruce, western hemlock, and mountain hemlock. The native deciduous trees are cottonwood, willow, poplar, birch, and alder.

The Port Wells district is included within the Chugach National Forest, and the use of the timber is subject to the regulations of the

Forest Service, United States Department of Agriculture. The local office of the Forest Service is at Cordova. Commercial stands of timber are reported on Coghill River, Point Pakenham, Esther Passage, Harrison Lagoon, and Hummer Bay. Several booms have been cut in the Port Wells district for the Valdez sawmill. Only spruce trees are used. A few of the trees reach a diameter of 5 to 6 feet at the base, but these larger ones are usually branchy close to the base or are churn-butted, that is they taper abruptly. The size of butts in booms, measurements being made 16 feet above the cut, ranges from 17 to 36 inches, the average size being from 18 to 24 inches. Lumber suitable for most purposes can be cut near many of the prospects. The local needs for saw lumber are at present slight and will probably be largely met by a sawmill erected near the mouth of Avery River in 1913. Saw lumber is also obtainable at Valdez.

Devil's-clubs, salmonberries, blueberries, ferns, mosses, and flowers are abundant. Native grasses, suitable for horse feed, grow luxuriantly in some of the valleys and around timber line. All soils are glacially derived.

### ANIMAL LIFE.

Mountain goats, a few black bears, and rarely brown bears are reported within the Port Wells district. Moose tracks have been observed by prospectors at the head of Port Nellie Juan on Kenai Peninsula, and possibly moose may occasionally stray into the Port Wells district. Keeler,[1] in 1899, noted Townsend's sparrow, the redpoll linnet, the Arctic tern, the short-billed gull, and the black oyster-catcher in Port Wells. Ptarmigan, tattlers, murrelets, ducks, and grouse have also been reported. Salmon, cod, trout, and other fish are caught in the waters of the district. Clams are found in a few places.

### TRANSPORTATION.

The Port Wells district is reached by water. The main fiords and bays are navigable for large boats,[2] and at different times several of the large ocean-going steamers have entered these waters. Up to 1913 these visits have been irregular, however, no regular schedules or calling points having been maintained. In 1913 a 40-foot gasoline launch made weekly trips between Valdez and Golden, a distance of about 80 miles, carrying mail, passengers, and freight, stopping at Bettles and Hobo bays on each trip and making boat connections at Valdez for other Alaskan points and for Seattle. In 1913 there were no wharves or other means of landing in the Port Wells district and no hotels or roadhouses.

[1] Keeler, Charles, Days among Alaska birds: Alaska, vol. 2, Harriman Alaska Expedition, pp. 205–234, 1902.

[2] U. S. Coast and Geodetic Survey chart No. 8550.

Local transportation is largely by water, numerous small gasoline launches and rowboats being in use by prospectors for transporting supplies along the coast from the main distributing points. Though the conditions for water travel are especially favorable, land travel is difficult. The fiorded coast and mountainous back country will prevent any systematic development of land transportation within the district. A low pass between the head of Passage Canal and Turnagain Arm has been used by natives, Russians, and prospectors for many years for crossing from Cook Inlet waters to Prince William Sound. Trails have been built from many of the prospects to the nearest landing places on the shore, but they are usually steep and not well graded.

A fourth-class United States post office was established June 5, 1912, at Golden. The only local mail route maintained by the Post Office Department in 1913 was from Valdez by Unakwik Inlet (no office), Wells Bay (no office), and Hobo Bay (no office), to Golden and back twice a month from April 1 to October 31, and once a month from November 1 to March 31, each year. The contractor is required to perform the service by steamboat or other power boat.

## POPULATION AND SETTLEMENTS.

Golden, on the east side of Port Wells, about 4 miles north of Esther Passage, was the only settlement in the district in 1913. It consists of a few cabins and tents scattered along the east shore of a small bay. The town is the main distributing point for the district, and supplies for prospecting are obtainable here at a slight advance over Valdez prices. There are no other permanent settlements in the district, but cabins have been erected on Avery River, Barry Arm, Thomas Bay on Culross Island, Bettles Bay, at Port Wells between Hobo Bay and Harrison Lagoon, and at Hobo Bay.

Gold quartz was first discovered in the vicinity of Golden in July, 1911, and in September, 1911, 21 tents were standing on the sand spit at Golden. About 150 men were prospecting around Golden in that year. In 1912 there were a few prospectors in the district, and 49 men are reported to have voted at the election in Golden in that year. About 20 people remained in Golden during the winter of 1912–13. In the early part of the summer of 1913 there were 75 to 100 men in the district, but later some of these left for the Chisana. There were only 12 men in Golden on September 8, 1913.

The population is chiefly white and is interested principally in prospecting for and developing gold-quartz properties. As in other mining districts of Alaska, the population is greatest in the summer.

## GEOLOGY.

### GENERAL FEATURES.

The Chugach and Kenai mountains, within which the Port Wells district lies, consist, so far as known, of closely folded sedimentary rocks, chiefly slates, argillites, and graywackes, and of minor amounts of greenstones and some large intrusive masses of granitic rocks. Mesozoic and Paleozoic sediments are probably included in the series, but neither the detailed structure nor the stratigraphic succession are known. Earlier workers in Prince William Sound have subdivided the rocks of that region into two great divisions, the Valdez and Orca groups. The Valdez group, presumably the older and more metamorphosed, is described as consisting principally of slates and graywackes; the Orca group comprises interbedded slates and graywackes, with extensive greenstone flows and agglomerates, as well as thick conglomerate beds. Granitic stocks are reported to intrude both Orca and Valdez rocks. The Valdez group has been assigned to the Paleozoic era by earlier writers, and the Orca has been considered of Mesozoic age.

After making a reconnaissance of the entire Prince William Sound region Grant and Higgins [1] have mapped the rocks of the Port Wells district as a part of the Valdez group. In 1913, however, fossils similar to those by which Grant and Higgins [2] assigned a probable Mesozoic age to the Orca group were found at several localities in the Port Wells district, and doubt was thereby cast on the assignment of at least a considerable part of the rocks of this district to the Valdez group.

### SEDIMENTARY ROCKS.

#### SUBDIVISIONS.

The pre-Quaternary sedimentary rocks of this district are all regionally metamorphosed types, but some of them have been altered by local contact metamorphism produced by the intrusion of the large granite stocks. The variety of sedimentary rocks is not great. Four general lithologic subdivisions may be made: (1) Greenstones; (2) schists, slates, argillites, graywackes, and conglomerates; (3) contact-metamorphic rocks; and (4) conglomerates. The stratigraphic sequence of these subdivisions is probably the order in which they are mentioned, except the greenstones, whose position in the geologic column is not known.

[1] 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, Pl. II, 1910.

[2] Idem, pp. 32-33.

### GREENSTONES OF CULROSS ISLAND.

A broad band of greenstone outcrops on the south shore of Thomas Bay, Culross Island, extending from the entrance to within half a mile of the head of the bay, a distance of about 2 miles. This greenstone band strikes about S. 30° W. and dips between 80° W. at the west contact and 75° E. at the east contact of the greenstone and adjoining slates. A narrower band of greenstone, outcropping on the east shore of Culross Passage about 3 miles from the southern entrance, has a slightly more southerly strike and a dip of 70° W.

These greenstones are greenish, much altered, basic igneous rocks, presumably lava flows. They range from light-green aphanitic, cherty-looking varieties to dark-green, very fine grained varieties. On Thomas Bay they are, as a whole, hard and massive but are sheared in many places. At the Culross Passage locality they are altered to light-green schists. Some of these schists were originally finely porphyritic rocks, with small feldspar phenocrysts.

### SLATES, ARGILLITES, GRAYWACKES, AND CONGLOMERATES.

An interbedded series of slates, argillites, graywackes, and conglomerates covers the greater part of the Port Wells district. These rocks, so far as known, are of about the same age. Their relations to other formations are not known, and their subdivision into lithologic units must await detailed mapping. The total thickness of this series of rocks is not known, but must be many thousand feet. The eastern slopes of the mountains west of College and Harriman fiords, except Mount Emerson and its neighboring peaks, present in many places an apparent unbroken sequence of westward-dipping beds extending from sea level to their summits. Mount Muir, about 8,000 feet high, appears to consist chiefly of uniformly westward-dipping graywackes, including only here and there thin bands or lenses of slate. Near the summit of this mountain is a broad black band, probably slate, which is traceable for a great distance along the south and southeast faces of the mountain. On the west side of College Fiord and west of Barry Glacier individual graywacke members in a westward-dipping series, consisting chiefly of graywacke, are traceable for many thousand feet. North of Passage Canal cirques cut in northwestward-dipping sediments expose a section measuring 2,000 to 3,000 feet, consisting chiefly of graywacke but including four broad bands of slate which are traceable for fully a mile along the walls of the cirque. The section also includes zones consisting of narrow alternating bands of graywacke and slate. The rocks of the Point Pakenham group of peaks and the rest of the district are much more highly folded and faulted.

The general strike of the bedding and schistosity in the Port Wells district is from S. 30° W. to S. 70° W., conforming in general with the

trend of the major topographic features of the district. The dips range from 60° W. to vertical, although a few easterly dips occur. The least deformed areas, as noted above, are in the high mountains in the west and northwest parts of the district.

Narrow alternations as well as more massive aggregates of each lithologic type occur within this series, and the individual beds range from narrow streaks to broad zones measuring many hundred feet across. Broad zones of thin-bedded slate and argillite alternate with broad bands of graywacke, and massive graywackes and argillites are seen, with only here and there a narrow band of slate. The contacts between slates and graywackes are abrupt and sharp, as are those between argillites and either slate or graywackes, but the conglomerates grade with no sharp breaks irregularly into the inclosing graywackes and show no planes of sedimentation.

Conglomerates are of widespread occurrence but are the least abundant of the members of the sequence. They are best developed on Harriman Fiord, College Fiord, and on the west side of Port Wells. Conglomerate bowlders are also found in the east lateral moraine of the Yale Glacier. Both pebbles and matrix of these conglomerate bowlders are cut by quartz veins. The conglomerate on Harriman Fiord also is cut by quartz veins, some of which are reported by prospectors to be well mineralized. The conglomerate on the north side of Harriman Glacier is at least several hundred feet thick and has been traced for fully a mile along the strike. Most of the conglomerate beds of the district have a thickness of only a few feet. The conglomerates are well lithified, joint cracks cutting across the pebbles. The matrix, which is light to dark gray in color, is predominantly a fine-grained graywacke; rarely it is argillaceous. The matrix usually forms but a comparatively small part of the rocks, the proportions increasing, however, with the gradation of the conglomerates into graywackes. The pebbles include slate, quartz, argillite, quartzite (?), chert, felsite, diabase, and altered andesitic rocks. Their color ranges from the white of the quartz through the light-green of altered igneous rock to the dark grays and black of the argillites and slates. No pebbles of granite similar to the granites of the Port Wells district were observed in these conglomerates. The pebbles in some of the conglomerate beds are chiefly thin angular slate fragments, few having diameters greater than 3 inches. In other beds the pebbles were chiefly of the harder rocks and these are usually well rounded and well assorted.

The graywackes are massive light to dark gray fine-grained sedimentary rocks. They are composed chiefly of subangular fragments of quartz and feldspar, together with fragments of other minerals and rocks, embedded in a fine-grained carbonaceous, calcareous, and argillaceous matrix. The coarser beds in many places contain flat angular fragments of slate. In some of the graywackes small fragments

of fine-grained igneous rocks are numerous, and in one specimen the presence of grains of hornblende and pyroxene and fragments of graywacke, a fine-grained carbonaceous sedimentary rock, and a basaltic rock with feldspar laths, were observed. Some of these more basic graywackes are associated with the conglomerate on Harriman Fiord, which contains numerous igneous pebbles, and both were probably derived to a large extent from the erosion of basic igneous rocks.

The argillites are dark-colored, dense, very fine-grained, structureless sedimentary rocks. Most of the fossils which have thus far been collected in them have been found on the bedding planes of thin-bedded black argillites. The slates are dark-gray to black rocks with well-developed slaty cleavage. These rocks present all gradations in color and fineness of grain, from slates through argillites and graywackes to conglomerates.

Folding and shearing subsequent to the deposition of the beds of this series has rendered these rocks schistose in many places. Mica schists were also produced on Esther and Culross islands by the contact metamorphism accompanying the granite intrusions.

### CONTACT-METAMORPHIC ROCKS.[1]

The larger granitic stocks of the Port Wells district are surrounded by aureoles of contact-metamorphic rocks produced by the intrusion of the granite masses into the sedimentary rocks. The metamorphism of the graywackes and slates has yielded altered graywackes, mica schists, and knotted sillimanite schists. Within these contact-metamorphosed zones on both Esther and Culross islands are areas of gabbroic rocks whose exact genetic relations are uncertain. The gabbros of Esther Island have been considered pregranitic intrusives,[2] but their field relations suggest that they may be recrystallized basic igneous rocks. All these contact rocks are intruded by granite and granitic, aplitic, and pegmatitic offshoots of the granite stocks.

The altered graywackes are fine-grained, light reddish-brown rocks, composed of quartz and biotite with a few grains of orthoclase and plagioclase. The biotite is sufficiently abundant to give a characteristic reddish-brown color to the rocks. Nearer the contacts the rocks are medium grained, dark gray, massive, and more crystalline. Biotite mica schists and dioritic-looking rocks are the prevailing types. Biotite is still the predominant ferromagnesian constituent. Hornblende, muscovite, epidote, and apatite also occur. Knotted dark-gray slaty schists are found also on Esther and Culross islands.

[1] See also 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, 37, 38, 40–41, 49, 1910.

[2] Idem, p. 49.

The gabbros are fine to coarse grained dark-gray to greenish rocks. Grant and Higgins's description [1] of the gabbro on the east side of Esther Island is as follows:

> This gabbro exists in several phases. One phase is made up largely of poikilitic crystals of augite inclosing prismoid crystals of labradorite. This feldspar is about the same in all the phases of the gabbro. It is beautifully twinned, according to both the albite and pericline laws. Another phase has in addition to the augite and labradorite a considerable quantity of olivine which is very fresh. About each grain of olivine is a zone made up of thousands of acicular colorless crystals of actinolite. * * * No mechanical effects of deformation, such as granulation or slicing, are present in the gabbro.

On Culross Passage is found "a somewhat altered gabbro rather high in plagioclase feldspar (labradorite) and with a partial ophitic texture."[2] These basic rocks are in some places slightly mineralized by chalcopyrite and pyrrhotite.

### CONGLOMERATE.

A conglomerate-filled joint crack occurs on the south side of Point Cochrane and similar occurrences are reported on Point Pigot. On Point Cochrane the conglomerate cuts squarely across an interbedded series of black slates, dark-banded argillites, and massive graywackes striking S. 30° W. and dipping 65° W. to 90°. Abundant worm tubes (*Terebellina palachei* Ulrich) were found in this slate-graywacke series, and an argillite bowlder on the shore yielded an Inoceramya. This conglomerate, occupying a joint crack that strikes N. 75° W. and dips 85° N. to vertical, is traceable 100 feet across the beach. The width of the conglomerate band ranges from 6 inches (at the water's edge) to 2 feet. The conglomerate band is narrowest at the east end, where the pebbles are smaller and the rock is darker colored. The walls are sharp, distinct, and smooth. At one point a narrow conglomerate stringer extends out into the south wall along a crack in the graywacke. This stringer narrows down to one-fourth inch before it ends 6 feet from where it left the main conglomerate and 2 feet south of it.

The conglomerate is a well-lithified dark-gray rock, darker than the older conglomerates of the district. The matrix is very fine grained. The pebbles range from some the size of pin points to well-rounded bowlders measuring 10 by 21 inches. They include graywacke, argillite, slate, quartz, and a very few small light-gray, very fine grained pebbles, possibly of an igneous rock similar to a dike which outcrops near by. A characteristic feature of this conglomerate is the numerous rounded pebbles and bowlders of light reddish-brown metamorphosed biotitic graywacke similar to the rock occurring in the contact zones of the granites of Culross and Esther islands.

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[1] Grant, U. S., and Higgins, D. F., op. cit., p. 49. [2] Idem, p. 37.

### GREENSTONE TUFF.

Numerous bowlders of greenstone tuff are found in the beach gravels (wash) of Port Wells. They are dense fine-grained rocks of light-green color, conspicuous on account of the numerous small, thin, angular fragments of black slate which they contain. No rock similar to this has been found in place in this district, but some may occur in the higher parts of the mountains around Barry Glacier and the head of College Fiord. Paige and Knopf [1] have described similar rocks in the valley of Knik River.

### AGE AND CORRELATION.

The age of the sedimentary rocks of the Port Wells district is not definitely known, but in the light of present knowledge they appear to be in part Mesozoic and in part Paleozoic. Collections of fossils were made in 1913 in the slate-graywacke series at several points, but the paleontologic evidence was insufficient for an assignment of this series to a definite position in the geologic column. T. W. Stanton reported on the invertebrates collected as follows:

> The invertebrates of this collection are all referable to species of somewhat obscure nature, described by Mr. Ulrich as coming from the Yakutat group of Alaska, but I do not consider this determination to be established, although no additional information has come to light since it was published.

The fossils identified by Mr. Stanton were the following:

*Collection of invertebrate fossils from the Port Wells district, Alaska.*

13 AJ 128 (8601). North side of Barry Arm, about a mile south of Coxe Glacier.
*Inoceramya concentrica* Ulrich.
13 AJ 217 (8602). Point Cochrane.
*Terebellina palachei* Ulrich.
Trails, etc.
13 AJ 218 (8603). Fossil float from Point Cochrane.
*Inoceramya concentrica* Ulrich.
*Terebellina palachei* Ulrich.
13 AJ 260 (8604). East side of Coghill Point, College Fiord.
*Terebellina palachei* Ulrich.

Worm trails were also found at many other places in the district, and *Inoceramya concentrica* Ulrich was also seen in place in the slate-graywacke series on the west shore of Barry Arm at its junction with the north shore of Harriman Fiord. No collection was made at this place.

Certain other organisms collected in Port Wells in 1913 were determined by F. H. Knowlton, as follows:

[1] Paige, Sidney, and Knopf, Adolph, Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: U. S. Geol. Survey Bull. 327, pp. 13-16, 1907.

*Collection of fossil plants from Port Wells, Alaska.*

13 AJ 113 (6710). East side of College Fiord at Minor's prospect.
*Helminthoida abnormis* Ulrich.
*Helminthoida vaga* Ulrich.
13 AJ 128 (6711). North side of Barry Arm, about 1 mile south of Coxe Glacier.
*Helminthoida abnormis* Ulrich.
13 AJ 216 (6712). Cochrane Bay, west side, near head of bay.
*Calcellophycus rhombicum* Ulrich.

Mr. Knowlton's comment on these fossils follows:

These peculiar organisms are identified without hesitation as being the same forms named and described by E. O. Ulrich (Alaska, vol. 4, Harriman Alaska Expedition), from the Yakutat group, mainly near Kodiak, Alaska. Ulrich regards the age as Lower Jurassic, and to this I have nothing to add.

The slate, graywacke, and conglomerate series of Port Wells, therefore, from the evidence afforded by fossils, appears to be synchronous with the slates and graywackes on Woody Island near Kodiak and to be possibly of early Mesozoic age. It will be remembered that a Mesozoic age was assigned to the Orca group also, largely on account of the presence of the worm tubes *Terebellina palachei* Ulrich in the slates of that group.[1] The exact position of these terranes in the geologic column, however, is still in doubt.

The age of the greenstone on Culross Island is not known, but it is probably to be correlated with the greenstones of the Orca group of the rest of Prince William Sound.

The conglomerate at Point Cochrane was deposited in a fissure in the slate-graywacke series after the intrusion of the Esther granite and the granite of Culross Island, and the contemporaneous metamorphism of the intruded sediments. It is probably of late Mesozoic or Tertiary age.

## INTRUSIVE IGNEOUS ROCKS.

### DEEP-SEATED INTRUSIVES.

The deep-seated intrusive rocks of Port Wells are granitic bosses intrusive into much contorted sedimentary rocks of the slate-graywacke series. Large granite bosses form the central parts of Esther and Culross islands. Another large stock is exposed on Passage Canal, and several smaller irregular intrusions occur on the peninsula between Harriman Fiord and Port Wells and on the north side of Harriman Fiord and Barry Arm. The intrusive character of these granites is well established by the lack of basal conglomerates about the granites, by the contact metamorphism of the sediments about the stocks, and by the presence of dikes extending from the

[1] 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, p. 33, 1910.

granite into the surrounding sediments. With the exception of certain dike rocks and the conglomerate filling of the fissure on Point Cochrane, these granite intrusives are probably the youngest pre-Quaternary rocks of the Port Wells district.

Several of these granite intrusives have been described in detail by Grant and Higgins,[1] and much of the following description of the granites of Esther and Culross islands and the Passage Canal is abstracted from their report. The granite on Culross Island is a rather dark gray biotite granite. The quartz shows marked undulatory extinction and contains numerous roughly parallel sheets and lines of inclusions. The plagioclase varies from nearly pure albite in some individuals to oligoclase-albite in others. Both plagioclase and orthoclase are somewhat altered to sericite. The biotite is altering to actinolite. Magnetite, apatite, zircon, and sphene are also reported. Small brown grains, possibly allanite, are associated with the biotite. The aplitic phases of the granite are finer grained than the main granite. Their lighter color is due to a decrease in the quantity of biotite present.

A gray fine-grained granite covers an area about 4 miles long and 2 miles wide on the north side of Passage Canal. The feldspar content of this rock is chiefly orthoclase, but includes a few crystals of plagioclase, varying between andesine and oligoclase. The only dark mineral present is biotite, in part altered to chlorite. Small amounts of apatite, magnetite, and zircon are reported. A vug in this granite contained crystals of quartz, albite ($Ab_{93}An_7$), and chlorite.

The Esther granite, a gneissic biotite-hornblende granite, is the largest intrusive mass in the Port Wells district and one of the largest of the Prince William Sound region. It forms the greater part of Esther Island and covers an area approximately 4½ miles wide by 9 miles long. This granite is in most places slightly porphyritic with orthoclase phenocrysts. Smaller crystals of orthoclase occur in the groundmass. The plagioclase is about $Ab_{65}An_{35}$, or oligoclase-andesine, but many of the crystals have more acidic rims that grade to about albite-oligoclase in composition. The quartz is very undulatory and segmental in its extinction and in some places is partly granulated. Biotite is present in considerable amounts in all phases of the granite. The amount of hornblende varies from scarcely any to as much as the biotite. Accessory minerals are magnetite, apatite, zircon, and sphene. The average chemical and mineral composition of this granite, as determined by Grant and Higgins [2] by the Rosiwal method, is as follows:

[1] Grant, U. S., and Higgins, D. F., op. cit., pp. 36–46, 1910.

[2] Idem, p. 45, 1910.

*Average mineral composition of the Esther granite.*

| | |
|---|---|
| Quartz | 30.7 |
| Orthoclase | 19.2 |
| Plagioclase ($Ab_{65}An_{35}$) | 25.8 |
| Biotite | 17.1 |
| Hornblende | 7.1 |
| Magnetite | .1 |

*Average chemical composition of the Esther granite.*

| | |
|---|---|
| $SiO_2$ | 66.7 |
| $Al_2O_3$ | 13.6 |
| $Fe_2O_3$ | 1.4 |
| FeO | 3.0 |
| MgO | 2.9 |
| CaO | 3.6 |
| $Na_2O$ | 1.6 |
| $K_2O$ | 4.9 |
| $H_2O$ | .8 |
| MnO | .1 |
| | 98.6 |

A small exposure of granite on the north side of Barry Arm consists of a medium-grained, light grayish-green, much altered granitoid rock, composed principally of quartz, orthoclase, plagioclase, and calcite. Sericitization of the feldspars is marked. The ferromagnesian minerals are altered to a light-greenish aggregate. The contact phase of this granite is a light gray rock with an aphanitic groundmass and scattered greenish rodlike phenocrysts, possibly originally amphiboles.

A granite outcropping on the property of the Granite Gold Mining Co., on the west side of Port Wells, is a medium-grained, equigranular light greenish-gray rock, composed of quartz, feldspars, biotite, sericite, and chlorite. The ferromagnesian minerals are almost completely altered. The granite is cut by small quartz veins bordered by narrow carbonate bands which weather brown. Larger well-mineralized quartz veins occur in close association with this granite.

On the tip of a small point on the west shore of Port Wells between the above property and Harrison Lagoon, a breccia of slate, graywacke, and granite has been further brecciated and intruded by a similar granite, which in some places acts as a cement to both igneous and sedimentary material. In other places the breccia is cemented by an irregular network of porous crystalline quartz. Pyrite cubes, the largest half an inch across, occur in the granite. Graywacke and black banded argillite blocks up to 10 feet square are found in the breccia.

The gabbros in the contact zones of these intrusives are described under the heading "Contact-metamorphic rocks" (p. 206).

### DIKE ROCKS.

Numerous light-colored dikes cut the slates and graywackes of the Port Wells district and contrast strongly with the dark sedimentary rocks. The contact zones of metamorphosed sedimentary rocks surrounding the large granitic stocks on Esther and Culross islands are intruded by pegmatite and aplite dikes, and a few aplite offshoots from the granite of the Passage Canal extend into the sedimentary rocks on the north shore of Passage Canal. Large, nearly vertical dikes can be seen in the hills at the head of Pigot Bay, cutting the sediments back of and over the granite of Passage Canal; they are probably offshoots from this stock. Other dikes, provisionally termed quartz diorite porphyries, are widely distributed in the sedimentary rocks at long distances from the known granite areas. This occurrence, noted also in the Sitka district [1] and in the Seward-Sunrise region,[2] is equally marked in Port Wells.

Pegmatite, aplite, and granite dikes are abundant in the recrystallized rocks that surround the larger granite masses, and a few fine-grained sugary aplite dikes cut the granites on Esther Island and Barry Arm. Short, narrow dikes of aplite with quartz centers cut the Esther granite, and the metamorphosed sediments that surround this granite are intricately intruded by a variety of dikes, which show all gradations between white sugary garnetiferous soda aplites, composed chiefly of albite, orthoclase, and quartz; light blue-gray aplites with variable amounts of garnets and biotite; coarse-grained bluish-gray pegmatites; and fine-grained biotite granites. The metamorphic rocks on the south side of the granite of Culross Island are cut by numerous granitic and acidic dikes, most of them small. Some of the aplite dikes of the district are slightly mineralized. A small amount of pyrrhotite and chalcopyrite was observed along the center of one of the blue-gray aplite dikes on Esther Island, and in aplite dikes cutting the granite of Barry Arm pyrite, chalcopyrite, and arsenopyrite were recognized.

Dikes that may provisionally be termed quartz diorite porphyries occur in most parts of the district, but none are known in the vicinity of Golden or Avery River or on Esther or Culross islands. Most of these dikes are only 4 to 6 feet wide, although much larger ones are seen in a few places. They are aphanitic to obscurely finely porphyritic, with abundant rodlike phenocrysts. Extensive alteration has in many places obliterated the original porphyritic texture. These dike rocks are generally light greenish white to greenish gray, the phenocrysts being slightly darker than the groundmass. The rocks are usually much altered; the ferromagnesian minerals are com-

[1] Knopf, Adolph, The Sitka mining district, Alaska: U. S. Geol. Survey Bull. 504, p. 17, 1912.

[2] Johnson, B. L., Gold deposits of the Seward-Sunrise region, Kenai Peninsula: U. S. Geol. Survey Bull. 520, p. 140, 1912.

pletely changed and the sericitization of the feldspars is well advanced. The chief constituents of the altered rocks are quartz, feldspar (principally plagioclase), calcite, sericite, and chlorite. Plagioclase occurs both as phenocrysts and in the groundmass. The original ferromagnesian phenocrysts are now completely altered to aggregates of calcite, sericite, chlorite, and epidote, so that their original character is unknown, but some specimens are reported [1] to show distinctive amphibole cross sections. Some of the altered dikes contain mineralized veinlets of quartz and calcite, and dikes with such veinlets are usually metallized. Arsenopyrite and pyrite are the usual secondary sulphides in these metallized dikes.

### QUATERNARY DEPOSITS.

The Quaternary sediments consist of unconsolidated material, resting unconformably on the glaciated surfaces of igneous and metamorphic rocks and include glacial deposits of various types, terrace gravels, outwash gravels, delta deposits, beach deposits, and stream gravels. Much of the material is of glacial origin, although most of it has been later reworked by stream or wave action.

Purely glacial deposits are not abundant. A ground moraine, thin and patchy, covers the lower overridden bedrock slopes. Terminal morainal dams exist in the valley of Coghill River. Crescentic terminal moraines remain in front of Baker, Roaring, Bryn Mawr, and Wellesley glaciers, and fragments of early terminal moraines are found in front of Serpentine, Barry, Yale, Harvard, and Blackstone glaciers. An ablation moraine covers the lower lobate portion of Vassar Glacier. Submarine terminal moraines, or moraine bars, cross the mouths of Barry Arm and College Fiord, and the terminal moraine built by the Barry Glacier about 1898 extends below sea level. Medial moraines can be seen on some of the existing glaciers, such as the Bryn Mawr and Harvard glaciers. Lateral moraines are also well developed on and near some of the present glaciers.

Gravel terraces rest on the walls of College Fiord, and several of the cascading glaciers of College Fiord have built terminal moraines and outwash fans into the fiord, giving rise to a narrow flat at the base of the western fiord wall. Small alluvial and delta fans have also been built by streams from hanging glaciers into many of the fiords. Sand and gravel beaches, small and narrow, stretch along the shores or lie in rocky coves. Sandy bars, or spits, nearly close the mouths of lagoons at Golden, Point Pakenham, Hobo, and other bays. The outwash gravel plain near Amherst, Crescent, Williams, and Dartmouth glaciers is the largest deposit of this type in College Fiord. Other large outwash plains lie in front of the Toboggan, Serpentine,

[1] 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, p. 47, 1910.

Baker, Dirty, Pigot, Bettles, Portage, and Tebenkof glaciers, and on the west side of the terminal moraine built by the Barry Glacier about 1898. Tidal flats occur at the heads of many of the bays.

## MINERAL RESOURCES.

### DEPOSITS EXPLOITED.

The mineral resources of the Port Wells district comprise deposits of gold, silver, and antimony. At present gold and silver are the only metals recovered from the ores of this district. The gold produced comes only from lode deposits, and the silver occurs alloyed with the native gold of the gold ores. There are no productive gold-bearing gravels in the district, although colors of gold are reported in the outwash gravels at the head of Blackstone Bay and on Passage Canal. The deposits of antimony are small and of little commercial importance. An antimony prospect on Barry Arm has been described by Grant [1] in an earlier report. Only a few small stibnite-bearing quartz veins have since been found.

### HISTORY.

Prospecting has been in progress in the Port Wells district since at least 1896. In that year Teening Carlson and Albert Nordstrom are reported to have discovered gold-bearing gravels on the Billings Glacier stream, on Passage Canal. Mendenhall [2] noted the presence of pyrite-bearing quartz veins on Passage Canal in 1898, but no gold-quartz prospects are known to have been located in this district until 1907, when Albert Nordstrom, Teening Carlson, Ludwig Christiansen, and two others are said to have discovered and located the vein on what is now the property of the Thomas-Culross Mining Co., on Culross Island. This property was not held by the discoverers, and in October, 1910, the ground was relocated by N. L. Thomas, M. G. Thomas, and Ludwig Christiansen. The discovery, in the year 1911, on the south side of the lagoon at Golden, of a large bowlder of gold-bearing quartz, estimated to weigh 1½ tons, marks the beginning of a new period of mining activity in the Port Wells district. On July 31, 1911, the Golden Wonder No. 1 and Golden Wonder No. 9 veins were located by Charles Anderson and Louis Little. Following this discovery of gold-quartz veins at Golden a small rush of prospectors to the district took place, and much prospecting and locating of veins in that vicinity occurred. Most of the properties around Avery River and Golden were located in 1911.

[1] Grant, U. S., and Higgins, D. F., op. cit., p. 78.

[2] Mendenhall, W. C., A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: U. S. Geol. Survey Twentieth Ann. Rept., pt. 7, p. 306, 1900.

During the winter of 1911–12 development work is reported to have been in progress at several of these properties and at one on the west side of Esther Island. The season of 1912 was wet and unfavorable to prospecting, but some veins were discovered, chiefly on the west side of Port Wells. Development work continued on several properties during that year and the following winter. In 1913 numerous prospectors were scattered over the district and several new veins were discovered. Development work was in progress on properties at Golden, Avery River, Culross Island, Port Wells, Harriman Fiord, and Barry Arm. A few small test shipments of gold quartz were made to Valdez and Tacoma in 1911 and the following years. In 1913 an arrastre was erected at the Tolson & Stanton property at Golden. In the winter of 1913–14 a Lane mill is reported to have been installed at the property of the Granite Gold Mining Co., on the west side of Port Wells.

### GEOGRAPHIC DISTRIBUTION OF THE ORE DEPOSITS.

The Port Wells district is one of several more or less isolated gold-quartz districts which lie in a broad belt, concave southward, bordering Prince William Sound from McKinley Lake to Seward. The general characteristics of these districts are much alike and the deposits of the Port Wells district differ little from the gold-quartz deposits of the near-by Valdez and Seward-Sunrise districts.

The known mineralized portion of the Port Wells district has a northeast-southwest trend, paralleling in general the strike of College Fiord, Port Wells, and Cochrane Bay. (See Pl. IX.) The mineralized area, which is a few miles wide at the north end of College Fiord, widens rapidly southwestward and at the south end of the district has a width between known gold prospects of about 30 miles and extends in an east-west direction from Portage Glacier Pass to Eaglek Bay. The mineralized area apparently continues southwestward into Kenai Peninsula. Most of the prospects have been discovered in the west-central part of this triangular area, about Golden and Point Pakenham, and on the peninsula between Harriman Fiord, Port Wells, and Passage Canal.

The known vertical range of mineralization is over 3,000 feet, extending from sea level in various parts of the district to an elevation of more than 3,000 feet at the Hummel-Howell prospect, on the east side of Barry Arm. Gold deposits are distributed throughout the entire vertical range of mineralization, but very few have yet been discovered over 2,000 feet above sea level.

Prior to September 1, 1913, the gold and silver produced in the Port Wells district had been only that recovered from small sample lots of gold-quartz ore shipped from the several properties in the dis-

trict to Valdez and the Tacoma smelter and its value probably did not exceed $3,000. An arrastre near Golden was nearly completed during the summer of 1913 but was not in operation on September 1. Early in 1914, after the erection of a Lane mill, the Granite Gold Mining Co., on Port Wells, began to produce gold.

## GEOLOGIC RELATIONS OF THE ORE DEPOSITS.

### STRUCTURAL RELATIONS.

The determination of the distribution of the gold-quartz veins of the Port Wells district is largely a structural problem. The lodes appear to be most abundant in the more disturbed rocks, which are included in the triangular area between Mount Emerson, College Fiord, and Barry Arm, the peninsula between Harriman Fiord, Port Wells, and Passage Canal, and the region adjacent to Avery River and Golden. Three periods of fissuring are indicated. The first set of fissures resulted from the deformation contemporaneous with the intrusion of the granites and dikes; the second set of fissures, which were filled by quartz veins, were formed after the igneous intrusions; the third set were formed by post-mineral movements. Some of the earlier fissures appear to have been places of earth movements throughout all three epochs.

The gold deposits of the district are principally veins but include a few stringer lodes, and some of the acidic dikes have been shattered and cemented by mineralized quartz. The strikes of the veins vary locally. Northeast strikes prevail around Golden, for instance, and northwest strikes are most prominent on Barry Arm, Bettles Bay, and at some places on the west side of Port Wells. Taking the district as a whole, however, the strikes lie within the 145° included between N. 55° W. and east-west. The dips are as a rule between 60° and 90°. The veins and fissures are narrow, their width ranging generally from a few inches to 3 or 4 feet. Some of the fissures are sharp, clean cut, and quartz filled; others are shattered zones, lenses, or irregular networks of quartz cementing fractures between well-defined walls; and in still others the filling is chiefly pulverized and shattered country rock with but little quartz.

The character of the country rock has had little, if any, chemical effect on the deposition of most of the gold-bearing ores of this district. Most of the lodes are in the slate, argillite, graywacke, and conglomerate members of the slate-graywacke series. They show no evidence of chemical action in effecting ore deposition, and have the appearance of simple fissure fillings. In the greenstone of Culross Island and in the mineralized acidic dikes of the district a slight amount of sulphide impregnation of the altered country rock of the veins has taken place.

### AGE OF MINERALIZATION.

The gold ores of the Port Wells district were formed after the deformation of the slate, graywacke, and conglomerate series and the intrusion of the granites and the quartz diorite porphyry dikes. The granite of Barry Arm is cut by sulphide-bearing aplite dikes and was itself slightly mineralized after its intrusion and solidification. The granite on the property of the Granite Gold Mining Co. on Port Wells is cut by gold-bearing quartz veins. Sulphide-bearing pegmatites occur on Esther Island. Whether the sulphides are original constituents of these aplite and pegmatite dike rocks is not now known. Several of the quartz diorite porphyry dikes of the district have been shattered and then mineralized. An intimate relation is indicated between the igneous intrusions of the district and the metalliferous deposits. It appears closest between the aplite and pegmatite dikes and the quartz veins. No actual gradation from aplite or pegmatite dikes to quartz veins has been observed, however, although certain of the aplite dikes have quartz centers and in some places carry sulphides.

The mineralization of the Port Wells district is probably of Mesozoic age, following closely the granitic intrusions. It probably preceded the formation of the conglomerate on Point Cochrane, bowlders of contact-metamorphosed rocks similar to those produced by the granitic intrusions occurring in this conglomerate.

### CHARACTER OF THE ORES.

The ores of the Port Wells district are free-milling gold-quartz ores. The ore minerals are primary, the intense glacial scouring to which this district has been subjected removing any preglacial enriched zones which may once have existed and exposing the original sulphide ore deposits at the surface. The recentness of this glaciation has, moreover, afforded little opportunity for later surface alteration of the deposits. A small portion of the sulphides in the outcrops has been oxidized, but primary unaltered sulphides also show in practically all outcrops.

The mineralogy of the ores is simple. The dominant nonmetallic gangue mineral is quartz. Minor amounts of calcite and chlorite also occur. Mendenhall[1] has recorded the presence of fluorite in quartz veins on Passage Canal, but none was observed in the specimens collected in 1913. The primary metallic minerals of the ores are gold, silver, pyrite, galena, sphalerite, pyrrhotite, arsenopyrite, stibnite, and chalcopyrite. The economically important minerals are gold and silver, the silver occurring alloyed with the native gold.

[1] Mendenhall, W. C., A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: U. S. Geol. Survey Twentieth Ann. Rept., pt. 7, p. 306, 1900.

Secondary minerals found in the weathered outcrops of the veins are of little importance. Limonite is the most common oxidation product. The relative abundance of the gangue and metallic ore minerals is not known, but the sulphides are not particularly abundant in most of the ores.

## GOLD-QUARTZ PROSPECTS.

### ORDER OF DESCRIPTION.

The following descriptions are based on short visits to the properties examined, supplemented by office examination of the specimens collected at each property. All the prospects in the district were not visited, but enough were seen to permit general conclusions to be formed regarding the occurrence of the ore bodies. The descriptions are grouped by separate fiords and bays so far as possible, and these fiords are considered in geographic order from north to south. The arrangement of localities in each fiord has no significance as to relative importance of the separate prospects, nor is the amount of space devoted to a prospect any measure of its economic value.

### COLLEGE FIORD.

*General conditions.*—Good gold-quartz float has been reported on the upper end of College Fiord and considerable staking has been done, but the Minor prospect is the only one on which any underground development work has been done. Some gold-quartz float is also said to have been found near Williams Glacier, and an arsenopyrite ledge is reported in the mountains at the head of Coghill River. The Point Pakenham prospects are described together under the heading Barry Arm, and the Avery River and Golden prospects are considered under separate headings.

*Cann & Minor prospect.*—The prospect of J. H. Cann and C. J. Minor is on the east side of College Fiord, about 2 miles north of the mouth of Coghill River. The development work consists of a tunnel near sea level, about 65 feet long, and some stripping along the ledge above the tunnel and on a vein at an elevation of 250 feet. The country rock at the tunnel is slate and massive graywacke cut by an acidic dike. The vein is closely associated with the dike, in places cementing the shattered dike rock. The tunnel is driven S. 9° W. along a fault that intersects both dike and vein. The quartz exposed ranges in width from a few inches to 6 feet. The dike has a maximum observed width of 5 feet. Some calcite-bearing quartz stringers cut the graywacke at the mouth of the tunnel. The country rock at the upper showing is graywacke. The vein is about 3 feet wide and is exposed for 20 feet. It strikes approximately N. 56° W. and has a vertical dip. The walls are free but show no gouge. The mineralization appears to be slight in both veins. Quartz, calcite, pyrite, sphalerite, and chalcopyrite were recognized in the ores.

AVERY RIVER.

*Conley & McChesney prospects.*—These prospects were not visited, and the information regarding them given below was obtained from W. M. Conley. The Bluebell, Perseverance, and Whistler claims are said to be on the north side of Avery River between 2 and 3 miles from its mouth. The development work consists of a 40-foot tunnel on the Bluebell claim, a 10-foot shaft on the Whistler, and some stripping. The first two claims are reported to have been located in September, 1911, by W. M. Conley and R. J. McChesney. The vein on the Bluebell is 18 inches to 8 feet wide, that on the Whistler 3 feet wide, and that on the Perseverance several feet. All three veins are said to be traceable for considerable distances. Ore specimens from the Perseverance shown to the writer were bluish quartz with few sulphides. In specimens from the Whistler claim the quartz carried galena, pyrite, and chalcopyrite.

*Prospect of Sweepstake Mining Co.*—The Avery River prospect of the Sweepstake Mining Co. is on the north side of Avery River, above timber line, about 2 miles from the mouth of the river. The developments by the company include a 100-foot tunnel, an 18-foot shaft filled with water at time of the writer's visit, a trail from the mouth of the river to the workings, a log cabin, and a sawmill at the mouth of Avery River. The veins were discovered in November, 1911, by Charles Elwood and John Reuef. Development work is reported to have been started about March, 1912. Several tons of good ore taken from the shaft are said to have been shipped to Valdez in the spring of 1912.

The shaft, which is at an elevation of about 1,880 feet, was sunk on a fissure 5 feet wide, the ore shoot in which had a maximum width of 16 to 18 inches and a length as stripped of about 20 feet. The fissure strikes N. 65° W. and dips 45° W. in a thin-cleaved slate country. At the east end of the workings the fissure was 5 feet wide, but only the 4 inches of the fissure filling next the hanging wall carried quartz veins. The rest of the fissure filling consisted of black slate with a few small cross-cutting quartz stringers. The tunnel was driven at an elevation of 1,850 feet to intersect this fissure. The rock in the tunnel consists of sheared slates and graywackes and white, barren-looking quartz stringers.

A few hundred feet east of the tunnel there is a well-defined quartz vein, with an east-west strike and a vertical dip, cutting the schistosity of the slate graywacke country. The width of the fissure varies from 10 inches to 6 feet. The quartz is from 3 to 36 inches wide and in many places fills the entire fissure. Near the upper end of the outcrop the fissure ranges in width from 3 to 6 feet. It contains no well-defined vein, but includes numerous quartz stringers, some as much as 7 inches wide.

The gangue minerals of the ores include quartz, calcite, a brown-weathering carbonate, feldspar, and chlorite. The metallic minerals are arsenopyrite, pyrite, pyrrhotite, chalcopyrite, and gold. Limonite is present as a surficial oxidation product of the sulphides.

*North Star claim.*—The North Star claim is on the north side of Avery River, some distance west of the veins of the Sweepstake Mining Co. The vein is reported to have been located in 1911 by John E. Groth, Thomas J. Davis, E. S. Malone, Harry Thisted, William McKnight, Charles Stevens, and Felix Wilson. The development work consists of a 53-foot incline shaft with two short drifts, 10 and 15 feet in length, along the lead at the bottom of the shaft, and a crosscut tunnel, 20 feet in length, driven in 1913, at an altitude of about 1,620 feet. The shaft, which is at an elevation of 1,725 feet, is sunk on a fissure striking about S. 60° W. and dipping 60° N. The fissure, 5 feet in width at the surface, is in a sheared slate and graywacke country rock. The fissure filling appears to consist of sheared slates and graywackes, with closely packed stringers and lenses of quartz lying parallel to the fissure walls. The ore ranges in width from 6 to 30 inches but is said to average about 2 feet. The lead is reported to outcrop in spots for about the length of a claim. The quartz is said to pan well and to give good assay returns.

*Morning Star claim.*—Information regarding the Morning Star claim, which was not visited, was obtained from John E. Groth, who, with E. S. Malone, discovered it July 25, 1913. A 10-foot shaft has been sunk on a vein, which shows a width of 4 feet in the bottom of the shaft, though in other places it is much narrówer. It is said to be traceable for 3 claim lengths. The Morning Star claim is about 2 claims distant from the North Star claim.

*Consolidated claims.*—The information regarding the Consolidated claims, which were not visited, was furnished by John E. Groth. They are on the north side of Avery River and adjoin the Morning Star claim. The owners in 1913 were said to be John E. Groth, T. J. Davis, H. Thisted, E. S. Malone, William McKnight, and Charles Stevens. The development work consists ot a 10-foot shaft on a vein striking northeast and ranging in width from 6 inches to 2 feet.

### GOLDEN AND VICINITY.

*Nugget claim.*—The Nugget claim is above timber line, at an elevation of 1,700 feet on the mountain northeast of Golden. The veins were discovered by Stephen Roe August 14, 1911. No development work was done in 1911. The development work in 1913 consisted of a tunnel with about 175 feet of underground workings, a shallow shaft at the upper showing (original discovery), some stripping, and a trail from the shore to the property. A shipment of ore from both showings is reported to have yielded good returns.

The country rock of the ore bodies is graywacke and black slate. The two ore bodies are about 700 feet apart. The original discovery is reported to be a 4 to 10 inch vein, traceable 70 feet, with a northeast strike and nearly vertical dip. The tunnel is driven on the lower showing, a fissure 4 to 30 inches wide, with a length of about 200 feet. At the mouth of the tunnel this fissure strikes N. 80° E. and dips 75° N. At the east end of the vein the lead makes a curve southward, the last 10 feet having a northerly strike and a vertical dip. The fissure filling consists of sheared slate and graywacke. The quartz in the fissure varies from only a little in places to a solid vein 20 inches wide. The gangue is quartz, with some calcite and considerable chlorite. The metallic ore minerals include gold, silver, galena, and pyrrhotite. The ore is said to contain chalcopyrite and pyrite. Limonite occurs, as usual, as an alteration product of the iron-bearing sulphides.

*Mayflower vein.*—The Mayflower lead crosses the crest of the mountain northeast of Golden at timber line. Only a little open-cut work on the lead is reported. The country is the usual slate and graywacke. The lead is an 8-foot fissure, striking southwest and dipping 70° W. Stringers of quartz, from 2 to 8 inches in width, are reported in the sheared fissure filling. Low assays are reported.

*Golden Wonder No. 9 claim.*—The Golden Wonder No. 9 claim is above timber line on the mountain northeast of Golden, about 1½ miles from the town. The vein is said to have been located July 31, 1911, by Charles Anderson and Louis Little. The developments consist of a deep 30-foot open cut along the lead at an elevation of 1,440 feet, and some stripping. The country rock is chiefly slate with some massive graywacke. The beds are folded and sheared. The ore lies in a well-defined fissure striking southwestward and dipping 70° N. The fissure ranges in width from 8 to 44 inches, and is traceable for over 250 feet. The fissure filling consists of crushed slate, in some places with little or no quartz. In other places quartz occurs as long and narrow stringers and lenses lying parallel to the walls of the fissure. At the open cut the fissure is 44 inches wide and contains a 3-foot quartz lens about 100 feet long. The hanging wall side of this large quartz lens is smooth and shows horizontal slickensides, and there is an inch of gouge on the hanging wall.

The nonmetallic ore minerals include quartz and small amounts of calcite and chlorite. The gold is free. The sulphides are present as tiny specks in the ore and include pyrrhotite, pyrite, chalcopyrite, arsenopyrite, and sphalerite. Limonite occurs as a surface alteration product of the sulphides. Assays ranging from $30 to $100 are reported on this ore.

*Frodenburg & Bloom claim.*—The Frodenburg & Bloom claim is at an elevation of 1,150 feet on the mountain northeast of Golden. It is near the Golden Wonder No. 9, and was located July 23, 1913,

by Axel Frodenburg and Charles Bloom. The only development work consists of a little stripping. The country rock is chiefly graywacke. The fissure strikes S. 80° W. and dips 60° N. At one place a quartz lens, 10 to 18 inches wide and traceable 45 feet, fills the entire fissure. About 50 feet farther uphill a 25-foot stripping exposes a 10-inch fissure in graywacke with 8 inches of quartz. A few fine colors are reported to be obtainable from this quartz by panning.

*Mountain claim.*—The Mountain claim is located on a fissure that is reported to be the extension of the fissure on the Golden Wonder No. 9 claim. It is at an elevation of about 450 feet in the timber on the mountain northeast of Golden. The country rock is slate and graywacke. The development work in 1913 consisted of open cuts and stripping. The fissure is about 8 feet wide, strikes S. 70° W., and dips 85° W. Numerous small quartz stringers and bunches of quartz lie in the fissure filling, parallel to the walls. Most of the stringers are short and the largest have thicknesses of 2 to 3 inches. The ore contains much vein chlorite.

*Lucky Swede claim.*—The Lucky Swede vein is at the foot of the south slope of the mountain northeast of Golden, a short distance from the town. The lowest outcrop is at an elevation of about 800 feet. The vein was discovered and located in the summer of 1911 by Charles Anderson and Louis Little. The development work in 1913 consisted of a little stripping and trail cutting. The country rock comprises slate and graywacke. The ore body is a quartz-filled fissure striking S. 60°–70° W. and dipping steeply to the southeast (77°–85°). The vein is traceable for several hundred feet. Its width varies from 8 to 44 inches. The maximum width of solid quartz is 36 inches, but the average width is only 2 feet. The fissure in some place includes a little sheared slate and graywacke. The walls of the vein are in most places frozen. Where the walls were free no gouge was observed. The quartz shows a little secondary banding parallel to the walls.

This vein is only slightly mineralized. The ore pans free gold and assays ranging from $1 to $14 are reported. No sulphides were seen in the ore.

*Golden Wonder No. 1 claim.*—The Golden Wonder No. 1 is a short distance east of Golden, at the foot of the mountain, on the northeast side of the town. It was discovered and located July 31, 1911, by Charles Anderson and Louis Little. The development work in the fall of 1913 consisted of a 10-foot adit tunnel with a 15-foot approach, at an elevation of 350 feet, and some stripping along the ledge. A ton of the ore is said to have been shipped to Tacoma.

The country rock is the usual slate and graywacke. The ore body lies in a fissure that is reported to be traceable for more than 2,000 feet. The fissure strikes S. 60° W. and dips 70° N. and varies in

width from 2½ to 4 feet. The fissure filling consists of shattered and sheared slate and graywacke with lenses and stringers of quartz parallel to the walls. At the tunnel the quartz ranges from narrow seams to stringers 8 inches wide. The stripping at the discovery exposes the lead for about 75 feet. Here the quartz ranges in width from 1 to 6 inches. At an elevation of 590 feet only a few quartz stringers show in an 8-foot strip of the fissure. The maximum width of solid quartz reported is 10 inches.

The quartz is hard and bluish white. Secondary banding parallel to the walls appears in places. A small amount of calcite occurs as a gangue mineral. The metallic minerals recognized in the ore are gold, galena, and arsenopyrite. The fissure filling is said to assay $4 to $5 in gold per ton, and assays as high as $96 per ton are reported from the quartz.

*Arrowhead claim.*—The Arrowhead claim was located by H. C. and H. R. Johnson January 1, 1913. It is on the shore south of Golden near the entrance to the small bay on which Golden is situated. The development work at the time of the writer's visit comprised a 20-foot adit tunnel, a little stripping, and a cabin. The country rock is slate and graywacke. The tunnel is driven S. 70° W. along a vertical fissure parallel to the shore. The width of the fissure varies from 6 inches to 8 feet, and it appears to be traceable for several hundred feet. The fissure filling consists of sheared slate carrying quartz stringers parallel to the walls. The amount of quartz in the tunnel varies from a few stringers to a mass that is reported to fill the entire face of the tunnel. On the shore along the line of the fissure there is a quartz outcrop 125 feet long by 8 feet wide, with 2 feet of slate and with quartz stringers on the east wall. This quartz occurs as closely packed lenses. The ore appears to be only slightly mineralized. It contains few sulphides, only pyrite having been observed.

*Griset claims.*—Along the shore near Golden Edwin Griset has located several claims on which little development work has been done. A 6-foot shaft has been sunk on a lead that is traceable for about 75 feet. A quartz lens 5 feet thick outcrops on the shore. The shaft exposes an 18-inch vein of white quartz that strikes southwest and dips north on one side of the shaft. A mass of shattered graywackes 32 inches wide, with quartz seams, forms the opposite side of the shaft. A 10-foot tunnel just west of the post office crosscuts a 33-inch fissure striking S. 65° W. and dipping 55° N. The country rock is the usual slate and graywacke. The fissure is reported to be traceable about 300 feet. Gouge occurs on both walls and quartz lenses and stringers appear in the fissure filling. About 22 inches of quartz shows in the north wall of the tunnel but only a few quartz stringers in the fissure on the south wall.

The Keynote claim is about a mile south of Golden and about 400 feet from the shore, on the north bank of a small stream, at an elevation of 75 to 100 feet. This claim was located September 7, 1913, and at the time the property was visited the lead had been stripped about 40 feet. The vein ranges in width from 3 to 6 feet. The quartz in surface showings is much shattered and breaks free from the hanging wall with a little gouge. Bunches of quartz also occur in the country slate and graywacke. Sulphides are scarce in the ore, and arsenopyrite and pyrite were the only ones recognized. The ore pans fine gold.

*Golden Eagle claim.*—The Golden Eagle lode outcrops on the steep timbered north slope of the mountain south of Golden, between 500 and 600 feet above sea level. This prospect is said to have been discovered late in August, 1911, by Charles Anderson and Louis Little. A large gold-bearing quartz bowlder, weighing about a ton, was found on the south side of the lagoon on this claim. This bowlder was broken up and shipped to the stamp mill at Valdez in September, 1911, and is reported to have yielded $42. A shipment of ore is also reported to have been made from this property in 1913. The development work consists of two tunnels, 155 and 45 feet in length, and a trail to the property from the shore.

The country rocks are black slates and dark-colored graywackes, much folded and faulted. The ore deposit appears to be a stringer lode, in the folded and faulted slates and graywackes. It is reported to be traceable 400 or 500 feet. The lode varies in width from 2 inches to 10 feet or more. At the mouth of the upper tunnel it is about 10 feet wide. In the bluff between the two tunnels no lead shows, the graywacke walls apparently coming together and cutting it out. The lode strikes about S. 20° W. and has a vertical dip. The distribution of quartz is very irregular. Masses of quartz, the largest 18 inches across, occur in the lower tunnel, which is driven in slate along a slate-graywacke contact. The slate carries numerous quartz stringers parallel to the contact. At some places 2 to 4 feet of solid quartz can be seen in the lode; at others the quartz occurs as numerous narrow stringers.

The gangue is predominantly quartz but contains also chlorite. Gold occurs native. Few sulphides are seen in the ore, pyrrhotite being the only one recognized. Assays are reported ranging from blanks to $175 per ton. A 10-foot sample over the mouth of the upper tunnel is said to have assayed $9.20.

*H. M. Carter claims.*—The O. K. No. 1 and New York claims of H. M. Carter were located in the fall of 1911. They lie north of the Tolson and Stanton prospect, at an elevation of 1,750 feet on the west slope of the mountain south of Golden, about 1½ miles from the settlement. The only development in September, 1913, was a short open

cut. The country rock is schistose slates and graywackes. The ore deposit consists of a series of small parallel fissures carrying quartz stringers and lenses. The largest fissure ranges in a width from 4 to 12 inches. The maximum width observed on any body of quartz was 10 inches. The fissures strike S. 70° W. to S. 85° W. and have a vertical dip. The ore carries considerable fine gold and is reported to yield good assays.

*Tolson & Stanton prospect.*—The prospect of Michael Stanton and C. P. Tolson lies between 1,500 and 1,600 feet above sea level on the mountain about 2 miles south of Golden. It was discovered and located in September, 1911, by the present owners. The development work in September, 1913, consisted of a tunnel about 155 feet in length and some stripping along the lead. An arrastre, a cabin, and a trail to the shore were also built.

The country rock consists of closely folded slates and graywackes. The ore deposit occupies a fissure from 2 to 5 feet wide, which is traceable about 300 feet. The fissure has a southwest strike and a vertical dip. The fissure filling consists of sheared slate and graywacke with stringers and lenses of quartz parallel to the walls of the fissure. The amount of quartz in the fissure varies from place to place. The widest quartz lens or stringer was 24 inches across. At an elevation of 1,620 feet a 10-inch quartz stringer extends into the west wall of the fissure. At an elevation of 1,660 feet a line of quartz outcrops extends 50 feet southwestward from the fissure. In places only a few small quartz stringers occur in the fissure.

The gangue minerals are quartz, calcite, and chlorite. The metallic ore minerals are gold, arsenopyrite, sphalerite, pyrite, and pyrrhotite. Some arsenopyrite impregnates the slate country rock.

### BARRY ARM.

*Paymaster lode.*—The Paymaster lode was not visited, and the information regarding it given here was obtained from the locator, Peter Black, who discovered and located it in the fall of 1912. It is above timber line on a mountain on the east side of Barry Arm, about 1½ miles from the shore. The vein is reported to strike about north and to be traceable for 200 to 300 feet. Its width ranges from 1½ to 3 feet. Pans and assays of gold ranging from $18 to $88 per ton are reported.

*Walters, Brasslin & Atkinson prospect.*—The prospect of A. W. Walters, J. Brasslin, and Robert Atkinson is 1½ miles from Barry Arm, on the west side of a stream that flows into Barry Arm just west of Point Pakenham. Float was found in 1911 in a small creek that crosses the ledge, which was discovered July 2, 1913. A lower crosscut tunnel, 52 feet long, at an elevation of 265 feet, an upper adit

tunnel, 25 feet long, at an elevation of 300 feet, open cuts, and stripping comprised the development work in September, 1913.

The country rock is the usual slate and graywacke. The ore deposit is a small vein, which is traceable about 170 feet. At the upper tunnel the vein ranged in width from 2 to 8 inches, but its average width was about 3 inches. It strikes N. 21° E. and dips vertically at the tunnel and shows a thin gouge on both walls. At one place it is offset 2 feet by a small fault. About 20 feet south of the mouth of the tunnel the course of the vein swings round to N. 40° E. A few barren-looking quartz stringers occur in different parts of the lower crosscut tunnel. The vein, which is crosscut at the face of this tunnel, has a strike of N. 11° E. and a vertical dip. The east wall is free, with gouge; the hanging wall is frozen. Arsenopyrite occurs in considerable quantity in the ore, some stringers of solid arsenopyrite an inch thick being seen. The other metallic ore minerals are galena, gold, and sphalerite. The oxidized outcrop of the ore body is reported to yield big pans. Assays of the ore are said to range from $23 to $88.

*Simonton & Mills prospect.*—The prospect of J. L. Simonton and Fred Mills is in the timber on the northeast side of Barry Arm, about a mile from shore, at an elevation between 900 and 1,000 feet. The Alaska Wonder ledge was discovered and staked July 4, 1913. The development work consists of stripping the vein and cutting a trail to the property. The country rock is graywacke and some slate. The ore body has been traced about 200 feet. It varies in width from 6 inches to 5¾ feet of solid quartz. The walls are in most places frozen, but in some places break free, without gouge. The lead strikes a little west of north and has a vertical dip. At an elevation of 1,025 feet a nearly parallel 4-foot quartz vein joins this vein. In places these veins consist of shattered graywacke and numerous branching stringers of white quartz. The ore minerals are galena, pyrite, chalcopyrite, and gold.

About 400 feet north of this ledge is a large outcrop of quartz 10 to 12 feet wide, which has been traced for about 50 feet by a series of open cuts. This quartz appears to be but slightly mineralized.

*Prospects of Charles Cameron.*—The three prospects of Charles Cameron are on Barry Arm, on the west side of Point Pakenham. Two of the prospects are at sea level and close to the shore; the other is in the timber at an elevation of 785 feet, about three-fourths of a mile north of Point Pakenham.

About 200 feet from the shore is a vein, which was located in the spring of 1912. It occupies a small well-defined fissure striking north and dipping 50° E. The width of the vein varies from 4 to 20 inches, averaging between 10 and 15 inches. It has been stripped about 100 feet. The country rock is slate and thin banded argillite. The foot wall of the vein is free but shows no gouge. In the 25-foot adit

tunnel a thin gouge lies along the hanging wall. The vein shows secondary banding parallel to the walls. The quartz is white, and in places is vuggy and contains coarse quartz crystals, though at other places it is fine and compact. The mineralization is slight. Free gold is reported, and calcite, arsenopyrite, chalcopyrite, and pyrite were recognized in the ore. The ore contains also a cream-colored carbonate with curved cleavage surfaces.

Near by on the shore another quartz vein is exposed in a 15-foot vertical bluff. This vein was located June 30, 1912. The country rock is slate and graywacke. The strike is apparently N. 45° W.; the dip is 20° N. at the foot of the bluff and 60° N. at the top. The width of the vein ranges from 8 to 15 inches. The walls are free but show no gouge.

The Last Chance No. 2 claim was staked May 2, 1913, by Charles Cameron. It is at an elevation of about 775 feet on the north bank of a small creek about three-fourths of a mile north of Point Pakenham. The country rock is massive graywacke and a little slate. The vein strikes S. 10° W. and dips 50° W. and varies in width from 3 to 36 inches. It has been traced about 150 feet. The walls are free but show no gouge. A slight secondary banding parallel to the walls is evident in some places. The quartz is white, is vuggy in spots, and contains large quartz crystals and a few specks of arsenopyrite. The ore is said to pan good and a $13 assay is reported.

*Griset & Benson claim.*—The property of Edwin Griset and O. T. Benson, on the east side of Point Pakenham, was not visited, and the information here given was obtained from Edwin Griset. It includes Eureka and Spruce groups, which were located in the spring of 1912. The developments consist of a 30-foot crosscut tunnel, open cuts, and stripping. The ledge has been traced about 300 feet and shows an average width of 3 feet of quartz, with a maximum width of 7 to 8 feet. The vein has a nearly vertical dip.

*Mitchell & Myers mineralized dike.*—The property of J. E. Mitchell and W. H. Myers is on the south side of Mitchell Creek, a tributary to Barry Arm from the south near the mouth of the arm. The claims are timbered. The lowest outcrop of the ore body is about 30 feet above sea level. The property was discovered September 2, 1912, by the present owners. The development work consists of a few open cuts. An acidic dike, 67 inches wide at the lowest showing and 5 feet wide at the upper showing, cuts the slate country. The dike strikes S. 50° W. and dips 53°–75° W. and is reported to be traceable four claim lengths. Between the two showings visited, a distance of about 1,000 feet, the dike is concealed. The ore deposit consists of mineralized quartz veins and stringers cementing the shattered dike. At the lowest outcrop gold-bearing quartz stringers, the largest 8 inches wide, with frozen walls, occur in the

dike. At an elevation of 180 feet a quartz vein 3 inches wide, with free walls, strikes N. 51° W. and dips 60° E. A few quartz stringers with frozen walls also occur here. The gangue minerals of the ore are quartz and calcite. The metallic ore minerals are arsenopyrite, galena, and gold. Pyrite is also reported. Assays on the dike alone are said to range from $1.40 to $7. Higher assays are reported on the quartz.

HARRIMAN FIORD.

*Black & Hogan prospect.*—The prospect of Peter Black and William Hogan was located in August, 1913, on the north side of Harriman Fiord, a short distance east of the foot of the Serpentine Glacier. The claims are timbered. Newspaper accounts state that a 200-foot adit tunnel was driven on one of the veins during the winter of 1913–14.

The country rock consists of graywacke cut by much altered light-gray fine to medium grained granite dikes and masses. Several nearly parallel quartz veins are reported. At an elevation of 350 feet an 18-inch quartz-filled fissure strikes N. 26° W. and dips 73° W. in graywacke. Faint secondary banding parallel to the walls shows in places. This vein is stripped to an elevation of 400 feet. A few hundred feet northeast of this vein is a second vein, 10 to 14 inches wide, striking N. 20° W. and dipping 67° W. in a graywacke country rock. Secondary banding parallel to the walls shows in places. The walls are free. The lowest showing on the property is at an elevation of 110 feet. This vein cuts a massive graywacke ledge and a vertical granite dike 6 feet in width. A large granitic mass is intrusive into the graywacke about 100 feet east of the vein. The width of the vein varies from 2 to 8 inches. The strike is N. 15°–40° W. and the dip is 77° E. to vertical. The ore contains galena, gold, arsenopyrite, and sphalerite.

*Prospect of J. W. Reiter and M. J. Olson.*—The prospect located by J. W. Reiter and M. J. Olson on Point Doran about August 27, 1913, was not visited. The information regarding this property was obtained from J. W. Reiter. The vein is located within 500 feet of the tip of the point. The quartz ledge ranges in width from 8 inches to 3 feet and is reported to be traceable about 200 feet. The same partners own two claims farther up Harriman Fiord, on which there are said to be six parallel veins in graywacke. These veins show from 8 to 30 inches of quartz. Stibnite occurs in one of the veins and chalcopyrite and galena in another.

*Sweepstake Mining Co.*—The property of the Sweepstake Mining Co., on Harriman Fiord, is above timber line on the south side of the fiord, near its head, at an elevation of about 600 feet. The vein, known as the Imp, is said to have been discovered in July, 1912, by Chris Pedersen and Ole Hanson. Development work began in

November, 1912, and ceased in February, 1913. In August, 1913, the developments consisted of a 150-foot tunnel and some stripping along the vein. The country rock comprises interbedded slates and graywackes, thin bedded in places, in others principally graywacke, cut by numerous acidic dikes 6 to 48 inches thick. The vein fissure crosses one of these dikes at the mouth of the tunnel. The vein is well exposed for about 150 feet. It strikes east and dips 85° N. at its upper end, and strikes S. 84° W. and has a vertical dip at the lowest exposure. The width varies from 1 to 5 feet. The upper or east half of the outcrop averages 3 feet in width; the remainder of the vein ranges in width from 10 to 18 inches. The walls are free in some places and frozen in others. No gouge is visible. The quartz vein filling appears to stop at the dike, and irregular bunches and stringers of quartz cement the shattered dike. The narrower parts of the vein are the more mineralized. Secondary banding parallel to the walls is also prominent in the narrow part of the vein. Gold, arsenopyrite, pyrite, sphalerite, galena, chalcopyrite, stibnite, calcite, and quartz were observed in specimens taken from the outcrop and obtained from the tunnel dump.

*Prospect of White & Jones.*—The Skypilot ledge, located by Frank White and Harold Jones in September, 1912, is on the north side of Harriman Glacier, about 600 feet above sea level. This prospect was not visited, the information given regarding it having been furnished by Frank White. The country rock is conglomerate and slate. The vein is reported to be traceable 450 to 500 feet and to range in width from 2 feet at the lower end to 5 feet at the upper. Gouge occurs on both walls. The vein is said to strike northwest and to have a vertical dip. The ore pans free gold and is said to assay well.

## PORT WELLS.

### HARRISON LAGOON (HARRIS SLOUGH).

*Olsen & Viette claims.*—The Dominick ledge is about 2 miles from Port Wells, at an elevation of 1,300 feet, on the north side of a cirque at the head of a creek draining into Harrison Lagoon. The lead is above timber line. It was located in September, 1912, by Hogan Olsen and Dominick Viette. The developments in the fall of 1913 consisted of a short crosscut tunnel, some stripping, and a trail to the shore. Eight men were at work on the property at that time.

The country rock consists of argillites and graywackes intruded by a large dike or boss of medium-grained light-gray igneous rock. The ore deposit lies in a well-defined fissure, 3 to 4½ feet wide, with a strike of S. 30° W. and a dip ranging from 80° E. to vertical. This fissure is reported to be traceable about 2,000 feet. The shear zone carries considerable waste material and at no place is the fissure

filling known to be all quartz. A maximum of 2 feet of quartz is reported. The shattered fissure filling is in places silicified and cemented by the quartz. Gouge occurs on both walls, ranging from thin seams to layers 4 inches thick. Quartz, calcite, pyrite, sphalerite, gold, and chalcopyrite occur in the ore. The gold is all fine.

SHORE BETWEEN HARRISON LAGOON AND HOBO BAY.

*Granite Gold Mining Co.*—The property of the Granite Gold Mining Co., better known locally as the Tatum property, is 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 of about 580 feet, is on the end line between the Port Wells No. 1 and the Port Wells No. 2 claims. A trail extends from the shore to the workings.

The vein was discovered July 19, 1912, by M. L. Tatum and Jonathan Erving, and a shaft was sunk on the vein. About 5 tons of ore taken from the shaft are said to have been shipped in December, 1912. The developments August 22, 1913, included a 30-foot incline shaft, a 170-foot crosscut tunnel with 2 drifts on the vein, 75 and 60 feet long, 150 feet from the mouth of the tunnel; surface stripping; and a log cabin. The Granite Gold Mining Co. was incorporated later, additional underground development work was done, and a mill was erected during the winter of 1913–14.

The country rock consists of interbedded slates, graywackes, and blue-black argillites cut by large masses of considerably altered medium-grained light-gray to greenish-gray granite. The ore deposit occupies a fissure striking S. 75° W. and dipping 60° N. in the shaft and striking N. 50°–72° W. and dipping 43°–55° N. in the tunnel and drifts. The width of the fissure varies from 3 inches to 3 feet and greater widths are reported in recent developments. The lead is traceable on the surfaces about 150 feet. The walls are free, gouge showing on both walls in the upper part of the shaft. The walls in the shaft are slate and graywacke. In the tunnel and the drifts the hanging wall is granite. The fissure filling is shattered graywacke, quartz veins or a quartz network cementing the shattered graywacke and inclosing the angular graywacke fragments in a network of porous white crystalline quartz.

The gangue minerals include quartz, calcite, and a brownish-weathering carbonate. The quartz is open textured, like a mass of interlocking crystals. The metallic ore minerals are gold, pyrite, sphalerite, stibnite, galena, arsenopyrite, and chalcopyrite. High assays are reported from some of this ore.

HOBO BAY.

*Reed, Gauthier & Cooper prospect.*—The prospect of F. W. Reed, Burt Gauthier, and H. B. Cooper is on the south shore of Hobo Bay

near its head. It was located in June, 1912, by the present owners. The developments in September, 1913, included a 160-foot crosscut tunnel at an elevation of about 40 feet, a shallow shaft on the lead about 60 feet above the tunnel, open cuts, stripping, a 25-foot adit tunnel on the shore, a 30-foot winze in this tunnel, and a log cabin.

The country rock consists of interbedded black slate and dark-gray graywackes. The ore body occupies a fissure, which has been stripped at intervals for 800 or 900 feet. The fissure strikes between S. 30° W. and S. 60° W. and dips about 70° N. It ranges in width from 30 to 36 inches. The fissure filling is crushed slate and graywacke with quartz stringers and lenses. The proportion of quartz varies in different places in the fissure. The width of the quartz lenses ranges from 3 to 14 inches. One 8-inch lens was traceable 25 feet. Quartz, calcite, pyrrhotite, chalcopyrite, sphalerite, and pyrite occur in the ore, which is also reported to assay well in gold.

BETTLES BAY.

*Yakima ledge.*—The Yakima ledge is on the north shore of Bettles Bay near its head. It was located June 12, 1912, by Joshua Brereton, Teunes Oome, and Ben Howell. The developments include a 25-foot tunnel and some stripping. The country rock is graywacke and slate. The tunnel is driven along a vein striking N. 12° E. and dipping 80° W. This vein has been traced 60 feet. The width of the fissure ranges from 10 to 31 inches and the width of the contained quartz ranges from 10 to 31 inches also, although in places there is as much as 15 inches of crushed slate fissure filling. Secondary banding parallel to the walls is evident in places. The walls are free and the hanging wall in places shows heavy gouge. The ore contains quartz, calcite, gold, pyrite, sphalerite, arsenopyrite, galena, chalcopyrite, and pyrrhotite.

*Hermann & Eaton prospect.*—The Hermann & Eaton prospect is on Eaton Creek about a mile northwest of the head of Bettles Bay. This property, known as the Mineral King group, is said to have been located by George H. Hermann June 4, 1912. The developments include an incline shaft, reported to be 117 feet deep, a 65-foot drift on the vein at the bottom of the shaft, some stripping on the lead, a shaft house covering hoisting engine, pump, and boiler, and a trail from the shore to the property.

The country rock is fine-grained dark-gray graywacke and argillite. A large dike is reported to cut these metamorphic rocks about 100 feet from the vein. The ore deposit occupies a fissure and is traceable about 200 feet. The fissure strikes N. 26° W. and dips 45° E. at the surface and 50° E. in the lower part of the shaft. The width of the fissure filling is from 2 to 6 feet and averages about 3 feet. The proportion of quartz to shattered graywacke in the filling varies. The

fissure is exposed in the stream 75 feet west of the shaft, where its filling is about 6 feet wide and consists mostly of quartz but includes some graywacke. Twenty-five feet below the collar of the shaft 13 inches of quartz occurred in a 39-inch fissure. At 60 feet the fissure was 23 inches wide, 19 inches of which was quartz. The quartz veins parallel the walls and there are very few cross fractures. Large lenses of quartz, 15 to 25 feet long, overlap, pinch out, or play out into stringers which in places unite with similar stringers from other lenses to form veins, or the stringers themselves widen until they are several inches across. The hanging wall of the fissure shows no gouge and most of the quartz veins break free from the graywacke with no gouge. The ore contains quartz, calcite, sphalerite, pyrite, galena, chalcopyrite, gold, pyrrhotite, and arsenopyrite.

*George & McFarland prospect.*—The prospect of Harry George and J. W. McFarland is on the south shore of Bettles Bay near its head. It was located September 30, 1911. The development work includes a 45-foot tunnel, a winze reported to be 40 feet deep in the tunnel, some stripping, and a cabin. The country rocks are slates and graywackes, which are intruded by acidic dikes. The lead has been traced about 50 feet. The tunnel is driven S. 26° E. along a fissure dipping 70° N. A narrow acidic dike is cut by this fissure at the winze. At the mouth of the tunnel are two sets of quartz-bearing fissures. The width of the quartz varies from 1 to 12 inches, and the stringers are short. The ore contains quartz, gold, pyrite, and galena.

### HUMMER BAY.

*Prospect of Everson, Harris & Parker.*—The Hummer vein is about three-fourths of a mile northwest of the head of Hummer Bay on the south side of the valley, at an elevation of 400 feet. It was discovered June 10, 1912, and located June 15, 1912, by C. W. Everson, Fred Harris, and A. Parker. The developments include a 40-foot tunnel with a 15-foot approach, a winze of unknown depth in this tunnel, and some stripping. The country rock consists of slates, argillites, and graywackes. The ore deposit consists of numerous irregular quartz stringers in folded, faulted, and sheared slates, argillites, and graywackes. A width of about 10 feet of this stringer lode is exposed. The general strike is from S. 10° W. to S. 40° W., and the dip is 60° W. The quartz stringers are in general parallel to each other and to the strike of the lode. These stringers range in thickness from 1 to 12 inches. The longest stringer is traceable about 60 feet, its width varying from 3 to 12 inches. The winze is sunk on this stringer. Some of the stringers break free; others have frozen walls. The mineralization appears slight. Quartz, a cream-colored, brown-weathering carbonate, galena, pyrite, and chalcopyrite were recognized in the ore.

PIGOT BAY.

*Westburg & Domenzet prospect.*—The Tomboy ledge of Isaac Westburg and Joseph Domenzet was not visited. The following information regarding it was furnished by Joseph Domenzet. The vein is at an elevation of about 2,500 feet on the ridge north of Pigot Bay. It is about 3 miles from Port Wells. The trail to the prospect leaves the head of a small bay between Hummer and Pigot bays. The vein was located July 24, 1912. The developments consist of a 16-foot tunnel and some stripping. The vein has been traced about 250 feet and ranges in width from 1 to 28 inches. About 100 feet of the vein will average 22 inches in width. A specimen of the ore furnished by Joseph Domenzet contained quartz, gold, galena, and limonite.

*Dunklee & Reilly prospect.*—The Black Bear and Yellow Horse claims of E. A. Dunklee and J. J. Reilly are on the north side of the Pigot Glacier stream valley, a mile or more northeast of the head of Pigot Bay, at an elevation of about 700 feet. These claims were located July 7, 1913. The developments comprise a 5-foot tunnel with a long approach, some stripping, and a trail to the head of Pigot Bay. The country rock is argillite cut by acidic dikes. The vein lies in a small well-defined fissure, which cuts the argillites and a 9-foot dike. The fissure strikes S. 63° W. and dips 60° N. It is traceable for about 250 feet. The average width is probably less than 6 inches, but the vein shows from 1 to 24 inches of quartz in different places. The walls are free and in one place 3 inches of gouge was observed. Secondary banding parallel to the walls is evident in places. The ore contains quartz, calcite, chalcopyrite, gold, pyrrhotite, galena, arsenopyrite, and sphalerite.

PASSAGE CANAL.

The prospects on Passage Canal were not visited, but some information regarding them was obtained from prospectors who had seen them. They are all on the north side of the fiord and according to the descriptions include gold-quartz veins, stringer lodes, and a mineralized acidic dike. The rocks on the north side of the Portage Glacier Pass are in places slightly mineralized.

*Bullion ledge.*—The Bullion ledge is near the east side of the foot of Billings Glacier and is about three-fourths of a mile from shore. The information regarding this property was furnished by Teening Carlson. The lode was located in 1911 by Albert Nordstrom, Teening Carlson, and George Furman. It is of low grade and is apparently a stringer lode in slate. The mineralized zone is reported to be a belt of slate 3,000 feet long and 1,200 feet wide, with numerous quartz stringers 1 to 18 inches wide from 1 to 10 feet apart in the slate. Fine free gold is reported in the ore.

*Hillside vein.*—The following information regarding the Hillside vein was furnished by John P. Hansen, who with James Young located the property August 28, 1913. The vein is at an elevation of about 1,000 feet near the head of a westerly tributary of the Billings Glacier stream. The vein is said to be 30 feet in length and 3 feet in width in the widest place. A specimen of the ore furnished by Mr. Hansen contained quartz, gold, pyrrhotite, chalcopyrite, sphalerite, and galena.

*Prospect of Ernest King.*—According to information furnished by Ernest King, who discovered this vein August 23, 1913, it is on the north side of Passage Canal a quarter of a mile from the head of the bay, at an elevation of 700 feet. It is 100 feet in length and has a maximum width of 1 foot. The walls are said to be free.

*Collins, Fish & Barry prospect.*—A mineralized dike near the east side of the foot of Billings Glacier was located in August, 1912, by Philip Collins, G. Q. Fish, and George M. Barry. The country rock is slate and graywacke. The ore body is reported to be a mineralized dike 1½ to 5 feet in width, which is traceable several thousand feet. The seams of quartz, which occur in fractures in the dike, vary greatly in thickness, the widest measuring 8 inches. The ore is said to pan well. It contains quartz, calcite, a cream-colored, brown-weathering carbonate, arsenopyrite, and galena. The dike is greatly altered.

ESTHER ISLAND.

*Kavanaugh & Boon prospect.*—The prospect of H. C. Kavanaugh and August Boon is on the west side of Esther Island a short distance south of a large bay. It was located September 12, 1911. The only development consists of a 5-foot tunnel at an elevation of 375 feet. A shipment of ore is reported to have been made from this property. The ore deposit lies within the contact zone of the Esther granite. The ore body examined was a shattered graywacke bed cemented by irregular bunches and stringers of fine-grained dense white quartz, which is tightly frozen to the graywacke. The ore body exposed at the tunnel is about 20 feet long and 6 feet wide. The strike is southwest; the dip is vertical. A narrow ill-defined zone of bluish quartz, 1 to 4 inches wide, along the west wall carries considerable free gold. The ore contains quartz, chlorite, gold, pyrrhotite, galena, chalcopyrite, and pyrite.

*Prospect of Fish, Collins & Stewart.*—The prospect of G. Q. Fish, Philip Collins, and E. D. Stewart is on the southwest part of Esther Island, at an elevation of 800 feet, about a mile from the shore. It was located in September, 1912. The underground development work consists of a 40-foot adit tunnel. The ore deposit lies within the contact zone of the Esther granite and the country rock consists of contact-metamorphosed argillites and graywacke. The ore body

lies in a fissure striking N. 7°–22° E. and dipping 85° W. to vertical. It is traceable about 100 feet and ranges in width from 44 to 56 inches. The walls are well defined, gouge appearing on both walls. In the tunnel little quartz shows in the fissure except a vein 1 to 4 inches wide, which lies along the hanging wall, but 2 feet of quartz is reported in one of the surface showings. The ore consists of fine-grained bluish-white quartz carrying gold, pyrrhotite, and chalcopyrite.

EAGLEK BAY.

*Eldorado ledge.*—The Eldorado ledge is on the south shore of a small bay on the west side of Eaglek Bay. The lowest outcrop is at an elevation of 600 feet. The vein was located in June, 1913, by Frank White and Chris Pedersen. The country rock is slate and graywacke. The ore deposit lies in a fissure 12 to 48 inches wide, which forms a pronounced gulch in the mountain side. This fissure strikes approximately S. 40° W. and dips 75° N. and outcrops for 400 feet. The hanging wall is massive graywacke. The fissure filling is sheared and shattered slates and graywacke with quartz stringers and lenses. The amount of quartz in the fissure filling varies. A maximum width of 2½ feet of quartz is reported. At some places the fissure contains no quartz. The ore has a bluish-gray appearance. Assays on the fissure filling are said to show $4 to $5 in gold; assays on the quartz are reported up to $100. Specimens of this ore were assayed for platinum for the Geological Survey with negative results. The minerals in the ore include quartz, calcite, gold, arsenopyrite, pyrrhotite, and pyrite.

CULROSS ISLAND.

*Thomas-Culross Mining Co.*[1]—The property of the Thomas-Culross Mining Co. is on the south side of Thomas Bay (Eagle Harbor), about 1,500 feet from the shore. The lead was discovered and located in 1907 by Albert Nordstrom, Teening Carlson, Ludwig Christiansen, and two others, but was not held by them. On October 2, 1910, the ground was relocated as the Bugaboo No. 1 and Bugaboo No. 2 claims by Ludwig Christiansen, N. L. Thomas, and M. G. Thomas. The developments on the property include a 140-foot crosscut tunnel at an elevation of 230 feet, two shallow prospect shafts on the vein, some trenching, and a frame bunkhouse erected at the bay shore. Five tons of ore is said to have been shipped to Tacoma from this property.

The lead so far as traced is all in greenstone. Slates and graywackes show in a stream bed about 50 feet north of the tunnel mouth, and everything north of that point appears to consist of slates with sandy phases and a few beds of graywacke. The greenstone-slate contact is not visible.

[1] Considerable information regarding this property was furnished by W. L. Taylor.

The ore body lies in a fissure in greenstone. This fissure is traceable 800 to 900 feet and is 36 inches wide. It strikes about S. 10° W. and has a vertical dip. Stringers and lenses of quartz occur in the sheared greenstone fissure filling. When the shear zone was cut in the tunnel only a few stringers of quartz, 1 to 3 inches wide, were found in the fissure. At one point on the outcrop of the lead, however, a quartz lens 4 to 14 inches wide has been stripped for 20 feet. Some of the quartz shows secondary banding parallel to the walls of the fissure. The country rock is impregnated in places with arsenopyrite crystals. The ore contains quartz, calcite, chlorite, arsenopyrite, pyrrhotite, gold, chalcopyrite, galena, and sphalerite.

*Prospect of John Sells.*—The Culross No. 1 claim is on the south side of a small bay, on the west side of Culross Island, at an elevation of 725 feet. It is about a mile west of the property of the Thomas-Culross Mining Co. It was located October 5, 1911, by W. B. Harris, and relocated January 1, 1913, by John Sells. The country rock is schistose sandy slates, the schistosity of which strikes S. 30° W. and dips 80° W. The ore body consists of closely grouped quartz lenses and stringers, paralleling the schistosity of the country rock in strike and dip. Irregular stringers and bunches of quartz also occur in the slates. The widths of the quartz lenses range from 4 to 59 inches and the maximum length exposed of any lens or stringer is about 15 feet. The quartz-veined area is about 200 feet in length and has an apparent width of at least 15 feet. Pyrite was the only sulphide recognized in the ore.

# MINING ON PRINCE WILLIAM SOUND.

By B. L. JOHNSON.

## GOLD MINING.

### WORK OF THE YEAR.

Interest in the gold-mining developments on Prince William Sound in 1913 centered in the Valdez, Tiekel, and Port Wells districts. Considerable development work was in progress and some prospecting was being carried on in these districts in spite of the fact that the placer strike on the Chisana caused a rush of many of the local prospectors to that district during the summer. In the fall there was a rush to the Nelchina placers. The mining developments in the Port Wells district up to and including 1913 are reported elsewhere in this bulletin. In the Tiekel district considerable development is reported on gold-quartz prospects on Hurtle, Glorious Fourth, Boulder and Fall creeks. Gold-quartz prospects have been located at different times on the Prince William Sound shore of Kenai Peninsula, on Blue Fiord, McClure Bay, Jackpot Bay, and Kings Bay. In 1913 some prospecting was in progress, but no active development is known to have been carried on. Gold-bearing gravels are reported on Nellie Juan River.

### VALDEZ DISTRICT.

In the Valdez district the Cliff mine was in 1913, as heretofore, the most important producer. The mill, with 6 Nissen stamps, was operated, except for short stops of some of the stamps, throughout the year. About 45 men were employed at the property. Three shifts were worked in the mill and two shifts in the mine. The underground developments are now said to total at least 8,000 feet. Development work was carried forward on the 500-foot level until it was stopped by water, and the pumps were then pulled out and the water was 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 these levels.

The Gold King, which is about 7 miles from tidewater on Shoup Bay, at an elevation of about 3,800 feet on a nunatak in the Columbia Glacier, made contributions to the gold production of the district in 1913. A 3½-foot Huntington mill, run by gasoline engines, was

erected during the spring and summer of 1913. Milling started August 13, 1913, and it is said that between 200 and 300 tons of ore had been milled before the close of the season. Between 25 and 36 men were employed by the company at different times. The underground development work consists of the No. 1 tunnel, with 500 feet of drifts and tunnels, a 60-foot winze, and 90 to 100 feet of drifts from the bottom of the winze; the No. 2 crosscut tunnel, 400 feet in length; the No. 3 crosscut tunnel, 45 feet in length, with 100 feet of drifts, and some open cuts and stripping. A 110-foot raise is reported to have been put in later. The total amount of underground workings is about 1,150 feet of drifts and tunnels, a 60-foot winze, and a 110-foot raise. Several buildings have been erected at the mine and a midway house has been built on the Shoup Glacier. A telephone line connects the mine with the buildings on Shoup Bay.

The Cameron-Johnson Gold Mining Co., on Shoup Bay, installed a 5-stamp mill and concentrator. Power is furnished by a Pelton water wheel. The mill is said to have started late in July, 1913, and to have stopped about October 1, 1913. Nearly 200 tons of ore is reported to have been milled. An average of 30 men were employed on the property during the working season. A temporary tram was erected between the mine and mill; it was later dismantled. Nine tunnels, from 25 to 217 feet in length, are reported, the total work comprising about 1,000 feet of tunnels and 76 feet of raises. Mining was in progress until the middle of September, 1913.

A small 1-stamp mill was run on ore from the Minnie claim, and about 4 tons of ore is said to have been milled. Two men were at work on the property during the summer of 1913. The total developments comprise 35, 20, 15, and 5 foot tunnels and a small cabin.

On the Olson claims, on Shoup Glacier, one man was at work for a part of the season. The developments in 1913 included a 36-foot tunnel, a 130-foot tunnel, a 7-foot shaft, and some stripping and open cuts.

On the Rambler claims 4 men are said to have driven 63 feet of tunnel, making the total length of the Rambler Tunnel 230 feet. It is also reported that an 18 and a 20 foot shaft were constructed.

An adit tunnel 130 feet long is said to have been driven on the Bence-McDonald claims in 1912, but only assessment work was done in 1913.

Two men are reported to have driven two short tunnels, 20 and 32 feet in length, on claims adjoining the Minnie and Bence-McDonald claims.

A 32-foot tunnel is reported to have been driven in 1913 on a claim situated between the Minnie and Cameron-Johnson claims.

At the Alice Mines (Ltd.), on Shoup Bay, development work was stopped early in February. Fifteen men were employed until February 11, 1913. The underground developments are said to comprise

a tunnel, a 100-foot shaft, 100 feet of drifts along the lead at the bottom of the shaft, and a raise to the surface from the tunnel level above the shaft.

Four men were employed by the Thompson-Ford Mining Co. in Uno Basin during the first half of the year and one man for the remainder of the season. The underground development work in the fall of 1913 included a lower tunnel, 325 feet long, with 2 drifts, 75 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 its bottom to the raise; and about 100 feet of drifts on a level 60 feet below the mouth of the raise.

About 50 feet of underground work by 2 men is said to have been performed on the Guthrie & Belloli property in Uno Basin. The total underground development on this property now consists of a tunnel about 150 feet in length.

The Sea Coast Mining Co., on Shoup Bay, employed an average of 12 men during the summer of 1913. The total underground work in October, 1913, comprised two tunnels, 50 and 238 feet in length, open cuts, and stripping. A large frame building has been erected at the shore, and a small building on the trail to the mine.

Assessment work was done in 1913 on the Bluebird group, near the mouth of Shoup Bay, and the total developments now comprise 115 feet of crosscut tunnel, considerable stripping, a trail to property, and three buildings on the beach. Development work was in progress during the year at the Sealey-Davis property, on Shoup Bay, where two men were at work. Three men were engaged in development work on the Three-in-One property, near the mouth of Gold Creek, in 1913.

On Mineral Creek a 2-stamp mill is said to have been erected on the property of the Mountain King Mining Co. A crew of 15 to 18 men is said to have been employed and considerable development work done. Three tunnels, 50, 130, and 450 feet in length, are reported. Four men were also at work during the summer on the Little Giant group, and two to four men were engaged in assessment and development work on the Millionaire, Hercules, Big Four, Blue Ribbon, Olson & Woods, Williams-Gentzler, Valdez Bonanza, and other claims on this creek.

The Valdez Mining Co., on Valdez Glacier, in 1913, drove about 100 feet additional in its crosscut tunnel, making the total length of the tunnel about 230 feet. The developments on the Ramsay-Rutherford property in October, 1913, are reported to have included a 130-foot shaft and between 400 and 500 feet of tunnels and drifts.

## COPPER MINING.

### CONDITIONS DURING THE YEAR.

Comparatively little attention was paid to copper prospecting or mining in 1913 in the Prince William Sound region outside of the developed and partly developed properties. The Ellamar and Beatson-Bonanza mines made regular shipments, as in former years, and the Fidalgo Mining Co. joined the ranks of the producers. Large forces of men were maintained at Ellamar and Latouche throughout the year, and a large force was employed at the Midas property during the spring. Eight men were employed continuously at the Fidalgo Mining Co.'s property and several men were engaged in development work by the Fidalgo-Alaska Copper Co. in the spring and fall. Two to four men were engaged in development and assessment work, either continuously or for short periods, on other Prince William Sound copper prospects. An important event of the year in the history of copper mining in this region was the entrance of the Granby Consolidated Mining, Smelting & Power Co. (Ltd.) into the Prince William Sound region through the purchase of the Midas copper property on Solomon Gulch in the Port Valdez district.

### VALDEZ DISTRICT.

The Midas property on Solomon Gulch, 4½ miles from Valdez Bay, was bonded in the fall of 1912 to the Alaska Development & Mineral Co. The developments on the property at that time are said to have comprised about 400 feet of underground work. Development work was actively carried on by this company during the winter of 1912–13 and the spring of 1913. Twenty-five men are reported to have been at work on the property in March, 1913. In the later part of June, 1913, when this company gave up its option on the Midas, the underground development work is said to have amounted to more than 1,500 feet of tunnels, drifts, and raises. The principal developments consisted of two adit tunnels, each several hundred feet in length, with a vertical interval between them of 92 feet, and three raises, two of which connect the two levels. No work was in progress in the summer of 1913. In the fall the property was bought by the Granby Consolidated Mining, Smelting & Power Co. (Ltd.), which began preparations for extensive development of the ore body.

### ELLAMAR DISTRICT.

The earlier development work at the Ellamar mine was confined to the removal of a rich copper shoot. In recent years other parts of the ore deposit have yielded pay ore, containing gold as well as copper, and at present the entire sulphide deposit is being mined as ore. In 1913 the 400-foot level was unwatered and development

work was confined to the 200, 300, and 400 foot levels and the stopes between these levels. The method of mining was changed during the summer, the filling system being then adapted. A new air compressor, installed in the spring of 1913, furnishes air for all underground work. A large 28-room bunkhouse with accommodations for 56 men was completed, a small wireless plant was installed, and a skipway was erected at the end of the wharf for loading the ore directly on board steamers. An average of 40 men worked on the property through the year. Steps were also taken in 1913 to increase the output of this mine.

No ore shipments were made in 1913 from the property of the Threeman Mining Co. on Landlocked Bay, but underground development work was in progress on the A. C. Co., Montezuma, and Keystone claims. Ten men are said to have been employed early in the spring, but this force was later reduced to 4 men. The field work of 1912–13 has demonstrated the presence in ore from the Keystone claim of a copper-iron sulphide, containing about 16 per cent copper, in intimate association with the chalcopyrite. The relative proportions of the two sulphides in this ore are not known.

The Landlock Bay Copper Mining Co. is reported to have had 2 or 3 men engaged in underground development work during a part of the year. Assessment work only was done on other properties in the Ellamar district.

### PORT FIDALGO.

Descriptions of the three copper mines on the south side of Port Fidalgo—the properties of the Fidalgo Mining Co., the Fidalgo-Alaska Copper Co., and the Dickey Copper Co.—are included in a forthcoming report on the Ellamar district. Their history and development are summarized briefly here.

The property of the Fidalgo Mining Co. was discovered in 1905 by T. W. Blakney and H. H. Herren. The Fidalgo Mining Co. was incorporated about a year later. During the summer of 1907 the present lower tunnel was driven about 400 feet. In October, 1912, the developments consisted of about 600 feet of underground work. The mine was operated continuously in 1913 with an average crew of 8 men, working one shift each day. The main underground developments at present include a lower adit tunnel 450 feet in length at an elevation of about 850 feet, an upper tunnel 240 feet long, 100 feet above the lower tunnel, a raise connecting these two tunnels, and stopes between the two levels. A 65-foot raise connecting the upper tunnel with the surface is reported to have been put through late in the fall of 1913. A 2,000-foot two-bucket aerial tram was completed early in 1913. The surface improvements on the property include trails, wharf, ore bunkers at the landward end of the wharf, aerial tram connecting

the lower bunkers with ore bunkers and sorting house at the upper terminal of the tram, log eating and sleeping quarters at an elevation of 825 feet, log blacksmith shop and log gasoline engine shed at the mouth of the lower tunnel, and a log cabin and shake shed on shore 1,000 feet east of the wharf. A 900-foot surface tram connects the mouth of the lower tunnel with the upper terminal of the aerial tram. The upper ore bunkers are reported to hold about 50 tons. The lower ore bunkers are of logs and have a reported capacity of about 500 tons of ore. The first shipment of ore from this property was made in February, 1913, to the Tacoma smelter. Several other shipments were made later in the year.

The property of the Fidalgo-Alaska Copper Co., better known locally as the Schlosser property, is said to have been discovered in June, 1907, by Charles Schlosser. The Fidalgo-Alaska Copper Co. was then formed and development work was started in the fall of 1907. Considerable underground work has since been done. A small crew of men were at work on the property in the spring of 1913. The property was idle during the summer, but development work was again started in the fall and a shipment of ore is said to have been made to the Tacoma smelter later in the year. Several hundred tons of ore are reported to have been shipped in previous years. The underground workings in July, 1913, comprised the lower tunnel, at an elevation of about 800 feet, with 550 feet of crosscuts and drifts, two stopes, and a raise; a forked tunnel at 950 feet elevation, the tunnel forking at the mouth into two branches 75 and 500 feet in length, with a raise in the long branch; a short tunnel at an elevation of 1,005 feet forking 45 feet from the mouth into two branches 10 and 15 feet long; two shallow shafts, at an elevation of 1,050 feet, one of which extends down into the west branch of the upper forked tunnel; three other short tunnels, a shallow shaft, open cuts, and stripping. The surface improvements included trail, wharf, ore bunkers at wharf, frame building close to ore bunkers, an aerial tram, reported to be 2,800 feet long from the wharf to the mine, and several log buildings at the mine. A portion of the wharf was washed away during the summer of 1913.

The prospect of the Dickey Copper Co., known locally as the Mason & Gleason claims, was discovered by George Mason and Mark Gleason in July, 1907. About 50 feet of underground work had been done when the property was bonded in 1910 to W. A. Dickey, who later bought it. Some development work was done in 1911 and 1912. In the spring of 1913, with 4 men at work on the property, the trail was constructed, ore bunkers were built, 110 feet of tunnel and 70 feet of drift were driven, and about 600 tons of ore were mined. Operations were discontinued July 1, 1913. No ore shipments had been made to that date. The underground developments in July,

1913, included a lower tunnel with several hundred feet of drifts and crosscuts and a raise; an upper tunnel 125 feet long, with a 25-foot raise, and a stope 30 by 8 feet, extending from the tunnel to the surface; an intermediate tunnel 35 feet long between the upper and lower tunnels; a 30-foot winze connecting the upper and intermediate levels; and a short crosscut tunnel on the outcrop of the lead. Surface improvements consisted of a 2-mile trail to the shore of Irish Cove, a small shake warehouse on the shore, a log cabin at the mine workings, two log ore bunkers, with a total capacity of about 800 tons, just below the mouth of the lower tunnel; two shake sheds at the mouth of the lower tunnel; and a log blacksmith shop and a small log ore shed at the mouth of the upper tunnel. The ore mined, about 600 tons, was, in July, 1913, stored in the ore bunkers.

### LATOUCHE AND KNIGHT ISLANDS.

The Beatson Copper Co., on Latouche Island, was a regular shipper of copper ore in 1913 to the Tacoma smelter. An average of about 60 men were employed during the year, working two shifts of 8 hours each. At times during the summer this force is said to have decreased to about 40 men. Development work in 1913 consisted in drifting south in the ore zone on the main level, removing the overburden from the outcrop of the ore body, and mining the ore in the bluff pit by the glory hole method. The ore was trammed from the main level to the sorting house, hand sorted, and stored in the ore bunkers. It was loaded on the steamers by an electric belt conveyor. Only assessment work is reported on Knight Island.

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

Assessment work was performed on copper prospects on Unakwik Inlet, Wells Bay, and Glacier Island. Some short tunnels are reported on copper properties on Siwash Bay.