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THE SITKA MINING DISTRICT ALASKA

BY

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By Alfred H. Brooks.

The first attempt at lode gold mining in Alaska was made near Sitka in 1871 but was soon abandoned. In the succeeding quarter of a century but little was accomplished in this field toward establishing productive enterprises. An era of commercial mining was begun by the discovery of gypsum deposits near Iyoukeen Cove about 1902 and of auriferous lodes near Klag Bay in 1905. The output of the mines at these localities, which are on Chichagof Island, in the Sitka district, has helped to swell the value of the annual mineral production of Alaska.

Several geologists have visited the Sitka region since 1895 and brief reports regarding its mineral resources have been published, but most of these are out of stock at the Geological Survey. The growing interest in the mineral resources of this field led to their further investigation by Mr. Knopf in 1909 and to the preparation of this report, which summarizes all the data thus far collected. Its preparation and publication is in accord with the general plan to publish summary accounts of the geology of the mining districts of Alaska as fast as circumstances permit. In conformity with this plan reports have already been published on the Ketchikan, Wrangell, Juneau, Berners Bay, and Porcupine mining districts of southeastern Alaska.[1]

As the areal geology and the stratigraphic sequence in the Sitka district are still imperfectly known, this report is necessarily of a preliminary character; but if the mining industry of the Sitka district continues to advance, more thorough studies will be undertaken as soon as circumstances permit.

Mr. Knopf's conclusion, here set forth, that the graywacke-slate belt paralleling the line of granite intrusives along the western side of Chichagof and Baranof islands is a promising field for the occurrence of auriferous lodes should be of interest to the prospector. His

[1] Wright, C. W., The Porcupine placer district, Alaska: Bull. U. S. Geol. Survey No. 236, 1904, 35 pp. Spencer, A. C., The Juneau gold belt, Alaska; Wright, C. W., A reconnaissance of Admiralty Island, Alaska: Bull. U. S. Geol. Survey No. 287, 1906, 161 pp. Wright, C. W. and F. E., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, 210 pp. Knopf, Adolph, Geology of the Berners Bay region: Bull. U. S. Geol. Survey No. 446, 1911, 58 pp.

suggestion that the graywackes and slates may be of Jurassic or Cretaceous age, and not Paleozoic, as hitherto supposed, may have an important bearing on the geology of other parts of Alaska. These rocks have generally been correlated with the Orca group of Prince William Sound, whose age is undetermined but is supposed to be Mesozoic.

THE SITKA MINING DISTRICT. ALASKA.

By Adolph Knopf.

INTRODUCTORY STATEMENT.

In the following report the writer aims to present a brief sketch of the geology of the Sitka mining district, with especial reference to the mineral resources of the west coast. The mining industry of the district has been in a state of nearly complete stagnation during the last decade, but the discovery of high-grade gold ore in 1905 at Klag Bay, 50 miles north of Sitka, and the subsequent prosperous career of the mine founded on the original discovery have given a new impetus to development and have attracted attention to the comparatively unprospected territory on the west coast of Chichagof Island.

The data on which this report is based are drawn from various sources. In June, 1910, the writer spent three weeks in investigating the geology at Klag Bay and the surrounding inlets and subsequently spent a few days in examining the prospects in the vicinity of Sitka. To supplement the data obtained from his own field work the writer has drawn freely on the unpublished field notes of F. E. and C. W. Wright, and has examined their collections and microscopic thin sections. In 1904 F. E. Wright made a reconnaissance study of the geologic section from Taku Inlet to Sitka by way of Peril Strait and investigated the geology of Silver Bay and the west coast of Baranof Island as far south as Whale Bay; in 1905 C. W. Wright made a reconnaissance trip along the east coast of Baranof Island and around Chichagof Island. Brief preliminary accounts of these investigations have already been published,[1] but owing to unforeseen circumstances more detailed reports were not prepared. Because of the writer's partial familiarity with the field it became his task, in view of the renewed interest in the region, to assemble the known

[1] Wright, F. E. and C. W., Economic developments in southeastern Alaska: Bull. U. S. Geol. Survey No. 259, 1905, pp. 55–58. Wright, C. W., Lode mining in southeastern Alaska: Bull. U. S. Geol. Survey No. 314, 1907, pp. 59–61. Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, p. 84.

facts concerning its geology and mineral resources. The area is large and much of it is geologically unexplored and the knowledge of it is correspondingly meager, but it has nevertheless been thought worth while to bring together the existing geologic data.

HISTORICAL NOTES.

The first attempts at lode mining in Alaska under the American régime were undertaken in the vicinity of Sitka in 1871. This work was done on a quartz ledge outcropping at the falls of Indian River, 1 mile east of Sitka. Although no serious efforts were put forth, the matter aroused some local excitement, and news of the discovery appeared even in San Francisco newspapers. In 1872 three placer miners discovered near the head of Silver Bay the quartz ledge subsequently known as the Lower ledge, but it was considered valueless by them. Some of the ore was seen by Nicholas Hayley, who had previously worked in the mines at Grass Valley, Cal., and the Comstock, and who was then serving in the garrison stationed at Sitka, and the lode was located by him. Late in the same year he discovered the Stewart ledge, which was named after Maj. Joseph Stewart, United States Army. Before 1880 many other ledges had been discovered in the district around Silver Bay. In 1879 a 10-stamp mill was erected on the Stewart property.

Petroff,[1] writing in 1880, says:

> Discoveries of gold-bearing quartz have been made on Baranof Island, in the immediate vicinity of Sitka, only since the transfer of the Territory, and for a time quite an excitement was created; but now these ledges are scarcely worked at all, being simply held by the owners for further developments or until some process can be discovered for working with profit the peculiar grade of ore existing there.

In the winter of 1880–81 a considerable part of the population of Sitka participated in the stampede that led to the founding of Juneau. After the lapse of nearly 40 years since the original discovery of gold-bearing quartz, none of the properties at Silver Bay have been put on a productive basis. During that time some remarkable mining failures have taken place on Baranof Island, those at Rodman Bay and Pandé Basin being well known throughout southeastern Alaska. This state of affairs led to the nearly complete extinction of all interest in lode mining in the Sitka district, and it is only since the discovery of gold ore at Klag Bay on Chichagof Island in 1905 that interest has in some measure revived.

GEOGRAPHIC SKETCH.

The Sitka mining district comprises Chichagof, Baranof, and Kruzof islands, together with a few smaller islands. The total land area roughly approximates 4,500 square miles, the greater portion of

[1] Tenth Census, vol. 8, Report on the population, industries, and resources of Alaska, p. 30.

which is included in Chichagof and Baranof islands. Those two islands form in effect a single land mass, gradually tapering southeastward, separated into two parts only by a narrow body of water known as Peril Strait. Its extreme length from Point Adolphus on the north to Cape Ommaney on the south is 150 miles, and the average width is 30 miles. On the east the islands are separated from the other islands of the Alexander Archipelago by Chatham Strait, on the north they are separated from the mainland by Icy Strait, and on the west they are bordered by the Pacific Ocean.

The topographic features of the islands are entirely similar to those of the remainder of southeastern Alaska. The coast line is indented by numerous bays and fiords, many of which, like Tenakee Inlet and Whale Bay, penetrate far inland into the heart of the islands and render territory accessible that is otherwise nearly impenetrable. The relief is rugged and the mountains rise abruptly from the shore, at many places forming bold cliffs, hundreds of feet high, surmounted by precipitous slopes, rising 2,000 to 3,000 feet. The ruggedness increases toward the interior of the islands, and little is yet known concerning the inland portion of this region. In general, the altitudes range from 2,000 to 4,000 feet.

The region is well forested with coniferous species, mainly hemlock, spruce, and cedar, both red and yellow. Jack pine is found in small amount and is limited to open, boggy parks, being apparently unable to compete in the more favorable situations with the other conifers.

On the west coast, as at Klag Bay, the timber line reaches 1,500 feet above sea level, but in protected localities it reaches 2,500 feet. The diameter and height of the trees vary considerably from place to place; at Klag Bay, for example, 18 inches appears to be the average diameter, whereas along Indian River, east of Sitka, magnificent trees are common, spruces as much as 6 feet in diameter and 175 feet in height having been noted. As a rule, the supply of timber is adequate for general mining purposes, but the stand of logging timber is comparatively small and is soon exhausted at any one locality.

A thick and luxuriant undergrowth is common in the forest and consists largely of blueberry brush and devil's club, with various other kinds of growth, such as willow, alder, salmon berry, and the high-bush cranberry. On account of the frequent rainfall this undergrowth is almost continuously wet, and this feature, together with its jungle-like character and the numerous windfalls of timber, make the forest a formidable obstruction to the prospector.

The geographic and climatic features, as well as the forest, impose limitations on the prospector's activities. As the waterways furnish the only means of communication with the centers of supply, which are few and widely separated, a boat, preferably a power boat, becomes a necessary part of the prospector's equipment. The waters are often rough and stormy, the islands are exposed to the open ocean, and in winter the heads of the bays are frozen up—all conditions that tend to restrict prospecting to the summer months. In order to utilize the few favorable months of the year as effectively as possible, prospecting has hitherto been confined mainly to examination of the shore-line exposures and to the country closely bordering the coast.

CLIMATE.

The climate of the region is cool-temperate and humid. The precipitation is heavy, the number of rainy days is large, and foggy and cloudy weather is of frequent occurrence.

Records have been kept for a longer period at Sitka than at any other Alaska station, so that unusually full statistics concerning the climatic features are available. The mean annual temperature at Sitka is 44° F. The mean monthly temperature for February, the coldest month, is 33°, and for August, the warmest month, 56°, the mean annual range being thus only 23°.

The average annual precipitation, including melted snow, is 88 inches, and the extremes on record since 1868 are 59 and 140 inches. The average number of days during which precipitation takes place is 208. At sea level the precipitation is usually in the form of rain, but there is a considerable snowfall on the mountains, which, even at moderate altitudes, often remains until late in summer.

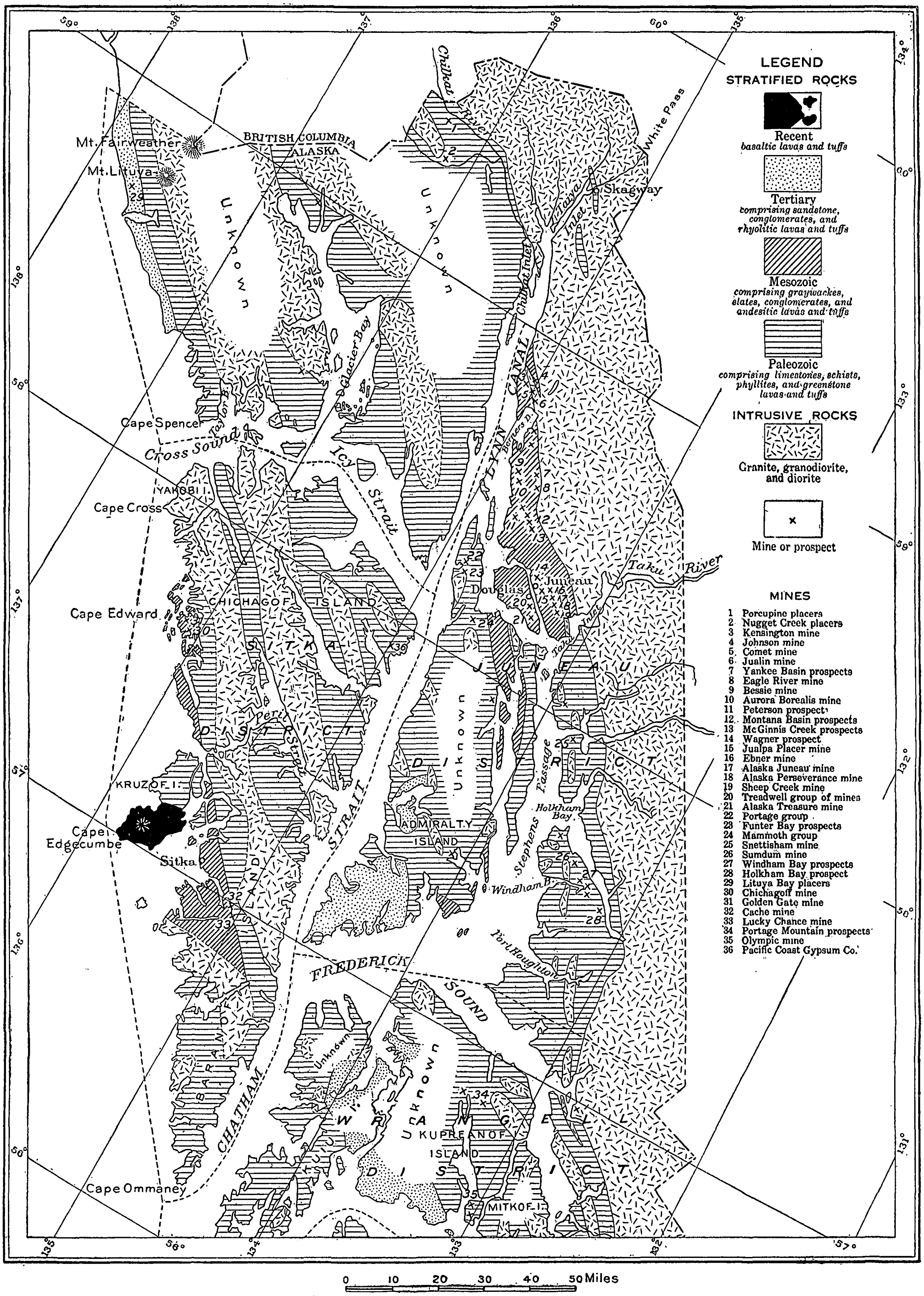
Climatic table for Sitka, Alaska.[a]

Length of record.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Ann.
Mean temperature, °F.:													
Jan., 1828, to Dec., 1876	31.4	32.9	35.6	40.8	47.0	52.4	55.4	55.9	51.5	44.9	38.1	33.3	43.3
Apr., 1881, to Sept., 1887	34.2	33.0	37.2	41.9	46.9	51.6	54.4	56.6	52.3	45.7	39.8	36.0	44.5
Mean precipitation, including melted snow, inches	12.17	7.47	6.70	5.61	4.11	3.31	3.55	5 84	9.67	11.96	9.80	7.88	88.10
Mean number of days with 0.01 inch or more precipitation	16.8	15.9	18.0	16.2	16.1	13.6	14.9	16.8	19.5	21.7	19.5	18.9	207.9

[a] These statistics are taken from the more comprehensive tables in Geography and geology of Alaska, by Alfred H. Brooks, with a section on climate by Cleveland Abbe, jr.: Prof. Paper U. S. Geol. Survey No. 45, 1906.

GLACIATION.

The present-day glaciation is represented, so far as is now known, by a few small glaciers only, but doubtless a number of others will be discovered when the interior of the islands becomes better known. At Pandé Basin, east of Sitka, a glacier occupies the hanging valley at the head of the basin; and another smaller glacier, known as Valdenar Glacier, lies at the head of Green Lake Valley, east of Silver Bay.



GEOLOGIC RECONNAISSANCE MAP OF THE SITKA AND JUNEAU MINING DISTRICTS.

After F. E. and C. W. Wright.

Evidence of a former greatly extended glaciation, of which the present glaciation is the vanishing remnant, is everywhere visible. The deeply fiorded character of many of the waterways is the most immediate token of the former glacial occupancy of the region, and this evidence is corroborated everywhere by smaller and more local features due to glacial action. These consist of polished and striated surfaces and of glacial drift several feet thick containing striated bowlders.

At Klag Bay broad, glacially smoothed surfaces were found up to an altitude of 1,300 feet on the flank of Doolth Mountain, an isolated mountain which is too small to have supported an independent glaciation. The smooth, flattish summit, reaching an altitude 2,100 feet above sea level, may itself owe its form to the action of an overriding ice sheet, for the neighboring mountains that attain higher altitudes show serrate profiles. As Doolth Mountain practically stands on the shore of the Pacific Ocean, these figures furnish a rough estimate of the minimum thickness of the ice sheet as it reached the open ocean during the glacial epoch.

GENERAL GEOLOGY.

The rocks of Chichagof and Baranof islands lie in broad belts that strike northwest and southeast, conforming with the prevailing structural trend of southeastern Alaska. The core of the islands is made up largely of granitoid rocks, mainly quartz diorites, which, as a rule, have been intruded parallel to the stratified rocks. The general distribution of the rocks is shown on the sketch map forming Plate I.

STRATIFIED ROCKS.

The oldest rocks consist of cherts, commonly brecciated and folded, and banded quartzite resembling graywacke. Small dikes of melaphyre cut the strata at numerous localities. These rocks outcrop for several miles along the north shore of Chichagof Island, between Idaho Inlet and Port Frederick, and continue southeastward from Port Frederick to Point Augusta. Although the thickness of this series of rocks has not been determined, it is believed to exceed several thousand feet. On the west at Idaho Inlet the rocks are intruded by light-colored quartz diorite, which is gneissic along the contact and has altered them to a compact biotite schist.

The overlying rocks are cherty limestones of Silurian age, as determined by fossils found at Port Frederick and Freshwater Bay. They are particularly well exposed along the south side of Freshwater Bay, where they have been studied in some detail.[1] The rocks stand nearly vertically and are over 1,000 feet thick, the lower two-

[1] Kindle, E. M., Notes on the Paleozoic faunas and stratigraphy of southeastern Alaska: Jour. Geology, vol. 15, 1907, p. 322.

thirds of this thickness consisting of dark-gray, thinly laminated limestones. Above the Silurian at this locality are 50 feet or more of Middle Devonian limestone, stratified in beds 1 to 4 feet thick.

A thick series of melaphyre lava flows and tuffs interstratified with limestone beds of Upper Devonian age is exposed on the northeast side of Freshwater Bay and forms a belt of rocks extending northwestward to Port Frederick. As the tuff beds are fossiliferous, it is probable that the lavas were erupted under submarine conditions. The melaphyres are mainly altered basalts, red, green, or black in color, the red being perhaps the most common. They are dense grained rocks and show a porphyritic texture, due to the presence of scattered crystals of feldspar.

Somewhat over 1,000 feet of limestone of Mississippian (lower Carboniferous) age overlies the melaphyres and is exposed in Port Frederick and along the northeast shore of Freshwater Bay. Concerning the latter locality Kindle reports:[1]

On the northeastern side of the bay, and opposite the Silurian and Devonian limestones already described, the Carboniferous limestones form a low, narrow peninsula, never more than a few hundred yards in width, projecting out 4 miles from the mainland. The strike varies from N. 35° E. to N. 40° W., but generally has a northwesterly and southeasterly trend. The dip is high, frequently 90°. It is sometimes easterly and sometimes westerly, the direction of dip depending on whether or not the limb of the large fold to which all this peninsula and the older beds on the south side of the bay belong is slightly overturned at any given point. The thickness of the several divisions of the limestones which are exposed along the north shore of this peninsula is indicated approximately in the following section, which begins about one-half mile above (northwest of) North Passage Point:

	Feet.
e. Breccia of large gray limestone fragments	100
d. Hard gray limestone, much fractured by numerous irregular joints, and breaking into small irregular fragments on weathering. Large Productoids common. Dip, 30° to 90° toward southwest. Strike, N. 40° W	90
c. Gray limestone with frequent bands of black chert. Fossils scarce. Dip, 80° to 90° NE. Strike, N. 10° to 20° W	275
b. Dark-gray limestone with black chert bands. Fossils abundant near upper and lower limits. Average strike, N. 30° E. Dip, 70° to 80° NW	250
a. Limestone similar to b. Corals common	275
	990

At Iyoukeen Cove, Freshwater Bay, gypsum beds have been found associated with cherty limestones, which apparently overlie the lower Carboniferous rocks exposed along the southwestern shore of the cove. They are provisionally regarded as of Permian or Triassic age.[2]

[1] Op. cit., pp. 330–331.
[2] Wright, C. W., The building stones and materials of southeastern Alaska: Bull. U. S. Geol. Survey No. 345, 1908, p. 125.

Along the west coast of Chichagof and Baranof islands the rocks appear to be divisible into two large subdivisions. The easternmost of these—that is, the belt of rocks lying against the granitic axis of the islands—consists of greenstones and phyllites, associated with limestones, cherts, calcareous chlorite schists, and amphibolite schists. The phyllites and schists are remarkably crinkled and contorted and in many places are gnarled and laminated with knots and veinlets of quartz. The greenstones, limestones, and cherts show at some localities a profound fracturing and brecciation, so that the rocks are in fact recemented rubbles. This feature is strikingly displayed along the shores of Nakwasina Passage and Katlian Bay, a few miles north of Sitka. Greenstone from Lisianski Peninsula, on Nakwasina Passage, proves microscopically to be an andesite of microlitic texture; tuffs and amygdaloids, as at the head of Ford Arm, form part of the greenstone series, so that without doubt they represent a succession of much-altered surface volcanic rocks. Fossils have not been found in any of the associated rocks, so that the age of this series of rocks is not known. By analogy with the Juneau region it has been surmised that they are of upper Carboniferous age.[1]

To the west of these rocks is a belt of graywacke and slate, which forms the bedrock at Silver Bay, Sitka, and Klag Bay. The strike is northwest-southeast and the dip is steep southwest, commonly 70° or higher. At many places the designation "slate-graywacke formation" is apt to convey a misconception as to the relative abundance of slate. At Sitka, for example, graywacke constitutes such a preponderant proportion of the formation that all the surface exposures consist essentially of that rock. East of the mouth of Indian River massive outcrops of graywacke several hundred feet thick appear, which show no discernible stratification. At one point near Indian River a 10-inch belt of fine conglomerate, trending N. 70° W., was noted. The matrix of this conglomerate is thoroughly lithified, so that the rock breaks across the pebbles. This stratum of conglomerate is not separated, as in ordinary sedimentary rocks, by sedimentation planes, but grades irregularly, though abruptly, into the inclosing graywacke.

The graywackes were designated "pyroclastic diorites" by Becker[2] and locally are usually referred to as diorites, but the sedimentary character of the graywackes has been uniformly recognized by all other geologists who have examined them.

Conglomerate and conglomeratic graywacke occur at Old Sitka. The pebbles of these rocks comprise slate, schist, chert, andesite, and

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908, p. 56.

[2] Becker, G. F., Reconnaissance of the gold fields of southern Alaska, with some notes on general geology: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, p. 43.

felsite. To the west the conglomerate is overlain by a great thickness of obscure rocks, possibly indurated argillites, much fractured and interlaced with quartz veinlets, whose derivation has not been satisfactorily determined. These in turn are overlain by conglomeratic graywacke carrying pebbles 2 to 3 inches in diameter and by the blue-gray colored graywacke typical of the Sitka region.

The slate-graywacke formation has so far proved to be unfossiliferous, and its age remains unknown. It is believed to rest unconformably on the greenstones and associated rocks to the east, but this unconformable superposition, if it exists, has not yet been observed in the field. The lithologic difference and the probably superior degree of metamorphism of the underlying rocks strongly suggest unconformity. So, too, does the character of the pebbles in the conglomerate beds; but as these beds are not basal conglomerates this fact is not conclusive, but is open to other interpretations. It is well to point out that a considerable volume of green graywackes, whose recognition and discrimination from greenstones is not possible by the unaided eye, underlies the conglomeratic beds at Old Sitka. The peculiar character of these graywackes may be due either to the fact that they represent transition strata or, on the other hand, that they are derived immediately from the underlying rocks.

The graywacke-slate formation has been tentatively assigned to the Permian.[1] It is not an unreasonable conjecture, pending the accumulation of stronger evidence, to suppose that it may eventually prove to be of the same age as the Berners formation of the Juneau region, late Jurassic or early Cretaceous. In lithology and degree of metamorphism of the graywackes and slates it bears a striking similarity to that formation.

The youngest rocks of the region are the postglacial lavas and tuffs that make up the volcanic cone of Mount Edgecumbe on Kruzof Island. It is reported, upon somewhat questionable evidence, that Mount Edgecumbe was in eruption as late as 1796.[2] The volcanic rocks are mainly basic andesites or basalts and display a striking diversity of color, texture, and crystallinity. They include black glasses, frothy pumices, and gray holocrystalline lavas. A lava collected at the shore east of Mount Edgecumbe consists of a gray, highly porous rock which is thickly studded with glassy tabular plagioclase feldspars, ranging in length from three-tenths to four-tenths of an inch. According to a rough estimate the feldspar phenocrysts form half the bulk of the rock. Small glassy grains of olivine are sparingly scattered throughout the rocks. Under the microscope the plagioclase phenocrysts prove to be a calcic labradorite near

[1] Wright, F. E. and C. W., Bull. U. S. Geol. Survey No. 347, 1908, p. 35.
[2] Becker, G. F., op. cit., p. 13.

Ab_1An_3; some of the olivine forms crystals large enough to be termed phenocrysts, but most of it is found in the mesostasis between the feldspar phenocrysts. The mesostasis is holocrystalline and consists of a doleritic aggregate of augite and feldspar laths, with accessory magnetite and hematite.

INTRUSIVE ROCKS.

DEEP-SEATED ROCKS.

Extensive masses of granitoid rocks form the central parts of the islands. The dominant type is a quartz diorite composed essentially of andesine feldspar, quartz, biotite, and hornblende. As a rule the dark minerals are not very abundant and the diorites are medium-grained rocks of light color. At a few localities rocks more basic than quartz diorite are known. Hornblende gabbro is found at the head of Tenakee Inlet, and a highly shattered and sheared gabbro occurs along Nakwasina Passage and Katlian Bay. At Port Althorp, on the north shore of Chichagof Island, exposures of hornblendite—a black rock consisting entirely of hornblende—form a mass one-fourth mile wide.

The intrusive rocks are commonly fresh and unaltered and are little affected by schistose or gneissic structures. The marginal portions of some of the intrusive masses, however, show gneissic foliation. At such localities the diorites are flanked by belts of crystalline schists, such as amphibolite schists and biotite schists, whose crystallinity diminishes at increasing distance from the contact. Such schists are encountered at widely separated points—at Patterson and Gut Bays, on the east side of the south end of Baranof Island, and along Icy Strait, on the north shore of Chichagof Island.

The intrusive character of the quartz diorite masses is well established, and with the exception of various dike rocks and the recent lavas on Kruzof Island they are the youngest rocks of the region. On account of their close resemblance to the dioritic rocks of the Coast Range on the mainland and their extensive distribution they are regarded as part of the great series of deep-seated igneous rocks that invaded the province of southeastern Alaska in late Mesozoic time.

Some older granitoid rocks may probably be included among the Mesozoic quartz diorites of the Sitka mining district, but they have not been certainly recognized and discriminated from the younger rocks on account of lack of detailed observations. The quartz diorite gneiss, containing large plates of biotite, at Schulze Head, Peril Strait, may belong to such an older series of igneous rocks, but this is hardly more than a suggestion.

DIKE ROCKS.

Pegmatite and aplite dikes accompany the quartz diorites, and lamprophyric dikes have been found at some places. Emerson[1] has described a spessartite dike as occurring at Hot Springs, near Sitka, and F. E. Wright has determined others from the same locality to be vogesites. The lamprophyric dikes are dark rocks resembling diabases, and they appear to be comparatively rare.

The aplite dikes are of greater importance and are widely distributed, though nowhere present in large numbers. They are finely granular white or light-gray rocks, with a tendency to an obscure porphyritic texture. They are locally known as porphyries but will here be designated diorite aplites. Microscopically they prove to have a hypidiomorphic or panidiomorphic granular structure and are seen to consist essentially of andesine (Ab_2An_1) with minor amounts of biotite or hornblende. Pyrite, calcite, muscovite, and chlorite appear as secondary minerals.

A remarkable feature connected with the diorite aplites is their occurrence in the graywacke-slate formation at long distances—as much as several miles—from known areas of the diorite intrusions. Equally striking is their uniformity of appearance, so that rocks collected from widely separated localities have identical characteristics. On account of their light color the dikes are readily distinguished on shore exposures from the somber-colored graywackes and slates that inclose them and on account of their conspicuousness their number, which is small, is likely to be overestimated.

RELATION OF INTRUSIVE ROCKS TO MINERALIZATION.

The general geologic investigation of southeastern Alaska has shown that most of the mineral deposits so far discovered occur in proximity to areas of dioritic rocks. The great masses of diorite are themselves practically barren of ore bodies. The conclusion has been drawn, from the clustering of mineral deposits around intrusive centers and from other facts, that the mineralization was an effect of the diorite intrusions; that the mineral-bearing solutions were expelled from great bodies of slowly cooling molten rock that underlay the diorites now exposed at the surface; and the metallic contents of the highly heated solutions were deposited in the colder surrounding rocks. The connection between intrusion and mineralization in southeastern Alaska is most clearly and forcibly illustrated by the copper deposits of Kasaan Peninsula and the Hetta Inlet region. These deposits are commonly situated at or near the contact of limestone with intrusive dioritic rocks and form highly irregular masses

[1] Harriman Alaska Expedition, vol. 4, p. 18, 1904.

and lenses embedded in the limestone. The ore consists of auriferous chalcopyrite associated with iron oxides and sulphides, calcite, and various lime silicates, principally the garnet andradite. The deposits belong to the so-called contact-metamorphic type of ore bodies and their mineralogic make-up shows that they were formed under conditions of high temperature—conditions obviously accompanying the intrusion of the diorites. Copper deposits of similar origin are found also at Rainy Hollow and White Horse, which are in Canadian territory but lie in the same metallogenetic province.

The gold-quartz deposits are less evidently of magmatic origin than are the contact-metamorphic copper ores. It is a noteworthy fact, however, that the gold content of the copper ores is comparable in amount with that of the ores exploited solely for their gold content, so that it is possible and perhaps probable that the gold in both classes of deposit was derived from the same source. The gold-ore bodies are found at greater distance from the intrusive masses, and payable deposits are not found in the belts of schists flanking the intrusive rocks.

The foregoing brief résumé of our knowledge concerning the origin of mineralization in southeastern Alaska has been presented in order to show upon what grounds a wider distribution of mineralization in the Sitka mining district than is at present known may be reasonably expected.

The extensive masses of dioritic rocks that have invaded the central portions of Chichagof and Baranof islands are a favorable geologic feature. The known auriferous mineralization took place subsequent to the injection of the diorite aplite dikes, and the probability is it was an effect of the great diorite invasion. It is a reasonable supposition, therefore, that if the mineralization follows the same laws that are believed to hold for the rest of southeastern Alaska, the long zones flanking the diorite belts constitute the territory in which other ore bodies than those now known are most likely to be found.

At present the only place in the region under discussion at which clear proof of the mineralizing activity of the diorite magma is shown is on Lemesurier Island, in Icy Strait. A deposit of molybdenite ore has been discovered here lying at the contact of diorite and limestone, the ore consisting of flakes of molybdenite intergrown with garnet and other lime silicates. Farther north, at Glacier Bay, copper ore, consisting of chalcopyrite in a gangue of garnet and calcite, is found in a similar geologic environment.

KLAG BAY.

GEOGRAPHY AND HISTORY.

Klag Bay is on the west coast of Chichagof Island and is part of an extensive archipelago[1] of which Khaz Bay forms the entrance from the Pacific Ocean. The coast north of Khaz Bay is flanked for several miles seaward by rocks, reefs, and low wooded islets.

Khaz Bay lies 16 miles northwest of Salisbury Sound, and the voyage from the mines to Sitka necessitates a coastwise run of 8 to 12 miles in the open ocean. The total distance to Sitka is 50 miles, and the operating mines maintain their own gasoline boats. Freighters plying between Seattle and southeastern Alaska bring in occasionally heavy machinery and supplies and take out shipments of accumulated concentrates.

During the winter the upper 3 miles of Klag Bay is frozen over.

The two productive gold mines in the Sitka mining district are at the head of Klag Bay. The high grade of the ore, which yields, as milled, from $15 to $90 a ton in gold, greatly exceeds that of the average value of the gold ore of southeastern Alaska, which in 1909 was $2.78 a ton. This has naturally attracted considerable attention to the region and has stimulated prospecting of the shores of the neighboring bays, inlets, and passages.

Gold was found at Klag Bay by chance in the summer of 1905 by an Indian engaged in salmon fishing, who went ashore to obtain water from a small stream near the head of the bay. While stooping to drink he noticed gold in one of the numerous fragments of quartz in the bed of the stream. On further examination he found that the ore contained considerable more free gold, and soon thereafter the find was reported at Sitka. The aid of white men was enlisted and the cropping from which the quartz float was derived was quickly discovered. Claims were thereupon located in accordance with the mining laws, the original discoverer retaining one-fourth interest. A small stampede from Sitka ensued soon after and a large number of claims were staked on both flanks of Doolth Mountain in September, 1905. (See fig. 1.) Two properties, known as the Chichagoff and Golden Gate mines, have been brought to the producing stage.

GENERAL GEOLOGY.

The general geology of the region at the head of Klag Bay is exceedingly simple. The rocks consist essentially of thick, massive beds of graywacke interstratified with clay slates. The only igneous rocks are a few narrow dikes of diorite aplite. To the northeast these rocks are succeeded by a wide belt of greenstones (altered amygdaloidal basalts in part), calcareous schists, limestones, and

[1] This archipelago is in part shown on Coast and Geodetic Survey Chart 8280.

highly contorted black phyllites and amphibolitic schists. This belt of metamorphic rocks is succeeded inland by diorite, which appears at the coast 15 miles northwest of Klag Bay and is exposed northward to Lisianski Strait.

The graywackes and slates are well exposed along the shores of the bay. As a rule they are not intimately interstratified, as is com-

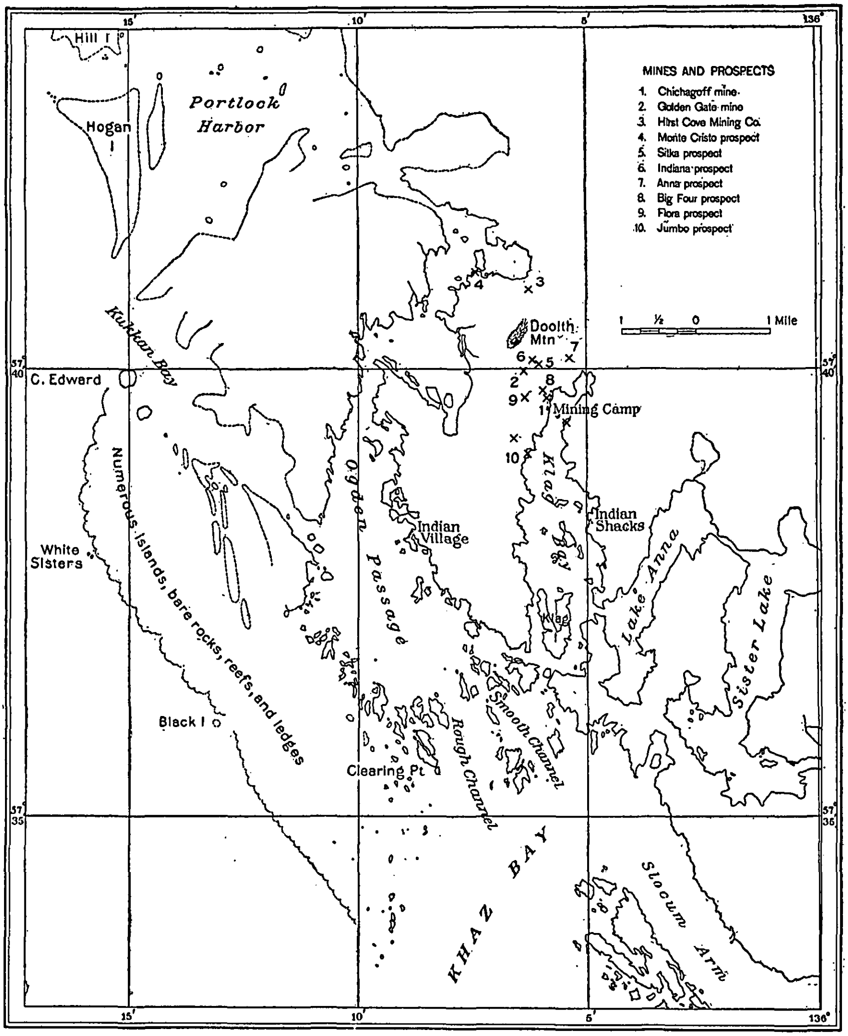


FIGURE 1.—Prospects at Klag Bay.

mon among the graywacke-slate formations of the Juneau region, Prince William Sound, and Kenai Peninsula, but form alternating belts several hundred feet thick. The graywacke is by far the dominant rock and forms massive exposures that are hundreds of feet thick and are without discernible stratification. Some strata, as shown by absolutely continuous exposures along the shore line, attain a thickness of 1,400 feet, and thicknesses in excess of 3,200 feet, in which perhaps a few narrow belts of slate are included, have been measured at the head of Klag Bay, as shown on figure 2.

The strike of the rocks ranges from N. 40° W. to N. 50° W. and the dip is 70° S. Whether the massive beds of graywackes maintain their great thickness for considerable distances along the strike was not determined, but it is believed that they will be found to dovetail with lenses of slate. The basis of this surmise is the fact that near the head of Ogden Passage a marked lenticular interstratification of graywacke and slate was observed. The lenses of graywacke range from a few inches to several feet in thickness and swell and pinch abruptly.

The rocks show a cleavage or fissility which is best displayed in the argillaceous members and is but poorly developed or absent in the graywackes. It coincides in direction with the stratification.

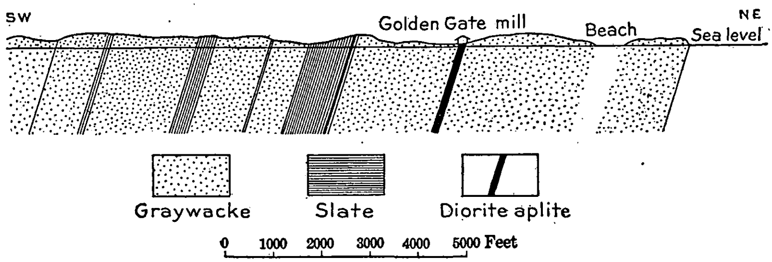


FIGURE 2.—Section across strike of rocks at head of Klag Bay.

Locally the slates show considerable plication, with tearing and kneading of thin intercalated strata, but no evidence was procured that folding on a more extensive scale has taken place.

PETROGRAPHY.

The graywackes are sedimentary rocks—impure sandstones—which are so firmly cemented that they fracture across rather than around the component mineral grains. They are exceedingly hard and tough and in color range from gray to blue-gray, usually weathering to an ash-gray tint on exposed surfaces. The outcrops are considerably jointed, so that the rock breaks in large angular blocks.

As a rule none of the mineral particles that go to make up the graywackes are distinguishable by the eye. The texture, however, varies considerably in different beds, and in the coarser-textured varieties of graywacke much glassy quartz can readily be detected in the form of numerous angular particles. All graywacke beds show the presence of many small angular fragments of black slate. Under the microscope the graywackes are found to consist largely of angular grains of quartz and feldspar, mainly plagioclase. The grains are poorly sized; the smaller are sharply angular, but many of the larger particles show rounded corners. Rock fragments are of common occurrence and comprise slate and other sedimentaries and pilotaxitic andesite, some of them perfectly rounded. The mineral particles do not form a closely fitting mosaic on account of the presence of a fairly large proportion of argillaceous matrix.

ECONOMIC GEOLOGY.

The ore bodies at the head of Klag Bay consist of quartz lodes occupying shear zones in graywacke. They coincide in strike and dip with the stratification and schistosity of the inclosing country rock. On account of the thick-bedded character of the graywacke, only the roughly schistose structure and not the stratification of the wall rocks is as a rule determinable near the lodes.

The ore bodies range in thickness from a few inches to 18 feet or more; in the producing properties the average thickness is perhaps 5 or 6 feet; in the prospects it is a few inches or at most a few feet. The values are localized in short shoots. In some lodes the fissuring is continuous for considerable lengths, but the fissured zone is barren of quartz and consists of sheared triturated graywacke; in other lodes the quartz is continuous but the gold values cease.

In the vicinity of the lodes the graywacke has been reduced to a black, highly-polished and irregularly schistose or slaty condition. In the midst of the sheared rock there remain numerous lenses and horses of massive graywacke. In places the shear zone may be 30 or more feet in width and correspondingly leanly mineralized.

The lodes show a well-marked ribbon structure, which is emphasized by the fact that the separate ribbons of quartz are separated by thin slabs of black schistose graywacke. These partings range from mere filaments to slabs several inches thick. As the quartz breaks free and clean from them, they often deceptively appear to form the walls of the ore body, but when they are broken through, more ore is commonly found behind them. Slabs of the lode slack off across the ore body up to such apparent walls, but however regular and well defined these walls may appear to be, not much reliance can be placed on the presumption that they mark the limits of profitable ore. Where the partings of schistose graywacke become thick and numerous the ore body becomes a typical stringer lode and a corresponding decrease in the grade of the ore takes place. In the ore shoots, however, the lodes consist practically of solid quartz.

The foregoing structural features of the ore bodies suggest that from a principal level driven along the general trend of the shear zone numerous crosscuts should be made into both the hanging wall and the footwall. Not only do the apparent walls prove unreliable guides concerning the ore bodies but it is conceivable that where large horses of graywacke occur in the shear zone, the ledge may split and curve around the massive rock and on resuming its general trend may follow a parallel course at a distance of some feet in either the footwall or the hanging wall of the original course.

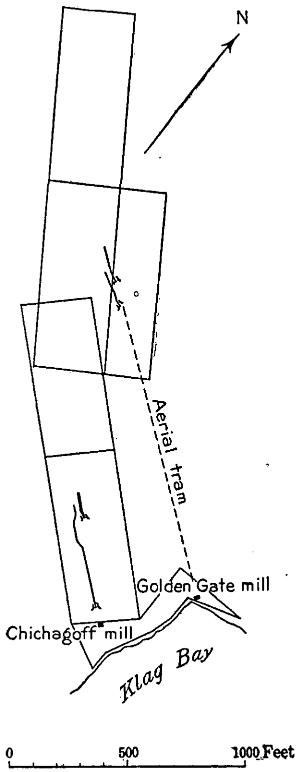


FIGURE 3.—Claim map of Chichagoff and Golden Gate properties.

The mineralogy of the ore is simple. The gangue is a milk-white quartz of drusy texture, with which a small amount of carbonate is associated. This weathers red on the dumps and is therefore plainly evident. In addition the microscope shows that some albite occurs with the carbonate. The quartz carries a considerable number of fragments of slaty graywacke, which are found microscopically to be completely sericitized.

Pyrite is the most abundant metallic mineral; galena and free gold are the only other metallic minerals. The presence of galena with the pyrite indicates everywhere high values in gold. The pyrite occurs not only in massive form but as deeply striated cubes in the vein quartz and also as minute cubes in the neighboring wall rock. Galena is relatively rare and is as a rule intergrown with pyrite; it does not occur in the wall rocks. The gold is found both as isolated particles embedded in the quartz and as particles intergrown with the sulphides.

The ores are fresh and show little evidence of oxidation, the unaltered sulphides extending practically to the surface—a fact undoubtedly due to the glacial abrasion that the region has undergone in the recent geologic past.

SPECIAL DESCRIPTIONS.

Chichagoff mine.—The Chichagoff mine, usually known as the DeGroff mine, is now the property of the Chichagoff Gold Mining Co. It is situated at tidewater at the head of Klag Bay (fig. 3). The milling plant in operation during 1910 consisted of two batteries of two 850-pound stamps, dropping 104 times a minute in triple discharge mortars. The ore was crushed to one-fourth inch mesh, and the pulp passed to a 10-foot Chilian mill. The concentrating equipment includes a classifier, two Wilfley tables, and one Wilfley slime table. The capacity of the mill was 20 tons a day. At present the tailings, which average nearly $10 a ton, are impounded for future cyanidation. Electric power is employed, which is transmitted 4½ miles from the generating station on Sister Lake. The hydroelectric plant and transmission line is under the control of a company jointly owned by the Chichagoff Gold Mining Co. and the Golden Gate Mining Co., both of which it supplies with power. The plant is rated at 150 horsepower and is driven by a turbine under 44 pounds pressure. In summer enough water is available to develop several times this power, but the capacity of the plant is fixed by the minimum winter flow.

In the summer of 1910, because of increased development of the mine and the inefficiency of the Chilian mill, it was decided to erect a new mill of standard design equipped with 10 stamps of heavier pattern. This mill will doubtless be in operation during 1911.

The ore body was found in 1905, as already related, by tracing to its source the quartz float so abundantly strewn in the bed of the small stream. The lode did not outcrop along the shore, but was found in place one-quarter of a mile inland, at an elevation of 275 feet. At the outcrop the lode ranged from 2 to 4 feet in width. The float ore was carefully gathered and shipped to the smelter at Tacoma. This ore was rich enough to yield between $15,000 and $20,000. The proceeds were applied to development work and the mine has paid its own way from the start. A drift tunnel 220 feet long was run on the ledge and two ore shoots were encountered, the second of which was 18 feet wide at a maximum and averaged $63 a ton across this width. Later a second tunnel was driven 162 feet vertically beneath the upper tunnel, commencing behind the mill, which is situated at the beach. Ore was encountered at 800 feet from the portal, apparently belonging to the bottom of the first ore shoot. A raise was put through to the upper tunnel, and the ore thus developed is now being stoped. Unexpectedly it was found that the ore shoot had a considerably greater strike length in the intermediate levels than was indicated on either the upper or lower tunnel levels. In addition to this encouraging feature the ore shoot maintained its width and remarkably high average value. Meanwhile development was vigorously continued on the lower tunnel in order to undercut the second ore shoot.

The geologic features at the mine are simple. The bedrock at the discovery outcrop is glaciated and covered with several feet of glacial drift containing striated blocks and cobbles of graywacke and some of diorite. The country rock inclosing the ore body is a nearly massive graywacke of dark blue-gray color and dense texture. It proves to be exceedingly hard and tough under the drill. In the main tunnel some thin beds of slaty argillite were encountered 200 feet from the portal and show that the stratification trends N. 55° W. and dips 70° SW., conforming to the general strike of the rocks at Klag Bay.

Near the lode the graywacke has been powerfully sheared and has been transformed to a black, brilliantly lustrous, schistose rock resembling a polished and slickensided slate. The strike of the shear zone along which the ore makes is approximately N. 45° W. and its dip is 70° SW. Rich ore is limited to short shoots, but on account of the youth of the mine the shape of the shoots is not well known. It is a fair inference from the data at hand, however, that they are lenticular in both strike and dip. The lode shows in places a pronounced ribbon structure and is traversed by numerous false walls. Some of these walls are remarkably well developed, and it might often be thought unlikely that ore would be found behind them.

On the main tunnel level a spur ledge was found making out into the footwall country rock at an angle of 30° to the main ore body. It was about 8 feet thick, but pinched out at the end of 75 feet. The rock included in the angle between the main ledge and the spur is more or less shattered and penetrated by quartz stringers and impregnated with pyrite.

The metallic minerals in the ore are pyrite, which is by far the most abundant, galena, and free gold. According to the mill returns, the sulphides constitute from 2 to 3 per cent of the ore.

Golden Gate mine.—The Golden Gate property, which is often referred to as the Mills property, one of the principal owners being Mr. W. P. Mills, of Sitka, is situated on what is undoubtedly the northwest extension of the Chichagoff lode. The main haulage tunnel is situated at an altitude of 1,000 feet and is connected by an aerial tramway with the stamp mill on the beach. The mill is of 10-stamp capacity, but only five stamps were installed at the time the mill was started in 1910.

The original discovery was made in September, 1905, on an outcrop exposed at an altitude of 1,520 feet. Great slabs of the lode lie scattered on the mountain side, many over a hundred feet from their position in place. Some of these slabs are 10 to 15 feet long, 5 feet or more wide, and several feet thick. The lode is 10 feet thick at the discovery cropping, where a spur ledge making a narrow angle with the main ledge extends 300 feet into the hanging-wall country rock.

A shoot of richer ore was later discovered lower on the mountain, and the development work has so far been directed toward exploring this ore. A drift tunnel at an altitude of 1,080 feet was driven on the lode and undercuts the ore shoot at a maximum depth of 127 feet. Subsequently a new tunnel, 80 feet below the older, was driven, and forms the main haulage way of the mine.

Surveys indicate that the Golden Gate and Chichagoff mines are situated on the same lode, but actual continuity can not be traced on the surface, either because glacial drift and vegetation cover the apex of the lode or because the shear zone is barren of quartz mineralization along the intervening stretch. Either condition is equally probable.

The geologic and mineralogic features of the ore body are similar to those of the Chichagoff. The average width of the explored portion of the ore body is somewhat smaller and the grade of ore is lower, although it was reported late in June, 1910, that a shoot carrying values comparable to those of the older property had been encountered.

On the surface 150 feet in the footwall country rock of the lode is a dike, which is 100 feet wide at its widest point. It trends parallel with the formation and can be traced a few hundred feet only. On the hanging-wall side the dike consists of a white coarsely granitoid rock, which the microscope shows is composed essentially of quartz and albite in hypidiomorphic arrangement, but much crushed. Toward the footwall the dike changes, apparently by gradation, into a rock resembling a greenstone. The microscope shows that this green rock formerly consisted of a coarsely granular assemblage of plagioclase, probably albite, hornblende, and biotite, but that it now consists of brecciated fragments embedded in a fine-grained matrix of attrition products composed of hornblende, chlorite, and feldspar.

Hirst Cove Mining Co.—The Hirst Cove property is situated on the northwest side of Doolth Mountain. A tunnel 800 feet long is driven on the lode at 400 feet altitude, at a point one-half mile inland from Mine Cove. The lode averages 3 feet in thickness, and the ore resembles that of the Chichagoff and Golden Gate mines, though metallic minerals are materially less abundant and are usually concentrated in the slaty material inclosed in the vein quartz. Some pay streaks remarkably rich in free gold have been encountered. This lode is sometimes considered the northwestern extension of the Chichagoff lode on the southeast side of Doolth Mountain, but it lies too far to the northeast—that is, in the footwall of the Chichagoff lode—to be the extension of that ore body.

Other prospects.—A considerable number of prospects, such as the Monte Cristo, Flora, Jumbo, Big Four, and others, have been located in the region around Klag Bay. The amount of development is generally small, and as the geologic features are entirely similar to the ore bodies already described individual descriptions are hardly necessary. The presence of these prospects indicates that mineralization is widespread throughout the region. The showing at the various prospects is commonly not large, but it must be confessed that if only the barren portion of the shear zone of the most productive mine of Klag Bay were known, it would hardly present a more encouraging appearance than that shown by the poorest prospect in the region.

Princess Pinder prospect.—The Princess Pinder prospect is not on the peninsula between Klag Bay and Ogden Passage, as are the others previously described, but is near the entrance of a bay locally known as Pinta Bay, 6 or 8 miles northwest of Mine Cove. Ore was discovered here in June, 1910, outcropping in the cliffs at the water's edge along a shore line that had been more or less thoroughly examined by various prospectors. This fact is of some interest and leads to the belief that the shore lines have not been so carefully examined but that other prospects will be discovered.

The ore body shows a face of 7 feet of coarse white quartz carrying some scattered bunches of pyrrhotite admixed with chalcopyrite. The trend of the deposit is probably S. 40° E. (true) and the dip is 80° SW. The footwall is a blue-black slaty rock and the hanging wall is a greenstone breccia. Assays of samples taken across the entire width of the lode show an average value of $10 a ton in gold.

SITKA.

GENERAL GEOLOGY.

The rocks in the vicinity of Sitka are mainly graywackes and slates striking N. 70° W. and dipping steeply to the south. Some fine-grained quartzites, in places so extremely fine grained as to resemble light-greenish cherts, are associated with them at various localities.

Igneous rocks are rare. A few dikes of diorite aplite cut the graywackes and slates. One of these dikes has been found to be mineralized and to carry free gold. A crushed dike of dark gabbro, somewhat impregnated with pyrite and pyrrhotite, is exposed on the northeast side of Bear Bay, an indentation of Silver Bay. The rock consists essentially of plagioclase feldspar, near bytownite in composition, and hornblende, probably secondary.

At Bear Lake, east of the bay of the same name, quartz diorite is encountered. It is a medium-grained granitic rock composed of plagioclase, quartz, hornblende, and biotite, and is of uniform grain, color, and appearance. The diorite is somewhat gneissic and banded near its contact with the sedimentary rocks, which appear to have been considerably altered as a result of the intrusion.

ORE DEPOSITS.

The ore bodies occupy shear zones in graywacke and strike parallel to the stratification of the country rock. The dips are steep—nearly vertical. The lodes form massive outcrops of white quartz up to 15 feet or more in thickness which are apt to show a short lenticular structure along the strike and to split up into stringer lodes. They are irregular in shape, bellying out and constricting abruptly. Near the lodes the country rock is much sheared and is penetrated by numerous transverse stringers as well as by veins parallel to the shear planes.

A characteristic feature of the ore bodies is the insignificant amount of metallic sulphides—in many ledges an almost vanishing quantity—contained in the vein quartz. Pyrite, pyrrhotite, and arsenopyrite are the principal sulphides; galena and sphalerite have been observed, but are extremely rare. The sulphides are at many places concentrated in and around fragments of slate or sheared graywacke included in the ledges, even though the quartz itself is barren.

Ore bodies of a type different from the auriferous quartz lodes already described have attracted some attention. These consist of beds of shattered quartzite, which is flintlike in texture, recemented by quartz veinlets, carrying in places, though rarely, pyrrhotite and arsenopyrite. Some quartzite strata weather so that the surface exposures somewhat resemble vein quartz, but the mineralization is so feeble that it is difficult to understand why they should have been located as ore bodies.

SPECIAL DESCRIPTIONS.

Cache mine.—The Cache mine, located in October, 1872, and originally known as the Stewart mine, is situated 1¼ miles east of the head of Silver Bay, at an elevation of 720 feet above sea level (fig. 4). A 10-stamp mill was built in 1879 but has long ago fallen into ruins, and the tramways leading to it are thicketed with new growth of alders. The mine has been in litigation for many years.

The ore body, which stands nearly vertical, is opened on three levels by drift tunnels aggregating 300 feet in length. The lowest tunnel is 160 feet long and trends S. 70° E.; at the mouth the ore body is 4 feet thick and increases to a maximum of 13 feet solid quartz, its average thickness being about 10 feet. The walls of the ore body are extremely curved, dipping in reverse directions from place to place. Practically no metallic sulphides are visible in the quartz, except a streak on the south wall, which is fairly mineralized with pyrite. The other two tunnels, the upper being about 80 feet above the lower, show essentially the same features, but not so much quartz.

Bauer mine.—The Bauer mine lies 2 miles southwest of the head of Silver Bay. The main development consists of a crosscut tunnel at an altitude of 1,250 feet. This tunnel, which is 900 feet long and intersects the main ore body at a depth of 400 feet, traverses thick massive beds of graywacke, which are gritty or conglomeratic at the portal, and encounters several smaller ledges striking parallel with the formation. At the end a drift 150 feet long is turned off on the ore body and trends S. 45° E. The hanging wall is slate and the footwall is graywacke. The ore body consists of cryptocrpstalline quartzite traversed by narrow quartz veinlets and leanly mineralized with pyrrhotite.

Cascade claim.—This claim is on the east fork of Indian River, 3 miles from Sitka, and is the only one discovered in the vicinity of

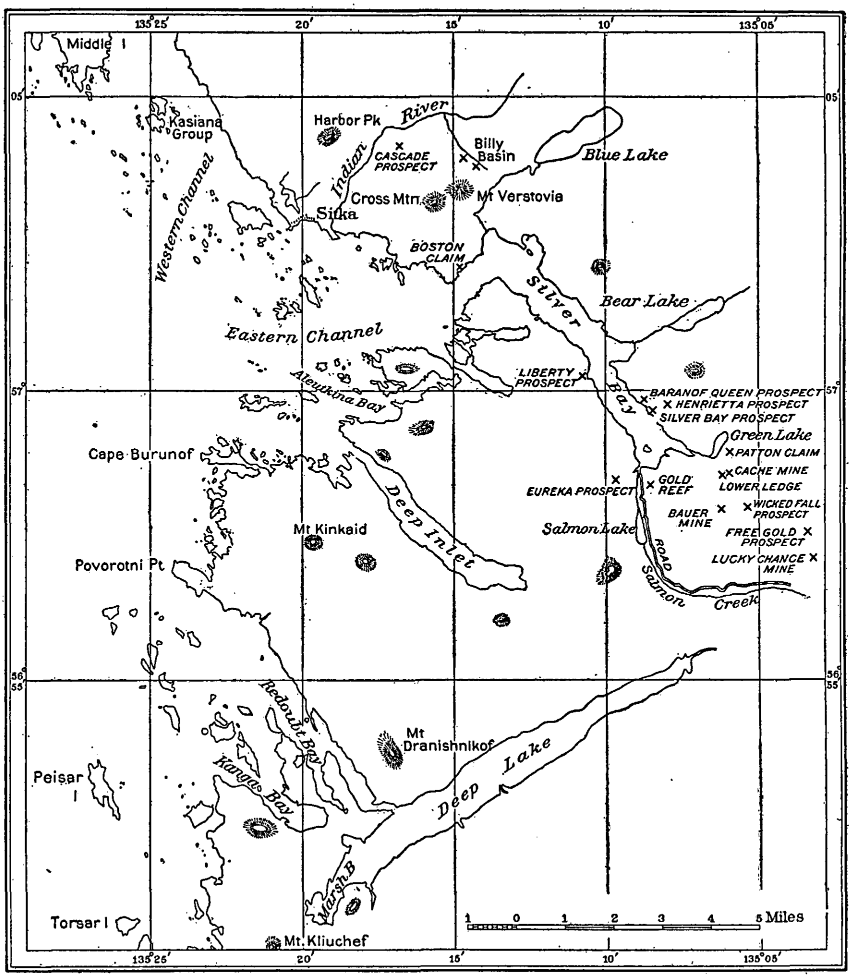


FIGURE 4.—Prospects in the vicinity of Sitka and Silver Bay.

Sitka or Silver Bay in recent years. The country rock at this locality consists of cherty quartzite and slate striking N. 55° W. and dipping approximately vertical. The quartzite, which is flintlike in texture, weathers milk white, so that it resembles a quartz lode. The ore body consists of shattered quartzite cemented by quartz veinlets and is in places mineralized with pyrrhotite and arsenopyrite. Chalcopyrite is present as an extremely rare constituent. A 5-foot bed of slate appears to form the wall rock on the southwest side of the ore body, but toward the northeast the boundary is indefinite. The ore body is exposed by open cutting and is 300 feet long. Its width apparently ranges from 4 to 20 feet, but these dimensions will doubtless be dependent upon assay returns.

Lucky Chance mine.[1]—This property is situated in a precipitous mountain range, 2,000 feet above sea level and 4 miles as the crow flies, or 7 by wagon road, from the head of Silver Bay. The quartz ledge has a maximum width of 8 feet where it outcrops, but in the tunnel it is not constant in width and appears to merge into a series of narrow stringers penetrating the mineralized slate-hanging wall. The footwall, of graywacke, is locally known as diorite because of its compact, massive structure. A 600-foot tunnel follows the ledge and connects through a raise with a surface pit. The surface improvements comprise a 10-stamp mill, a sawmill, and a water-power plant. High values are reported from parts of this vein and many specimens of free gold have been obtained.

Other prospects.—Many other prospects, partly developed, notably the Lower Ledge, Bullion, Free Gold, Liberty Lode, Silver Bay group, and the Boston are still held in the above-described area, some of which have very favorable surface showings, but lack of capital and inefficient management has caused a suspension of explorations for the last few years.

NONMETALLIC RESOURCES.

GRANITE.[2]

Granite is a possible resource of the region, although, so far as is known to the writer, no attempt has been made to utilize this resource. The market that might logically be expected for Alaskan building stone comprises Portland, Oreg., and the cities on Puget Sound. The fact that granite from the quarries at Raymond, Cal., which are 200 miles from the seaboard, is able to compete with the local product of the Pacific Northwest in their home market indicates a strong possibility for Alaskan granite, provided it is of requisite grade. The quarries can be located at tidewater, and the water haul to market is no longer than that from San Francisco to Puget Sound. At present the only output of building stone from southeastern Alaska is marble, and this has been increasing steadily from year to year.

[1] Wright, F. E. and C. W., Economic developments in southeastern Alaska: Bull. U. S. Geol. Survey No. 259, 1905, p. 58. The matter in this and the following paragraph is quoted literally from the report cited.

[2] See also Wright, C. W., The building stones and materials of southeastern Alaska: Bull. U. S. Geol. Survey No. 345, p. 123, 1908.

The general distribution of granite is indicated on the sketch map (Pl. I, p. 10). Stone of good quality is found at Gut Bay on the east coast of Baranof Island and at the east end of Long Arm, Whale Bay, on the west coast of the same island. At the latter locality the granite is of handsome appearance. It is of light-gray color, medium texture, and even grain. The feldspars are clear and fresh and give the rock a live color. Accurately designated the rock is a quartz diorite, consisting of plagioclase feldspar (andesine or labradorite, quartz, biotite, and a minor amount of hornblende. The biotite, as a rule, is splendently lustrous. The accessory minerals are zircon, apatite, and magnetite.

GYPSUM.[1]

THE GYPSUM DEPOSIT.

The only extensive deposit of gypsum known in southeastern Alaska is situated on Gypsum Creek, a mile from its mouth, at Iyoukeen Cove on the east side of Chichagof Island. The gypsum beds apparently overlie the Carboniferous rocks exposed along the southwestern shore of Iyoukeen Cove and forming the ridge southwest of Gypsum Creek, though the area of contact is buried under deep gravel deposits along the beach and in the valley. The mountain ridge to the northeast is made up of a granitic mass intruding the older limestone and quartzite. Structurally the gypsum beds are folded and steeply tilted and were probably laid down previous to the granitic invasion. They are at present regarded as of Permian or Triassic age.

The geology in the immediate vicinity of the gypsum beds is obscure and neither foot wall nor hanging wall of the deposit is exposed. Bluffs of a cherty limestone striking northwest and dipping to the northeast are exposed near the entrance to the tunnel at the lower mine workings on Gypsum Creek. The gypsum beds in the tunnel and lower levels have an east-west to N. 70° E. strike, with a northerly dip of 20° to 60°. Channels representing old watercourses and now filled with gravel wash are numerous throughout this deposit. These gravels resemble unconsolidated conglomerate beds and have been mistaken for both hanging and foot walls of the gypsum beds at points in the workings. A careful inspection of the gravels shows that the wash has the same character as that now in the creek bed. Of significance is the presence of cobbles of granite corresponding to the intrusive mass at the head of the creek, which invaded the area subsequent to the deposition of the gypsum beds.

MINE DEVELOPMENTS.

This gypsum deposit, the property of the Pacific Coast Gypsum Co., has been extensively developed during the last few years and large shipments of the rock are being made to the plaster mill at Tacoma, Wash., where it is prepared for the market. The developments consist of a wharf 2,000 feet in length, extending to deep water, where rock bins of 1,000 tons capacity have been built, and of a railroad about a mile in length to the mine workings. At the mine rock bins of 1,500 tons capacity have been erected, thus affording sufficient storage capacity

[1] Reprinted from Bull. U. S. Geol. Survey No. 345, pp. 124–125, 1908.

during intervals of transportation of the gypsum to the plaster mill. A vertical shaft has been sunk for 190 feet and from it two levels have been extended at points 90 and 160 feet in depth, both of which are almost entirely in gypsum. The main developments are on the 160-foot level and include 1,200 feet of workings, exposing the gypsum bed over an area 450 by 225 feet. Both the thickness and the lateral extent of the bed are still undetermined. At a point 800 feet west of the shaft investigations were made in former years of a gypsum exposure on the creek bank, where a short tunnel was driven and a 75-foot shaft sunk almost entirely in gypsum, but work at this point was discontinued.

MARKET.

Gypsum is in much demand along the Pacific coast as wall plaster and fertilizer and in the manufacture of cement. The Puget Sound market is supplied in large measure from the deposits in Kansas, Colorado, Wyoming, and Utah. The California market is supplied from local deposits and those in Nevada and Utah. Transportation from these points to the seaboard cities costs from $4 to $7 per ton, and the present market prices [1908] of first-grade gypsum products in these cities are as follows: Crude, $5 to $7 per ton; land plaster, $6 to $8 per ton; plaster of Paris, $8 to $11 per ton; wall plaster, $9 to $12 per ton.

CONCLUSION.

The known mineral resources of the Sitka mining district are gold and gypsum. To these granite may, perhaps, be added as a possible undeveloped resource.

The gold is found in quartz lodes, which commonly occupy shear zones in graywacke. Two properties, both situated at Klag Bay, on the coast of Chichagof Island, have so far been put on a productive basis and give strong promise of a prosperous career. The ores, which range in value from $15 to $90 a ton, are of considerably higher grade than the average ore of southeastern Alaska. A large number of ore bodies of the same general character have long been known to occur near Sitka, but owing to the low-grade ores contained in them none have yet been brought to a producing stage.

The ore bodies of the region show neither in their mode of occurrence or origin any obvious or immediate relation to contacts of dissimilar rocks, to dikes, or to other igneous rocks. The principal mineral belt appears to lie along the edge of the slate-graywacke formation bordering the band of metamorphic rocks that flank the diorite occurring in the central portion of the islands. The better-known ore deposits are found in graywacke, but this is doubtless a fact of no essential significance and should not deter the prospector from searching in other kinds of rocks. The question is sometimes asked by the prospector whether the formation at some particular locality is favorable. To this it can be answered that experience has shown that no one kind of rock is more likely to contain gold-ore deposits than another. In point of fact, a more complex set of conditions is necessary than the presence of a "favorable formation." That a favorable set of conditions is most likely to be found in the zones that border the long belts of granitic rocks traversing the region has already been maintained in this report. The indications afforded by present developments point strongly to the conclusion that the entire strip of territory contiguous to the west coast of Chichagof Island offers a more encouraging inducement to the search for new ore bodies than any other part of the region.

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