MINERAL DEPOSITS OF THE WRANGELL DISTRICT.

By A. F. Buddington.

INTRODUCTION.

This report is based on a reconnaissance by the writer in the southern part of the Wrangell mining district during three months in 1921. F. E. and C. W. Wright[1] made a geologic reconnaissance of the Ketchikan and Wrangell districts in 1905, and the accompanying map (Pl. I) is in part based on their work. Further details of mining developments and economic resources of this district may be found in the annual summary reports on the mineral resources of Alaska for 1904 and later years.

GENERAL GEOLOGY.

Intrusive rocks.—The Coast Range batholith, which consists essentially of quartz diorite, is the predominant rock of the mainland except near the coast, where belts of schist are included. The batholith that forms the core of Etolin Island is made up of diorite cut by a mass of granite. Bosses and stocks of quartz diorite, diorite, and granite are found on the islands, and quartz diorite and granite dikes are common in their vicinity. Masses of gabbro and hornblendite, a dark rock consisting essentially of hornblende, occur on the west side of Zimovia Straits, on some of the adjacent islands, and in Circle Bay on Woronkofski Island (Pl. I).

Metamorphic complex.—The metamorphic complex comprises, in order of increasing metamorphism, phyllite and phyllitic quartzite and graywacke with thin dark hornblendic layers; kyanitic, staurolitic, and garnetiferous quartz-mica schists interbedded with micaceous quartz schist; local beds of marble; a little garnet-sillimanite schist; hornblende-plagioclase schist; and, where most intensively metamorphosed, aplitic injection gneiss. On the mainland the quartz diorite near the borders of the schist belts may show relics of disintegrated and shredded blocks of schist. The rocks of this complex are of sedimentary origin and may include beds of both Paleozoic

[1] The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, 1908.

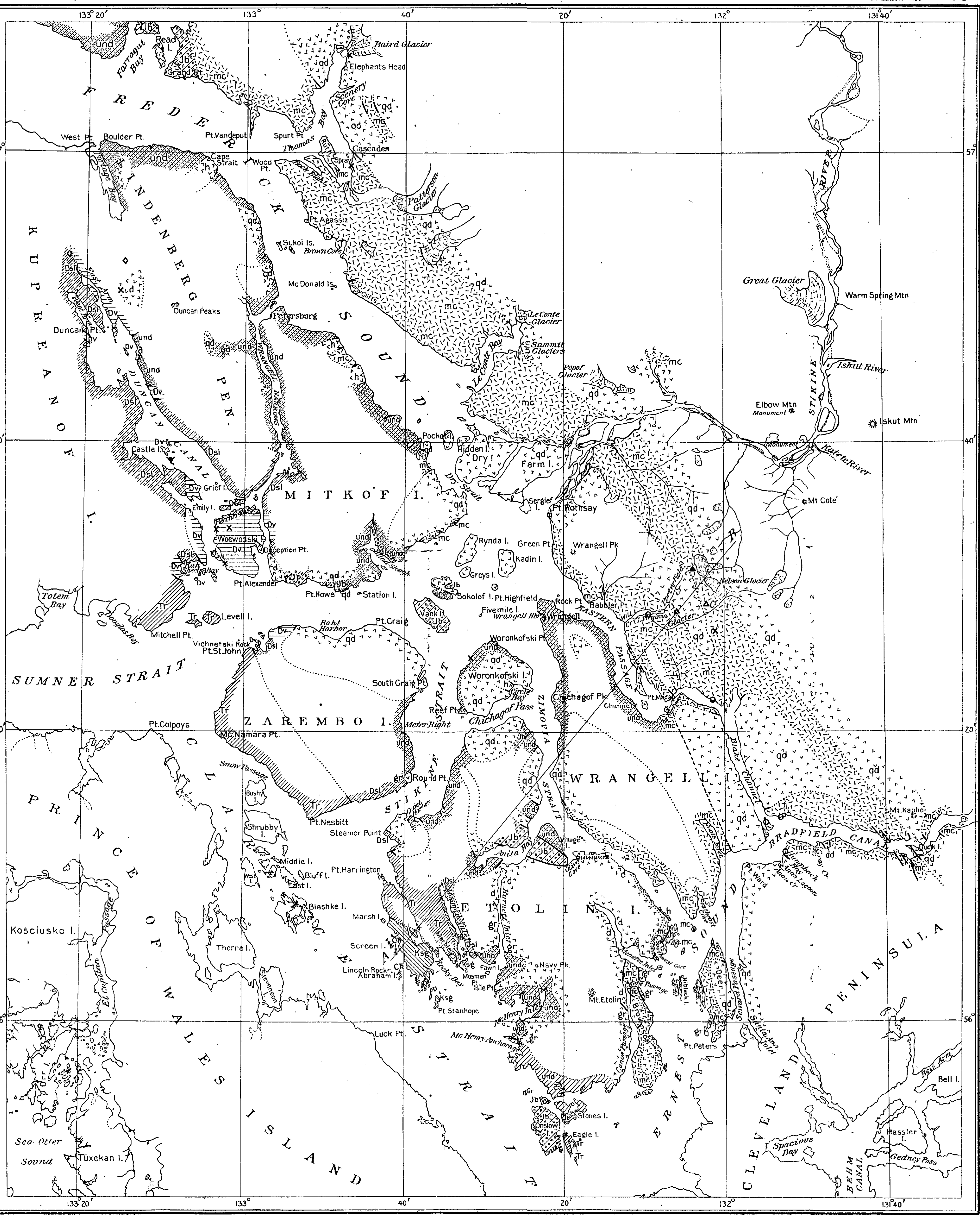
and Mesozoic age which have been recrystallized under conditions of contact-regional metamorphism attendant upon the intrusion of the Coast Range batholith.

Undifferentiated rocks.—The group of undifferentiated rocks consists for the most part of relatively thick beds of gray to greenish-gray rocks which are distinctly grained but in which the boundaries of the individual grains are indistinguishable with the naked eye. Intercalated and associated with them are beds or thin layers of black slate. The predominant rock is a graywacke or quartzitic sandstone having a cleavage which ranges from that due essentially to original bedding to that due to intense shearing, mashing, and recrystallization. In the latter variety the rock splits readily into thin leaves, thus resembling phyllite, and weathers a characteristic light-gray color. The graywacke consists largely of quartz or of altered fragments of plagioclase feldspar in an argillaceous, chloritic, or sericitic groundmass. Quartz may be absent or it may constitute relatively pure quartzite or phyllitic quartzite. Fragments of slate and other rocks are common in the graywacke, and in places the fissile varieties weather with a pseudoporphyritic or tuffaceous aspect. Locally calcareous beds are intercalated. Ottrelitic slate, hornblendic quartzite, and phyllite are found in the areas of greater metamorphism, as in McHenry Inlet, on Etolin Island.

The age of these beds is doubtful, and it is probable that they include formations of two or more ages. At Wrangell, along Eastern Passage, and on the west side of Frederick Sound the slate layers show traces of organic remains which Edwin Kirk states resemble those associated with graptolites found by him at Wrangell. He assigns a Silurian or older age to this series. On the other hand, the belt on Etolin, Zarembo, and Kupreanof islands appears to underlie the greenstone breccia formation provisionally assigned to the Jurassic. This would indicate that these beds were possibly the equivalent of the Mesozoic rocks having similar relations and character that occur in the Ketchikan and Juneau districts. The data at hand do not permit a positive decision.

Devonian rocks.—The Devonian rocks comprise (1) dark argillaceous slate with thin layers of black or dark chert; (2) massive limestone interbedded with gray calcareous or dark slates, with which are intercalated thick beds of banded slaty black, green, and white chert and chloritic, siliceous dolomitic, and green hornblende schists; and (3) a series of volcanic rocks.

The chloritic and hornblende schists intercalated with the limestone are in part altered tuffs and in part sheared and altered andesitic lavas containing amygdules of calcite. On the Castle Islands, in Duncan Canal, the flows are more massive, show a well-developed



EXPLANATION

BEDDED ROCKS

- **Tr** — Basaltic and rhyolitic flows, interstratified with breccia, tuff, conglomerate, and sandstones. TERTIARY
- **Ksg** — Slate and graywacke with occasional chert nodules and thin layers of impure limestone. UPPER JURASSIC OR EARLY CRETACEOUS
- **Jb** — Schistose metaphyre breccia (greenstone) with intercalated tuff and flows and beds of slate and graywacke. JURASSIC ?
- **CR** — Thin-bedded limestone with calcareous conglomerate. CARBONIFEROUS AND TRIASSIC
- **Dv** — Andesitic flows, breccia, and tuff, with intercalated dolomite and slate and altered intrusive masses of dark diorite. UPPER DEVONIAN
- **Dsl** — Slate, chert, and thick-bedded limestone; of Middle Devonian age, with some schist, local andesite flows, and intrusive diorite sills. DEVONIAN
- **und** — Undifferentiated rocks (Cleavable graywacke, quartz phyllite, foliated sandstone, slate, and quartzite). IN PART SILURIAN OR OLDER; IN PART MESOZOIC

INTRUSIVE ROCKS

- **qd** — Chiefly quartz diorite; in part diorite(d), hornblendite(h), and granite(gr). UPPER JURASSIC OR LOWER CRETACEOUS

METAMORPHIC COMPLEX

- **mc** — Crystalline schists of sedimentary origin and injection gneisses; locally with intercalated beds of marble. PROBABLY IN PART PALEOZOIC AND IN PART MESOZOIC

MINERAL PROSPECTS

- Gold predominating
- Silver predominating
- Copper
- Zinc predominating
- Barite
- Garnet
- Marble

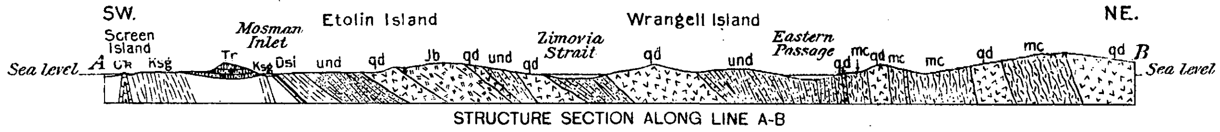
Boundary known

Boundary approximate

Boundary uncertain

Base from U.S.Coast and Geodetic Survey charts

Geology by A.F.Buddington
Surveyed in 1921



STRUCTURE SECTION ALONG LINE A-B

GEOLOGIC MAP OF PART OF WRANGELL DISTRICT, SOUTHEASTERN ALASKA

Scale 1/500,000

5 0 5 10 MILES

1922

pillow structure, and are interbedded with limestone, slate, and a little siliceous dolomite and chert.

The volcanic series comprises schistose andesitic tuffs, breccias, and flows with intercalated beds of slate and rusty-weathering impure, siliceous, impalpably fine-grained dolomite. Calcareous tuffs are found in Kah Sheets Bay. The volcanic rocks are mostly dense, felsitic, and pale gray-green; in the porphyritic varieties plagioclose feldspars usually constitute the phenocrysts. Some schistose hornblende porphyry, however, is present.

Sills of much altered fine-grained diorite or greenstone are common throughout the sedimentary formations, and masses of medium-grained altered gabbro or diorite intrude the volcanic rocks on the west side of Woewodski Island.

Structurally, the slate and chert series appears to underlie the limestone and slate formation, and the volcanic rocks occupy the trough of a synclinorium in the limestone and slate. Fossils were obtained only from the limestone beds, which are best exposed along the two arms at the head of Duncan Canal, on Kupreanof Island, and in the arm northwest of Emily Island, in the same canal. Fossils obtained from several localities were identified by Edwin Kirk as of Middle Devonian age. Upper Devonian volcanic rocks are known at several localities in southeastern Alaska, and the volcanic series that overlies the limestone may be in part of this age. They present a contrast to the prevalent character of the greenstone formation mapped as Jurassic, in which the rocks are predominantly coarse porphyritic agglomerates with phenocrysts of altered augite.

Carboniferous and Triassic rocks.—Thick-bedded limestone and conglomerate, in a highly disturbed condition, form the Screen Islands, off the west coast of Etolin Island, in Clarence Straits. These beds are reported by G. C. Martin to comprise two limestone formations separated by a thick and massive conglomerate; the upper limestone is probably of Mesozoic age, and the lower limestone is probably Carboniferous. On the northernmost island there are exposed beds about 900 feet thick, comprising limestone with intercalated beds of coarse conglomerate and conglomeratic and sandy limestones about 200 feet thick. The conglomerate and overlying limestone are probably of Triassic age. The cobbles and pebbles in the conglomerate are predominantly chert and limestone with some rhyolite porphyry and greenstone. Fossils obtained by the writer from a limestone cobble in a conglomerate bed on the largest island were identified by T. W. Stanton as of Carboniferous age, which indicates that the conglomerate probably overlies the Carboniferous limestone unconformably.

Jurassic (?) rocks.—The rocks assigned tentatively to the Jurassic system consist predominantly of schistose and altered porphyritic basic volcanic breccias, with a minor amount of interbedded tuff, slate, and graywacke, and flows. The most conspicuous feature of the rocks consists of the abundant black hornblende crystals that occur as phenocrysts in the fragments of the breccias. In the more massive phases plagioclase feldspars, in all stages of alteration to epidote, chlorite, sericite, and other secondary products, form the groundmass. In the more altered phases actinolite is an abundant constituent and the feldspars may be entirely altered to secondary products. In other districts less altered phases of what is possibly the same formation have been determined as augite melaphyre and andesite porphyry. The rocks are similar to the greenstones of the Juneau gold belt and of Gravina Island, in the Ketchikan district. For those in the Gravina area a Jurassic age has been suggested by Chapin,[2] and the greenstone or schistose melaphyre agglomerate of this district may be of similar age, though no fossils were found to corroborate this conjecture, and the structural evidence is indeterminate.

Upper Jurassic or Lower Cretaceous rocks.—Neither the top nor bottom of the next series of rocks is shown. The lower portion of the series is essentially a black argillaceous slate formation, very thin bedded, with layers and partings of graywacke. Thin intercalated layers of rusty-weathering limestone are common, and many of the beds contain conspicuous nodules of blue-black chert and of limestone. Rarely a thin bed of fine conglomerate is present. The upper portion of the series comprises graywacke with intercalated beds of slate; the graywacke is in part thick bedded and in part thin bedded like the slate. Fossils collected from this formation were identified by T. W. Stanton as *Aucella crassicollis* Keyserling? and an imprint of *Belemnites* sp. He further stated that the *Aucella* occurs in the form of distorted specimens of the type *crassicollis*, which indicates Lower Cretaceous age if the specific identification is correct, and that the formation is not older than Upper Jurassic. The rocks of this series are the least metamorphosed of all the Mesozoic formations of this district. They are overlain unconformably by Tertiary volcanic rocks on the north.

Tertiary rocks.—The Tertiary formations consist predominantly of a series of tilted and slightly folded or faulted volcanic lava flows, with associated breccias, tuffs, and coarse lava conglomerates in the lower portion and some interbedded sandstones and normal quartz and slate conglomerates very near the base. The lavas comprise olivine basalt, feldspar basalt porphyry, basalt, and andesite, with intercalated rhyolite flows near the base. Dikes of feldspar basalt porphyry, augite-feldspar basalt porphyry, basalt, and andesite are

[2] Chapin, Theodore, The structure and stratigraphy of Gravina and Revillagigedo Islands, Alaska: U. S. Geol. Survey Prof. Paper 120, pp. 95–97, 1918.

very abundant throughout the basal portions of the formation. Basaltic sills and dikes are abundant in the adjoining older country rocks, and dikes and sills of rhyolite porphyry are present but much less common. Amygdules with fillings of chalcedony, chlorite, calcite, and locally epidote are abundant in many of the basaltic and andesitic lavas. Felsite conglomerate in beds as much as 1,000 feet thick occurs in places, as northwest of Point Nesbitt, on Zarembo Island.

These rocks overlie the older formations unconformably. Plant impressions, fragments of silicified wood, and rare thin seamlets of coal are found in the shales intercalated in sandstone southeast of McNamara Point on Zarembo Island. The plant remains collected here were identified by F. H. Knowlton as *Sequoia langsdorfii* Heer, coniferous wood, fragments of dicotyledons, and stems, probably of grasses and sedges, indicating the probable age as Eocene.

ECONOMIC GEOLOGY.

Only two mineral deposits in the Wrangell district have passed beyond the prospecting or development stage. The Helen S. mine, on Woewodski Island, is reported to have produced about $35,000 worth of ore, mostly in gold, but this mine has been abandoned for several years. The garnet mine north of Wrangell, on the mainland, has been worked intermittently for many years and is a producer at the present time. Promising mineral deposits are found, however, both along a belt within the metamorphic complex on the mainland and along a belt of rocks in the vicinity of Duncan Canal on Kupreanof Island. (See Pl. I.)

RELATION OF MINERAL DEPOSITS TO ROCK FORMATIONS.

The great masses of igneous rocks, particularly the Coast Range batholith itself, are in general regarded by prospectors as unfavorable sites for the finding of ore deposits. This belief may possibly be relatively true for the main batholithic mass of the mainland, but the gold vein reported in a shear zone in the quartz diorite at the head of Thomas Bay, the gold veins in granitic rocks in the Ketchikan district, and the gold veins in the diorite of the Berners Bay area indicate that the outlying intrusive masses are not barren.

Within the metamorphic complex on the mainland there is a distinct belt of mineralization that includes the veins at Berg's Basin, Glacier Basin, and Groundhog Basin and at the Lake group, 10½ miles east of Wrangell. (See fig. 1.) The ores here are associated with intrusive sheets and dikes of acidic and basic porphyries and felsites. The veins include both high-temperature replacement deposits and fissure veins. Veins of zinc ores, of galena with a moderate content of silver, and of gold-silver ores are found. As indicated by float near the mouth of Andrews Creek the porphyries associated with the mineral veins of this belt are also found in the mountains on the east side of the south branch of Andrews Creek, and this extension of the belt has not, to the writer's knowledge, been thoroughly prospected. Gold veins have been found in the schist belts on Thomas and Le Conte bays.

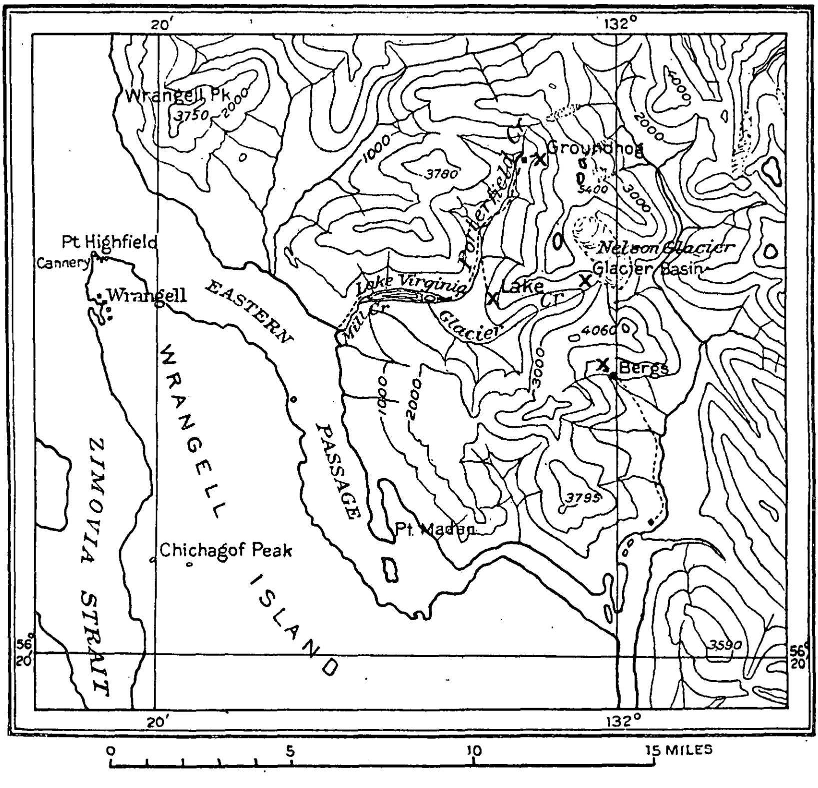


FIGURE 1.—Sketch map showing prospects east of Wrangell.

No prospects are known to the writer within the areas mapped as undifferentiated rocks, though in the Juneau and Ketchikan districts gold veins have been found in similar rocks.

In the Ketchikan district many prospects have been opened on veins in the Devonian rocks. Similarly, in the Wrangell district a belt of mineralization is found in the areas of Devonian rocks along and at the head of Duncan Canal and Portage Bay. This belt includes the copper deposits on Kupreanof Island at the head of Duncan Canal; copper veins with a little gold and silver on Portage Mountain; veins with galena, sphalerite, pyrite, and chalcopyrite in limestone on Taylor Creek; a pyrite body in Castle Islands Bay; the barite deposit of the Castle Islands; on Woewodski Island the gold lode worked by the Helen S. mine, the Maid of Mexico gold vein, and the gold prospects on the west side of Wrangell Straits; and a pyrite body near the head of St. Johns Harbor on Zarembo Island.

In the Ketchikan and Juneau districts gold-quartz veins and lodes have been found in the Jurassic (?) greenstone lavas and interbedded slates. No prospects were seen by the writer in the rocks of this formation so far mapped in the Wrangell district, though they may be expected to occur here also.

Ore veins are not known to occur in the rocks mapped as Lower Cretaceous or Upper Jurassic in the Ketchikan district. Many quartz veins are found in shear zones within these rocks in the Wrangell district, but here too none have yet been proved to be mineralized.

The main ore-bearing solutions that formed the veins of this district are believed to have been directly or indirectly due to the intrusion of the Coast Range batholith and its outlying masses. The Tertiary rocks were formed after the period of intrusion of this batholith, and therefore mineral veins connected in origin with the intrusion will not be found in Tertiary rocks. The fact that no ore veins are known in the Tertiary rocks in the Ketchikan and Wrangell districts is in line with this reasoning. Thin seams and beds of lignitic coal are locally intercalated with sandstone and shale of the Tertiary formations, but none of commercial value have been found in the Wrangell district. Fluorite occurs as a filling in brecciated zones in the volcanic rocks on the southwest side of Zarembo Island.

ZINC.

GENERAL OCCURRENCE.

A mineralized belt of metamorphic rock occurs on the mainland about 14 miles east of Wrangell. This belt is 1 to 1½ miles wide and lies between two masses of quartz diorite intruded parallel to the foliation planes of the metamorphic rocks. These rocks are predominantly fine-grained gneisses and crystalline schists, with sheets and dikes of quartz porphyry, rhyolite, and diabase porphyry. Narrow aplite veins, injected parallel to the foliation planes are locally abundant, especially toward the eastern mass of quartz diorite. The gneisses comprise interbedded dark hornblende-plagioclase gneiss and purplish-brown gneiss consisting of layers of plagioclase feldspar and quartz. Thin layers of green pyroxene granulite or of a diopsidic hornstone are found locally along some of the ore veins. In the mountain above Berg's Basin are hornblende-feldspar schist and thick beds of garnetiferous kyanitic quartz-mica schist intimately penetrated parallel to the schistosity by quartz veinlets. A few thin intercalated beds of crystalline limestone are also found here. The whole group of rocks represents a series of sedimentary strata such as calcareous shale and impure sandstone with some layers of slate and limestone which have been metamorphosed to gneiss and schist by the rise of temperature and pressure and the widely wandering highly heated solutions accompanying the intrusion of the quartz diorite, aplite veins, and porphyry sheets and dikes.

The portion of the belt of gneiss and schist in which ore veins have been reported is the only portion in which sheets of quartz porphyry, rhyolite, and diabase porphyry have so far been found. It may therefore be surmised that the ores and these intrusive rocks may have had a common origin.

Bands of rock with disseminated pyrite and pyrrhotite of the "fahlband" type are found throughout the gneisses and schists. They are conspicuous on weathering because of the rusty-brown or red belts to which they give rise. The ore veins are found in a mineralized zone at least 7½ miles long. The main bodies (Groundhog group) are tabular replacement veins of pyrrhotite and sphalerite in the gneiss, but at Glacier Basin there are replacement veins consisting of sphalerite and galena, and at Glacier Basin and Berg's Basin sphalerite, galena, and pyrite are found in veinlets and pockets in sheets of fractured rhyolite and in crosscutting quartz veins having a comb structure. The zinc replacement veins of Groundhog Basin and the zinc-lead-silver replacement veins in Glacier Basin appear to be older than the quartz porphyry and rhyolite dikes and sheets, but the mineralized quartz veins are younger. This indicates two periods of vein formation here, the deposits of the older period being high-temperature replacement deposits and those of the younger period comprising fissure fillings accompanied by some replacement deposits formed under intermediate conditions of temperature and pressure. The replacement deposits of Groundhog and Glacier basins are in their mineral associations allied to ore deposits of the contact-metamorphic type, but in structure they resemble high-temperature replacement veins.

GROUNDHOG BASIN.

The Groundhog Basin group of claims is on the mainland about 13 miles east by northeast of Wrangell. (See fig. 1.) The claims are reached by a trail that starts from the mouth of Mill Creek, on Eastern Passage, and follows the left bank of Mill Creek for three-quarters of a mile to the mouth of Lake Virginia, at an altitude of about 100 feet above high-tide mark; thence by boat across the lake for about 2¾ miles to the head; and thence by trail about 6 miles up Porterfield Creek to an altitude of about 800 feet. The main

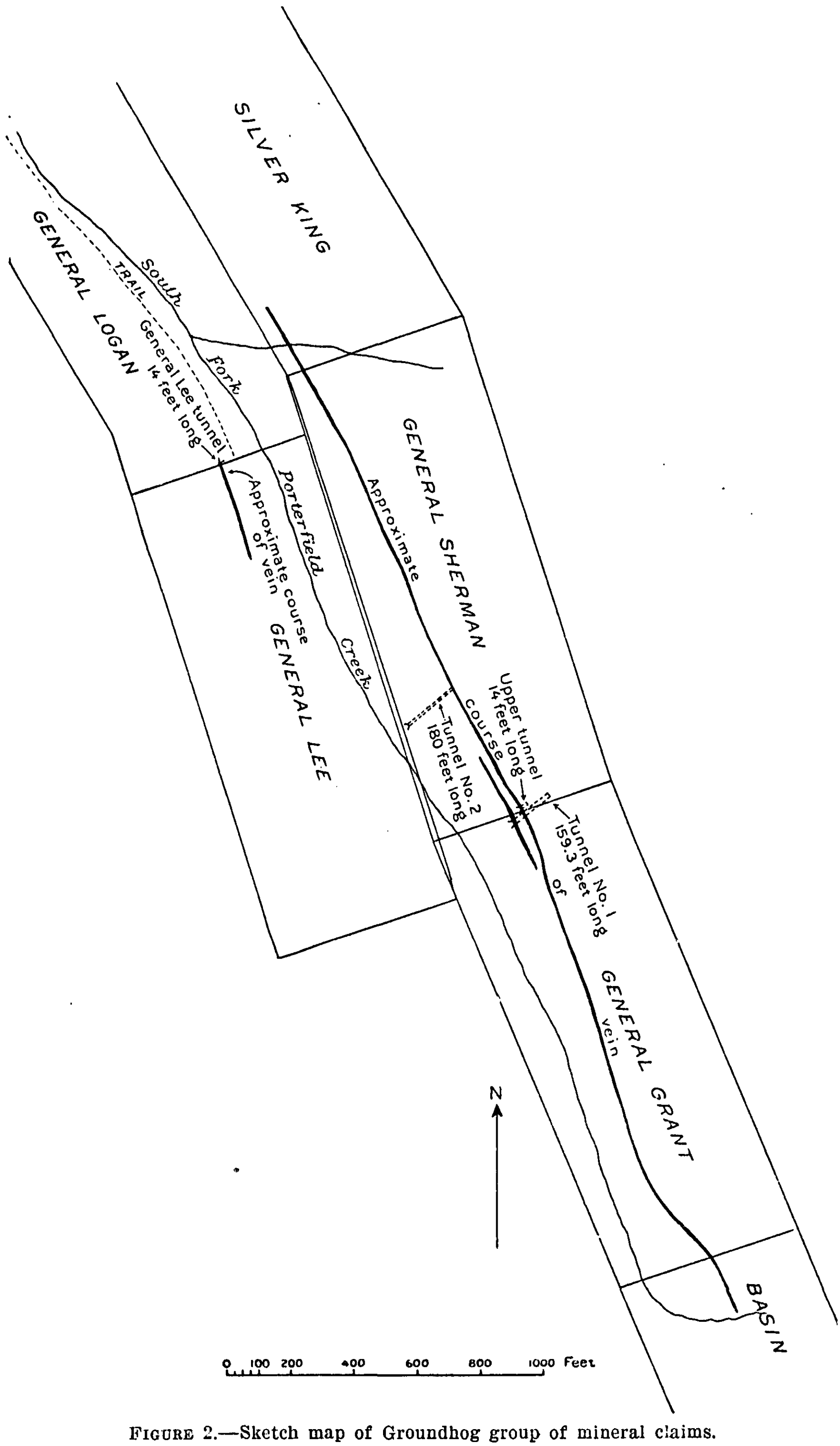


FIGURE 2.—Sketch map of Groundhog group of mineral claims.

workings are at an altitude of about 2,000 feet and lie along the face of a mountain 5,100 feet in height.

The original discovery of ore here was made by Ole Johnson and John Oleson, of Wrangell, in 1904, after following the strike of the rocks from the veins in Glacier Basin. A tunnel 104½ feet long was driven by them to crosscut the main vein, but work was stopped before the vein was reached. The title to their claims was purchased by W. D. Grant and associates in 1912, and in 1915 the property, comprising four claims (see fig. 2) was bonded to the Bon Alaska Mining Co. This company located 31 additional claims along the extension of the veins and on veins in Glacier Basin, to the southeast. Five claims along the extension of the main vein northwest of Porterfield Creek and two claims on a gash vein on the south side of the south branch of Porterfield Creek have been located by McKay & Leeds.

From 1915 to 1917 the Bon Alaska Mining Co. was actively engaged in developing the claims, chiefly the four claims leased by W. D. Grant and associates, known as the General Sherman, General Grant, General Logan, and General Lee. During the war period the company's option on these claims was not exercised owing to unfavorable conditions, and they reverted to their owners, by whom they are now held.

The claims are equipped with an air compressor and 4,000 feet of 4-inch pipe and 600 feet of 1-inch pipe to convey air to the workings. The compressor is driven by a 36-inch Pelton water wheel, which operates under a head of 280 feet, the water being supplied by 750 feet of 13 to 11-inch steel penstock pipe and a flume 500 feet long.

The main vein has been prospected by open cuts for a length of 3,200 feet and by three tunnels. An upper tunnel 14 feet long crosscuts the main vein at an altitude of about 2,280 feet on the General Sherman claim. Tunnel No. 1, about 80 feet almost vertically beneath the upper tunnel, is 159 feet long and likewise crosscuts the main vein. It starts on the General Grant claim and extends across the end line into the General Sherman claim. This tunnel was started by Johnson & Oleson and was completed by the Bon Alaska Co. in 1915 and 1916. Tunnel No. 2 is on the General Sherman claim at an altitude of about 1,914 feet, 430 feet northwest of the upper tunnel. It is 180 feet long, extends in a northeasterly direction, and crosscuts the main vein. Drifts have been driven on the main vein from this tunnel for 21 feet to the northwest and 52 feet to the southeast. A crosscut has been run back for 16 feet to the southwest from the end of the southeastern drift. Work on this tunnel was done by the Bon Alaska Co. in 1917.

Another vein about 125 yards distant horizontally parallels the main vein and lies on the southwest side of the south fork of Porterfield Creek. The General Lee tunnel crosscuts this vein and is on the boundary line between the General Lee and General Logan claims.

The ore bodies are tabular replacement veins in fine-grained gneiss. They conform in strike and dip with the gneiss, which trends north-northwest and dips about 60°–80° E.

The wall rocks of the main vein are in general fine-grained ribbon-banded injection gneisses consisting of alternating layers of purplish-brown micaceous plagioclase feldspar or of quartzite, layers of dark hornblende schist, and veins of light-colored aplitic rock, locally with some epidote resulting from the alteration of hornblende or from the contact metamorphism of limestone. Sheets of quartz porphyry with connecting dikes are common in the gneiss. A dense, compact dark-brown hornfels comprising alternating bands of micaceous quartzite and of plagioclase feldspar is found in places in immediate contact with the ore.

The main vein has been exposed by surface cuts and natural exposures for a length of about 3,200 feet. It has been sampled in the tunnels and by 19 trench cuts at the surface for a total length of about 1,600 feet. A report has been made on the property for the Bon Alaska Co. by Campbell, Wells & Elmendorf, of Seattle, Wash., and from this report the following data have been compiled. The width of the vein ranges from 1½ to 9 feet and averages about 3 feet. The northwesternmost portion of the exposed vein is more than 1,140 feet lower than the southeastern portion. The average of 24 assays, each made on the full width of the vein, is approximately zinc, 17 per cent; lead, 2½ per cent; silver, 1¼ ounces. The zinc content ranges from 9.4 to 30.6 per cent; lead from a trace to 12.5 per cent; and silver from a trace to 4.35 ounces. D. G. Campbell reports that preliminary experiments in the concentration of these ores by means of preferential flotation after roasting gave a concentrate of 45 per cent zinc and 14 per cent iron, and that this grade could probably be materially improved with some further work.

About 25 feet below the main vein is a parallel vein of similar character which pinches and swells and ranges from 10 inches to 4 feet in width. About 60 yards southeast of tunnel No. 1 this vein appears to die out into the country rock as a series of narrow stringers. It was not found in tunnel No. 2, 430 feet northwest of tunnel No. 1, and may die out in this direction or swing in to join the main vein. A layer of magnetite 6 inches thick, layers of pyroxene granulite, and a fine-grained to dense banded gneiss consisting of alternating layers of light-colored aplite, yellowish-green pyroxene granulite, and purplish-brown plagioclase feldspar are found at the southeast end of this vein.

About 350 feet beneath the main ore vein, measured at right angles to the dip, is another parallel vein. This has been crosscut by an adit where it is from 1 to 2 feet thick and of similar character to the others. An average sample of ore from both sides of this vein in the adit is reported by the Bon Alaska Co. to yield 8.60 ounces of silver to the ton, 4.85 per cent of lead, and 16.34 per cent of zinc. The immediate wall rock of this vein is a dense banded green and white hornstone consisting of alternating layers of light-green pyroxene, feldspar, and white quartzite with a trace of sphalerite and pyrrhotite. There is about 2 feet of such rock in the hanging wall, overlain by a compact ribbon-banded black and white quartzite. The black layers consist of very fine grained quartzite with a trace of feldspar and pyroxene and abundant disseminated particles of carbonaceous matter, from which they derive their color. The white layers are almost exclusively plagioclase and are locally adjoined by thin borders of pyroxene.

The ore in general consists essentially of pyrrhotite interstreaked and banded with gangue minerals (remnants of unreplaced country rock), dark-brown sphalerite, and a small and variable amount of galena and pyrite. A trace of chalcopyrite is present as dots and rods of microscopic size included in the sphalerite and locally as sparse grains in the ore. Minute veinlets of quartz and chalcopyrite cross the banding of the ore, and one 2-foot vein of this character is reported to have been found. The galena occurs as veinlets parallel to the banding of the other minerals, was brought in by solutions after the formation of the other minerals, and is irregularly distributed. The silver content varies roughly with the percentage of lead.

High-temperature replacement pyrrhotite-sphalerite deposits like this one are not common. The zinc deposits of Ammeberg, in Sweden, seem to bear the closest resemblance to it, and a summary description of their mode of occurrence will be of interest. The ore there is described[3] as occurring in fahlbands, layers, or zones in a banded gray " granulite " or fine-grained gneiss. Graphite, pyroxene, hornblende, and garnet are common accessory minerals. Small bands of grayish-green rocks composed essentially of diopsidic pyroxene are frequently seen in the banded " granulite." Some of the deposits contain essentially sphalerite; others are almost pure pyrrhotite formed by impregnation. Many of the smaller layers contain both

[3] Johansson, H. E., The Ammeberg zinc ore field: Cong. géol. internat., 11e sess., Guide des exc. No. 35, Stockholm, 1910.

sulphides in variable proportions. Pyrite is only locally present, and chalcopyrite is of exceptional occurrence. With the sphalerite traces of galena are usually present. Pyrrhotite does not occur in the zinc ore itself but is almost constantly seen in the footwall of the sphalerite deposits, where together with some galena and pyrite it impregnates a narrow band of silicate rock, usually associated with seams of siliceous limestone. The pyrrhotite does not everywhere form the definite footwall of the ore belt but may occur also within it, separating different branches or bands of the ore. The sphalerite deposits have a marked layer-like appearance and may be traced as a practically continuous band, generally not many meters in width, for almost 3¾ miles. Only the richer portions are worth mining. Some of the lenticular swellings are as much as 30 to 50 feet wide. The sphalerite is mostly of varieties poor in iron and hence of light-brown color. The low-grade milling ore averages about 21 per cent of zinc and forms the bulk of the product. The high-grade hand-picked ore averages 38 per cent of zinc. The total production from this field from 1857 to 1909 was 1,968,729 tons.

The country rock of the Swedish deposit, called "granulite," is similar to the banded gneiss described as occuring in association with the Groundhog ore. The mineral association, essentially pyrrhotite and sphalerite, is similar at both deposits. In the Swedish deposits, however, the sphalerite is an iron-poor variety and in the workable ore bodies is not intimately interstreaked with the pyrrhotite, like that of the Alaskan deposit. In their layer-like character and great extent in length the two deposits are similar. The veins of the Ammeberg deposit have been followed down the dip for 1,000 feet; and the great length and the present exposures of the Alaskan vein at greatly differing altitudes and its general character are favorable to its persistence in depth. The origin of the Swedish deposits is in doubt, but the mineral association indicates that they have been subjected to high temperatures.

SILVER-LEAD.

GENERAL OCCURRENCE.

Silver-lead veins have been prospected at the Lake group of claims (fig. 3), about 10½ miles east of Wrangell, and silver-bearing galena is found along the mineralized zone 14 miles east of Wrangell, where it is associated with the zinc ores at the Groundhog group, is the principal ore mineral at the Glacier Basin prospects, and is associated with sphalerite and pyrite at the Berg's Basin prospects. A little silver-bearing galena is also associated with the gold ores in the prospects on Thomas Bay and in the Maid of Mexico vein, on Woewodski Island.

LAKE GROUP.

The Lake group of claims is a little more than 4 miles east of the mouth of Mill Creek on Eastern Passage. The claims are reached by a trail that turns off from the trail to the Groundhog Basin about 2 miles from the head of Lake Virginia. The vein lies below timber line, at an altitude of about 1,500 feet.

The country rock consists of quartzite, slate, and chloritic schist adjoined on the northeast by intrusive quartz diorite. The vein, in

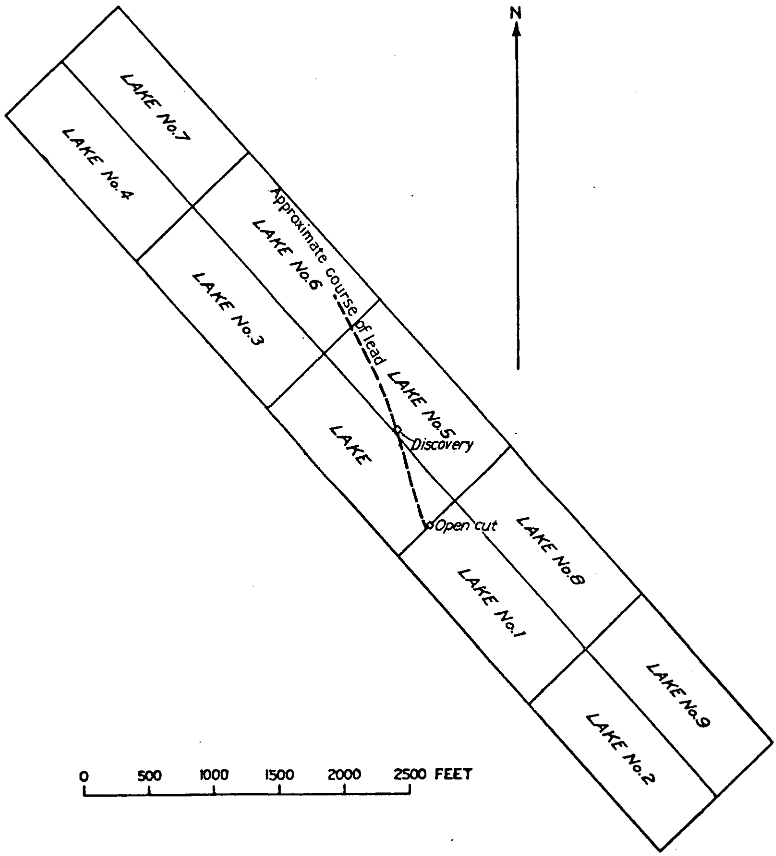


FIGURE 3.—Sketch map of Lake group of mineral claims.

general, conforms in attitude to the foliation of the country rocks, striking about N. 15° W. (magnetic) and having a vertical to steep easterly dip.

For the most part the vein consists of fissure fillings in or along a brecciated quartzite bed intercalated in chloritized schist. The ore minerals occur mainly in narrow veinlets along fractures in the quartzite but are found locally along the borders of the vein, where they may be several inches wide and several feet long and consist of almost solid galena. The maximum width seen of ore of this type was 6 inches.

The principal ore mineral is a coarse granular galena, with which occur here and there some sphalerite and a little chalcopyrite or pyrite. The gangue minerals are calcite and quartz.

An open cut 30 feet long has been made to crosscut the vein on Lake No. 5 claim, and a drift 25 feet long driven to the southeast. The vein here is from 4 to 5 inches wide and consists of nearly solid galena. An average of 4 tons of ore from the dump here is reported by Campbell, Wells & Elmendorf for the Bon Alaska Co. to yield 21 ounces of silver to the ton, 48 per cent of lead, and 9 per cent of zinc.

About 25 yards south of the open cut or tunnel the vein has been exposed by stripping of the overlying glacial débris and trenching of the vein along its strike for a length of a little over 100 feet. The vein lies along the face of the hill but strikes into it at a small angle, so that the upper portion of the stripping is about 60 feet above the lower end. In this stripping the vein has a width averaging about 13 inches and varying from 9 to 26 inches of well-mineralized rock. A basalt sill parallels the vein about 2 feet away on the east side. Another basalt sill parallels the vein at the south end on the west side for about 25 feet and then turns and cuts across the vein at the south end of the stripping. For about 20 feet it forms the footwall of the vein.

South of the long stripping several pits expose the brecciated quartzite, in which the fractures are filled with quartz veinlets but which shows only traces of ore minerals here and there. Drusy quartz is common, coating surfaces of the fractures. This relatively barren zone continues for about 150 feet. South of it the vein is again mineralized and is exposed for a length of 50 feet by two pits and a 15-foot stripping. The vein here is about 10 inches wide, and 6 inches of it is very heavily mineralized. At 100 feet farther south the mineralized vein is exposed by a pit in the glacial overburden.

The southernmost exposure of the vein is about 275 yards south of the tunnel, where a trench has been cut across the schists and exposes five stringers of galena aggregating perhaps 1 foot in a width of 10 feet.

About 200 feet south of the south end of the long stripping a tunnel has been driven on a stringer of galena and calcite several inches thick which strikes parallel to the foliation. This is a different vein from that described above. The entrance to the tunnel is now caved in.

These prospects are more favorably situated for development than other properties in this belt.

GLACIER BASIN.

Glacier Basin lies about 6½ miles in a straight line a little north of due east from the mouth of Mill Creek, on Eastern Passage. A trail formerly led up Glacier Creek to the prospects in the basin at its head, but this trail is now so overgrown that the best route is by the trail to the Groundhog claims and thence over the intervening mountain ridge by way of Nelson Glacier. One prospect is on the north wall of the basin at an altitude of about 2,400 feet, a little more than three-fifths of a mile downstream from the edge of the glacier in 1921. Nelson Glacier now extends much farther to the southeast than is indicated on the Coast Survey chart.

The prospects were located about 1899 by Nelson & Smith. The country rock consists of siliceous injection gneiss and hornblende schist and gneiss similar to the rocks of the Groundhog claims. Beds or "fahlbands" with disseminated pyrite and pyrrhotite are common and conspicuous because of their rusty brown or red color on weathering. Sheets of pale greenish-white rhyolite intrude the gneisses.

The vein, along which a tunnel about 40 feet long has been driven, is a tabular deposit formed by the replacement of what seems to be a bed of granulite consisting of epidote, diopsidic pyroxene, plagioclase feldspar ($Ab_{70}An_{30}$), and calcite, with a trace of garnet. The portion of the vein prospected by the tunnel, together with a border zone of gneiss, occurs as a long, narrow inclusion between two rhyolite sheets, which are seen to have resulted from the splitting of a single sheet farther up the mountain side. The western sheet appears to cut across the ore body, for a surface cut on the west side of the rhyolite, just west of the entrance of the tunnel, has exposed the continuation of the vein, and in the tunnel the ore is cut off on the northwest by the same sheet of rhyolite. At the entrance to the tunnel the granulite is 6 feet thick and very heavily mineralized for a width of 2½ feet. Narrow quartz veins with vugs lined with terminated quartz crystals or with a prevalent comb structure cross both the ore and the rhyolite. The rhyolite sills show slickensided or brecciated zones against the bordering gneiss, and the breccia zones are cemented with quartz. The hanging-wall rhyolite at the mouth of the tunnel is shattered and much reticulated by a network of quartz veinlets filling short fractures. Veinlets and sporadic pockets of galena, sphalerite, and pyrite are present throughout this shattered zone or stockwork, which is about 6 feet in width.

The ore consists of galena and sphalerite, with a little chalcopyrite and a trace of pyrite and pyrrhotite. For the most part the galena and sphalerite do not occur as a uniform mixed aggregate but as separate bands. Veins of almost solid galena or solid sphalerite several inches thick are found. The galena is reported to carry a moderate content of silver.

SILVER-GOLD.

The prospects in Bergs Basin are at the head of Bergs Creek and are reached by a trail 6 miles in length starting from tidewater at the head of Aarons Bay, at the north end of Blake Channel. The workings are at an altitude of about 1,600 feet.

The country rock is the same belt of gneiss and schist that contains the zinc veins of the Groundhog Basin and the silver-lead zinc veins of Glacier Basin, and the veins lie along the same general zone within this belt. The rocks comprise hornblende gneiss, kyanitic quartz schist, and light-colored gneiss injected by a few aplite veins. They are intruded by sills of creamy-white rhyolite and dark diabase porphyry. These intrusive sheets cut across the cleavage of the formations repeatedly at small angles. Here, as at Glacier Basin, one of these rhyolite sheets, about 12 feet thick, has been severely fractured and is intersected by a network of very narrow quartz veinlets carrying pyrite, galena, and sphalerite, thus constituting a stockwork. Sporadic pockets of sphalerite and galena are also found in this sheet. A quartz vein 1 foot wide, carrying moderate quantities of gold and silver, occurs within the same rhyolite sheet; and a tunnel, at present about 400 feet long, is being driven to intersect this vein in depth. Several open cuts have been made on narrow quartz veins along fault zones across the strike of the formation. One well-mineralized vein 2 feet wide, formed by the junction of two veins, is exposed at one place. Sulphides also occur in quartz vein fillings in breccia zones lying along the contacts of rhyolite and basalt sheets, but none over a foot thick were seen.

GOLD.

Several metalliferous veins carrying gold and some silver are found in the Wrangell district, but none are being actively worked. Most of the veins consist of milky-white quartz carrying a minor amount of sulphides and a trace of free gold and are localized as fissure fillings along shear or fracture zones. At the Helen S. mine, on Woewodski Island, however, a lode of pyritized greenstone and diorite (or altered gabbro), having a width of about 40 feet and exposed for a length of 1,000 feet, was worked as a low-grade gold mine. It is reported that the ore ran $3.66 a ton at the mill heads. This property was dismantled and abandoned several years ago.

MAID OF MEXICO VEIN.

The Maid of Mexico vein is about 1¼ miles east of the Helen S. mine on Woewodski Island. It lies along the contact between black slates and a rusty-weathering, impalpably fine-grained impure siliceous dolomite, the slate or the dolomite forming the hanging wall and the dolomite the footwall; the vein thus lies within the dolomite, or between the dolomite and the slate. The vein strikes about east and dips 60°–90° S. It has been traced at the surface for a length of 2,000 feet and ranges from 2 to 6 feet in width, averaging 4½ feet in the underground workings. The vein material consists predominantly of milky-white quartz with a little calcite and included lenses and films of the country rock, which is impregnated with a varying amount of disseminated sulphides. A rich pay streak, from 5 to 18 inches in width, is found in some places along the footwall, in others along the hanging wall, and in still others along both walls. The average value for the full width of the vein is reported to be about $20 to the ton. The ore minerals are predominantly sphalerite, pyrite, and galena, with a little chalcopyrite and free gold.

THOMAS BAY.

Just north of Elephant Head on the north arm of Thomas Bay is a gold lode held by Colp & Lee, of Petersburg. This lode is reported to consist of a mineralized shear zone 140 feet wide with associated sulphide-bearing quartz stringers in quartz diorite. The minerals in the quartz veins are predominantly pyrite and galena, with a little sphalerite and chalcopyrite. The tenor for the full width of the lode is low, averaging about $3 to the ton, but the richest part of the zone, 5½ feet in width, is reported to carry about $16 to the ton.

Another gold vein occurs in the southeast arm of Thomas Bay, on the conspicuous point of the mainland shown on the charts just south of Spray Island. The country rock here comprises a series of hornblende and quartz-mica schists. Some of the beds of quartz-mica schist, with thicknesses up to 100 feet, are so full of quartz veinlets that they literally consist of glassy quartz lenticels with mica schist partings. Locally there is little feldspar in these quartz veins. The ore vein at the shore is parallel to the foliation of the quartz-mica schist and appears to be only slightly mineralized. The vein can be traced about 250 feet from the shore to the mouth of a tunnel and is found to cross the foliation at a slight angle and enter a bed of hornblende schist. The ore zone exposed by the tunnel is a sheeted zone about 12 feet thick composed of milky-white quartz veins with a variable sulphide content and schist layers in about equal quantities. The included schist stringers are silicified and slightly pyritized, and slickensides along the walls of the quartz veins are abundant. The full width of the sheeted zone is not exposed in the tunnel and is possibly as much as 25 to 30 feet, although the zone is not equally mineralized throughout. The predominant sulphides are pyrite and arsenopyrite, with which occur a little chalcopyrite, pyrrhotite, and galena. Specimens of almost solid arsenopyrite several inches wide are common on the dumps.

EAST ARM, DUNCAN CANAL.

On a small creek that enters East Arm at about the middle of the east side a small gold prospect has been opened on the Silver Star claim (see fig. 4), about 2 miles from the coast, at an altitude of about 400 feet. Cuttings on the northwest side of the creek expose a pyritic black schist lying between walls of gneissoid diorite. This schist is composed essentially of hornblende with conspicuous crystals of biotite and is probably a basic segregation phase of the diorite, as the diorite becomes much more hornblendic at the immediate contact and grades into the schist. The schist is exposed along the creek for a length of about 20 yards. About 10 yards of the central zone is more highly pyritic than the border zones, the pyrite occurring as disseminated deposits and irregular veinlets. The border zones contain lenses of diorite similar to the wall rock, and adjacent to the walls veinlets of the black schist may be seen reticulating through the diorite. The whole mass of schist, as exposed, is in an advanced stage of disintegration and crumbles in the hand to a granular aggregate. About 10 feet of gneissoid diorite intervenes between the mineralized zone and another narrow zone of the hornblende schist on the northwest side, but the latter is nonpyritic.

Assays made for J. T. Towers by I. F. Laucks (Inc.), of Seattle, upon a sample of the mineralized phase of the schist yielded about 0.4 ounce of gold, 2 ounces of silver, and 0.3 ounce of copper to the ton and a trace of platinum. Samples of the pyritic schist collected by the writer were submitted to Ledoux & Co. for assay for metals of the platinum group, with the following results: Palladium, none; platinum, 0.0006 ounce to the ton; iridium, possible trace. The results show that the sample undoubtedly contains metals of the platinum group, but the amount is altogether too small to be of commercial value.

PYRITE.

A body of pyrite lies near the head of St. Johns Harbor on Zarembo Island. It is reached by a trail that leaves the beach about 200 yards south of the mineral spring on the west side near the head of the harbor. The trail runs about a mile southeast to the prospect, on the bank of a creek that enters the harbor on the west side near the head.

The vein consists of a tabular layer of very fine grained pyrite almost completely replacing a bed of chert and conformable with the bedding, which strikes east (magnetic) and dips 20° S. The footwall of the sulphide body is a crumpled siliceous schist, probably sheared chert, and the hanging wall is composed of thinly cleavable white chert beds. Underlying the chert is gray very fine grained sandstone with black slate laminae which give the whole rock a dark appearance.

The vein has been developed by a tunnel about 50 feet long driven down the dip of the sulphide layer and by a shaft about 100 yards due north of the tunnel and about 40 feet above it. The pyrite body is 7½ feet thick at the entrance to the tunnel, with a 7-inch barren layer of chert in the central portion. It is exposed along the brook for a length of 130 feet. About 100 feet west of the tunnel the vein is cut off by a fault striking N. 65° E. and dipping 60° N. A pyrite layer about a foot thick appears in the chert to the west of the fault. The shaft was partly full of water at the time of the writer's visit, and no examination was made.

Most of the pyrite retains a banded character resulting from the incomplete replacement of the chert layers. The amount of gangue, predominantly cherty quartz, is variable. Although some of the vein is solid pyrite, most of it contains some gangue.

Another layer of pyrite partly replacing siliceous schist is found on Kupreanof Island, on the beach above high-tide mark in the northwest corner of the bay about 3 miles due west of the Castle Islands in Duncan Canal. The siliceous schist is probably the result of shearing and metamorphism of chert beds. The pyrite layer here is about 4 feet wide and is exposed for 50 feet.

COPPER.

Traces of copper are found at most of the prospects in this district, but the only developed copper ore bodies are those of the Northern Copper Co. near the head of Duncan Canal, on Kupreanof Island (fig. 4). This property was formerly held by the Kupreanof Mining Co. The mine is 5¾ miles inland, at an altitude of 1,275 feet. Development work and the construction of a plank motor-truck road with connecting tram to the mine was started in November, 1918, and was in process of completion in 1921.

The ore bodies occur within a series of black slate and phyllite interbedded with chert and associated greenstones. In part the greenstones are altered dikes and sheets of diorite, in part they may be intercalated andesite flows, and in part they are probably contact-metamorphosed limestone beds. The ore is reported to occur predominantly along the contact of the greenstone and the slate, usually as replacement bodies in the greenstone but also replacing the slate. The property has been developed by many prospect pits, several open cuts, two main tunnels, and a shaft. At the time of the writer's

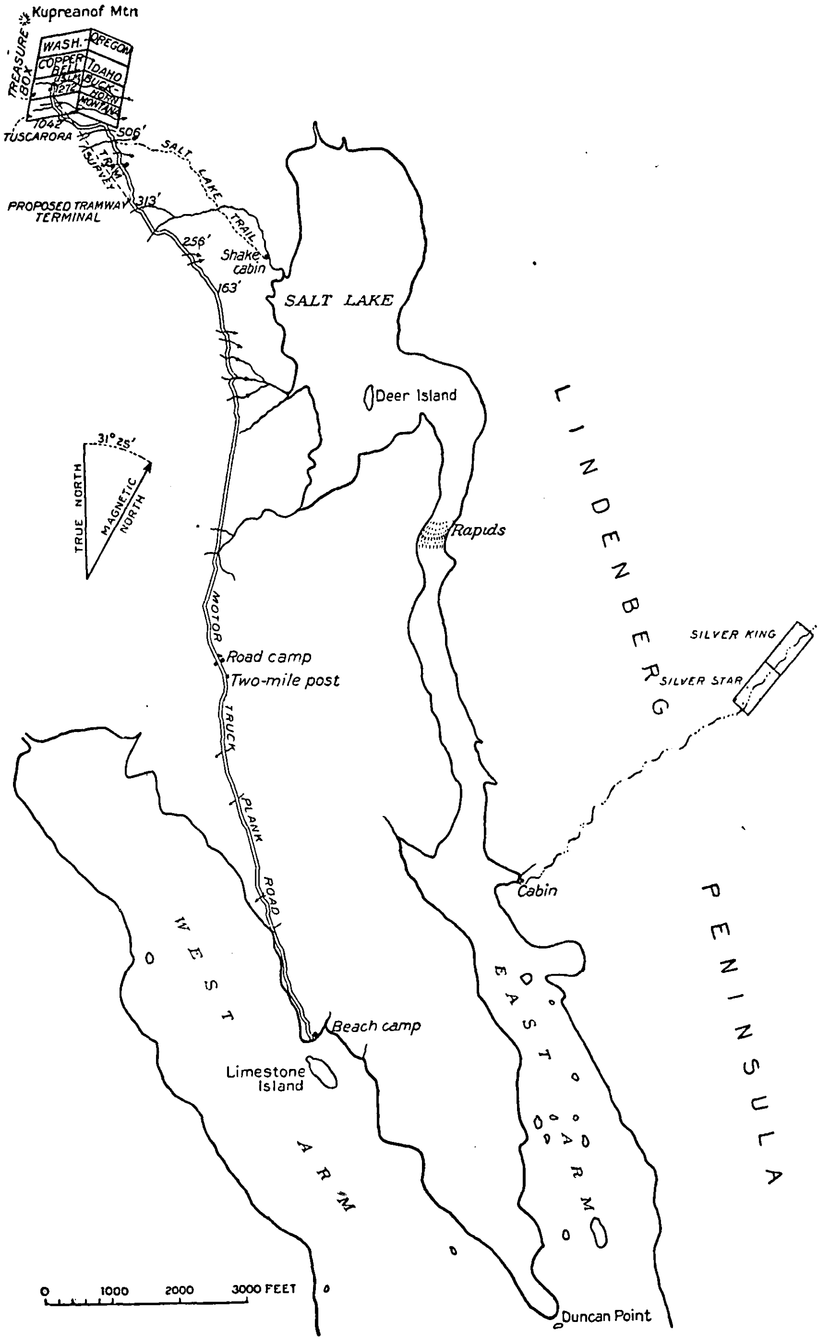


FIGURE 4.—Sketch map of claims of Northern Copper Co.

visit the trenches and prospect pits were caved in, and no detailed examination could be made. At a stripped area just east of the cabin the following relations were observed: The ore bodies lie on the crest of an anticline, and the beds and ore zones show gentle dips of 10° to 30°. The hanging wall of the ore body is a sheet of much altered fine-grained diorite composed of uralitic hornblende and plagioclase ($Ab_{90}An_{10}$). The footwall comprises interbedded slate and chert. The country rock of the ore, as indicated by unreplaced lenses remaining in the ore body, is a pyroxene granulite. This rock as seen in thin section consists of pyroxene, of a variety near hedenbergite, in euhedral crystals, with interstitial granular quartz shot through with hornblende needles. A little garnet is a local component of the rock. Magnetite octahedrons are very abundant and replace the silicate minerals. In thin local layers magnetite completely replaces the country rock. It also occurs along the joint planes. The ore mineral is cupriferous pyrite or chalcopyrite and occurs essentially as veinlets and blebs in masses of pyrrhotite which is replacing the pyroxene granulite. Narrow veins of pyroxene with a little pyrrhotite, chalcopyrite, and quartz are common in the country rock. The character of this ore body and its associated rocks very strongly suggests that it has been formed through the metasomatic replacement of a limestone bed. The mineral association and the successive order of mineral formation (silicates, magnetite, sulphides) are characteristic of many contact deposits. A little sphalerite is associated with the ore minerals at one prospect pit. Narrow veins of glassy quartz with calcite, carrying pyrrhotite, garnet, acicular hornblende, and a trace of sphalerite and chalcopyrite, cut the country rocks. Veins of quartz with epidote crystals are also found.

Wright states that this property was first located in 1900 and that a vein deposit 200 feet long and 3 to 6 feet wide is exposed at several points. The vein material, he says, is composed largely of sulphide minerals, chiefly pyrite and pyrrhotite, and contains chalcopyrite and a little gold and silver; the gangue consists of quartz and calcite. This vein deposit is probably one cut by the tunnel and was not seen by the writer. Specimens of chalcopyrite several inches in diameter with residual remnants of chlorite schist are found on the dump.

BARITE.

A deposit of barite was found in 1913[4] on one of the Castle Islands, in Duncan Canal. A short adit has since been driven on the deposit, and a few open cuts have been made to fulfill assessment requirements, but no important development work has been undertaken. The barite forms an isolated mass disconnected from the

[4] Burchard, E. F., A barite deposit near Wrangell: U. S. Geol. Survey Bull. 592, pp. 109–117, 1914.

main island at high tide. At low-tide level it is about 200 feet long, 75 feet wide, and roughly elliptical in shape. The top is about 35 feet above high-tide level. The barite vein dips about 50° NE. and is immediately underlain by schistose chert overlying pillow lavas. It is suggested by Burchard that the deposit may be the result of the replacement of a limestone bed. J. T. Towers estimates that there is 30,250 tons of barite below high tide and above low tide and 30,500 tons above high tide, making a total of 60,750 tons. Towers reports that an average of ten analyses of the material by G. S. Eldridge & Co., of Vancouver, was as follows:

Average analysis of barite from Wrangell, Alaska.

Barium sulphate ($BaSO_4$)	93.34
Silica (SiO_2)	2.68
Iron oxide (Fe_2O_3)	1.07
Lime (CaO)	.06
Magnesia (MgO)	.24
Zinc (Zn)	1.38
Sulphur (S)	.68
Copper (Cu)	.04
Moisture	.08
Undetermined	.43
	100.00

The minerals in addition to barite are quartz, pyrite, sphalerite, galena, magnetite, and graphite. The rock itself is a fine-grained crystalline granular rock resembling marble.

GARNET.

Garnets are being mined at only one locality, although garnetiferous schist and gneiss are common in the schist and gneiss belts of the mainland. In most places the garnets are not over a quarter of an inch in diameter and are unsuitable for mining. At the mine of the Alaska Garnet Co., however, 7½ miles north of Wrangell, the garnets are usually from a quarter to three-quarters of an inch in diameter and are easily separated from the schist in which they occur, especially from material that has weathered for a year or more. The crystals are almost uniformly symmetrical, and most of them show a combination of the dodecahedron and trapezohedron. The garnets are disseminated in beds of quartz-mica schist 10 feet or more in maximum thickness. These beds are intercalated between beds of more quartzose quartz-mica schist. The coarse crystallization of the schist is due to the recrystallization of interbedded slate and sandstone by heat, pressure, and gaseous solutions accompanying the intrusion of the mass of quartz diorite lying immediately to the south and southeast. Accessory minerals such as feldspar, graphite, kyanite, sillimanite, pyrite, pyrrhotite, and tourmaline are present in the groundmass of the garnetiferous schist. Tourmaline is usually considered to be of pneumatolytic origin, and sills of granite are found in the schist. The evidence indicates that the schist in which the economically valuable garnet ledges are found is of direct contact-metamorphic origin, and that the ordinary garnetiferous schist is due to regional metamorphism not so close to the contact with large masses of quartz diorite.

MARBLE AND LIMESTONE.

Beds of crystalline limestone, in many places true marble, are found in the belt of schist and gneiss along both sides of Bradfield Canal, on Ham Island in Black Channel, in the belt of schist and phyllite paralleling Eastern Passage and extending from the northwest end of Blake Channel to Lake Virginia, and on the east side of Mosman Inlet. They consist of limestone that has been recrystallized and metamorphosed to marble through the heat, pressure, and solutions attendant upon the intrusion of the closely associated large masses of quartz diorite. They are not necessarily at the immediate contact with such masses and may therefore be interpreted as of regional-metamorphic origin in contrast to contact-metamorphic origin.

These deposits have been described in detail by Burchard,[5] and those interested are referred to his report.

Beds of limestone of considerable thickness are found in Duncan Canal along the north shore and at the head of the arm running northwest from Emily Island, along and at the heads of the center and western arms, and on the islands at the head of the canal.

GRAPHITE.

The slates of the Wrangell district are prevailingly black from their carbonaceous content. With increasing intensity of metamorphism and recrystallization of these rocks the carbonaceous material became crystalline flake graphite. In the incipient stages of this process the carbonaceous material appeared first as disseminated dust; at a more advanced stage as a collection of this dust into microscopic spherules or into clotlike aggregates of spherules; and finally as individualized flakes. The graphite schist with crystalline flakes occurs only in the areas of more thoroughly recrystallized schist and gneiss, such as the belts on the mainland. Beds of schist with crystalline flake graphite are intercalated in the hornblende-feldspar schist north of Wind Point on Thomas Bay, particularly at the east edge of the schist belt, which here lies near the quartz diorite. The graphitic schist is more siliceous in character and usually

[5] Burchard, E. F., Marble resources of southeastern Alaska: U. S. Geol. Survey Bull. 682, 1920.

weathers a rusty brown, owing to the oxidation of its contained pyrrhotite and pyrite. A specimen examined from a bed near the east edge of the schist belt is a graphitic feldspathic quartz schist. It contains 6 per cent of graphite as disseminated flakes, with a diameter ranging from 0.2 to 0.7 millimeter and averaging 0.4 millimeter and an average thickness of 0.08 millimeter. The other minerals are quartz 54 per cent, plagioclase and orthoclase feldspar 26 per cent, biotite mica 9 per cent, and pyrrhotite 5 per cent. This schist is very similar in percentage of graphite and mineral character to some of the graphitic schists mined in New York. The percentage of biotite in the specimen examined is higher than desirable for the separation process used in New York; but this mineral varies from bed to bed, and other specimens with a very low mica content were seen. Specimens of graphitic schist obtained near Duck Island Cove, on Bradfield Canal, are reported by J. Ulmer, of Ketchikan, to have shown on analysis 8 to 10 per cent of graphite. Beds of graphite-bearing schist were also noted near the head of Knygs Lake on Stikine River and in the schist belt crossed by Andrews Creek.

FLUORITE.

The rocks along the southwest coast of Zarembo Island are Tertiary volcanic rocks with some sedimentary beds near the base. From McNamara Point to Point Nesbitt many narrow breccia zones and seams are present in the volcanic rocks, which include amygdaloid, rhyolite lava, and rhyolite porphyry. The spaces in the breccia zones and the small openings along seams in the rocks have been as a rule partly or completely filled with a fine-grained quartz showing mammillary surfaces or a drusy coating of small terminated quartz crystals. Less commonly these breccia zones and cavities have a filling of fluorite. One such zone, N. 50° E. (magnetic) of the buoy opposite Bushy Island, ranges from an inch to several feet in thickness. The fragments of the breccia were here first incrusted with a thin layer of chalcedonic quartz, on which fluorite was deposited. Coatings of clear pale-green crystalline fluorite a quarter of an inch thick and as much as an inch in width commonly incrust the fragments in such breccia zones or occur as fillings in narrow fractures. Fragments of basalt as large as a foot in diameter are completely incrusted with chalcedony and fluorite from a quarter to half an inch thick.