ORE DEPOSITS OF THE SALMON RIVER DISTRICT, PORTLAND CANAL REGION.

By Lewis G. Westgate.

INTRODUCTION.

Portland Canal, a steep-walled fiord, penetrates the Coast Range for some 90 miles from Dixon Entrance, at the southern boundary of Alaska, cutting obliquely across the trend of the mountains. This great trench through the mountains is extended northward by the alluvium-floored valley of Bear River, which reaches far back into the upland beyond the Coast Range (fig. 1). At 2 miles from its head Portland Canal is joined on the west by Salmon River, the mineral deposits of whose basin are here described. The valleys of Salmon and Bear rivers are separated by the Reverdy Mountains, a southward-trending spur of the main range. At the seaward end of this spur is the settlement of Hyder, which has a population of a few hundred people and is the ocean port, supply point, and post office of the Salmon River district. Its location is on the international boundary, and the steep slope immediately to the north has crowded the settlement onto the tidal flats, where it is in part built on piles. The newer part of the town, however, is in a better location to the northwest, on the gravel-floored Salmon River valley. Two miles to the northeast is the town of Stewart, on the British Columbia side of the boundary. Though older than Hyder, it has about the same population. The Salmon River region forms the southeastern part of the Ketchikan district.

Metal-bearing lodes, chiefly of gold and silver, were found in the Canadian portion of this region about 1898, and similar discoveries had been made on the Alaska side of the boundary by 1901. These deposits received relatively little attention until 1909, when a small boom was started in the Canadian district. This boom subsided in a few years, but meanwhile the town of Stewart and some 12 miles of railroad were built. Interest was revived in 1917 by the discovery of some rich silver ores on the Canadian side of the line, and in 1918 a commercial ore body was found at the Premier mine, which, though in the Salmon River basin, is also in Canada. As a result, many claims were staked on both sides of the boundary, and the town of Hyder sprang up. The upper part of the Salmon River basin lies in Canada, but its only practical mode of access is through

Alaska. (See fig. 1.) This lack of adjustment of the international boundary to the topography gives Hyder a much greater importance than it would have if it served only the Alaska portion of the district. Though no mines have been developed on the Alaska side, many claims have been staked, and on some of these, as will be shown, considerable work has been done during the last two years.

In view of the fact that the geologic features on the two sides of the boundary were known to be essentially the same, there appeared to be good hope that commercial ore bodies might be found in the Salmon River district. For this reason the writer undertook a geologic examination of the region, a task which occupied him from July 19 to August 17, 1920. Though the salient features of the geology are simple, the heavy vegetal cover below timber line greatly enhances the difficulties of field examination and increases the work of the prospector.

TOPOGRAPHY.

The region is one of mountainous topography and high relief. The floor of Salmon River and of its principal tributary, Texas Creek, rises from sea level to about 500 feet where they issue from their glacier sources. From these low valley altitudes the mountains rise steeply and in places by unscalable cliffs to heights between 5,000 and 6,000 feet. The highest points within the area examined are a little over 6,500 feet above the sea. The only level land in the district consists of the gravel-floored bottoms along Salmon River and Texas Creek The lower slopes, up to 3,000 feet or more, are covered with forest; at higher levels the mountains, where no covered by snow fields and glaciers, are largely bare rock. Even the narrower ridges along Portland Canal and the lower parts of Salmon River carry snow fields and small summit and cliff glaciers, and farther inland the larger valleys reach above snow line and serve as collecting basins for extensive ice fields, the sources of large valley glaciers. The snow line stands at about 4,500 feet, and the glaciers descend within 500 feet of sea level.

CLIMATE.

Portland Canal lies within the Pacific coast climatic province, an area of abundant rainfall and comparatively moderate temperature due to prevailing westerly winds from the Pacific Ocean. The annual precipitation at Fort Tongass,[1] near the entrance to Portland Canal, is about 130 inches; at the head of the canal it is less, possibly not far from 100 inches. The least rainfall occurs late in spring and early in summer, and abundant rains set in by September.

[1] Brooks, A. H., The geography and geology of Alaska: U. S. Geol. Survey Prof. Paper 45, pp. 162–165, 1906.

From November to March the precipitation is in the form of snow. The summers are not hot, and the temperature seldom drops much below zero in winter.

COMMERCIAL CONDITIONS.

Hyder, being on tidewater, is readily accessible throughout the year to large ocean vessels, but in 1920 Hyder had no wharf, and all freight was landed by scows. Provisions can be purchased in both towns, and more elaborate equipment can be brought from Ketchikan, with which there is communication about twice a week by means of gasoline boat. The distance from Hyder to Ketchikan is 155 miles by the water route. Stewart has steamer communication with Prince Rupert, British Columbia, 135 miles distant.

Travel inland is difficult, except along the few established roads and trails. The best road in the region is the one connecting Hyder and Stewart (2 miles), which is suitable for automobiles.

Salmon River and Texas Creek are swift and practically impassable streams, which effectually divide the country through which they run. Texas Creek and Salmon River south of Ninemile flow in a network of channels through a broad valley bottom floored with coarse gravels. A road has been constructed up the east side of the Salmon to Elevenmile and thence to the Premier mine, in Canadian territory. Except at a few points where it is forced to the valley side by eastward swings of the river, the road follows the bottoms and is therefore subject to overflow and washout, as was well shown in the high-water stages of August, 1920. Above Elevenmile the road is on the valley slope. From the road three pack trails branch off, one in Canada to the Big Missouri and neighboring properties, one at Elevenmile to the New Alaska property, and one up Fish Creek to the Watkins and Tonkin properties.

The only crossing of Salmon River is a footbridge at Ninemile. From this point a foot trail leads to Texas Glacier and thence by a low saddle 3 miles above the mouth of the creek to Salmon Glacier. Most of the prospecting in the region is done by men who pack their outfits on their backs through country where there is not even a foot trail.

The valley bottoms and mountain slopes up to 3,500 feet are heavily forested, chiefly with hemlock and spruce. In the valley bottoms and on the lower slopes there is good timber in sufficient abundance for mining and other local needs.

As yet there has been no demand for water power, and the possibilities of developing it have not been closely scrutinized. Fish Creek and its tributary, Skookum Creek, the largest of the small streams, descend rapidly and are worth consideration as sources of power. There are no accurate records of their flow, which is greatly diminished in winter. The other streams in Alaska east of Salmon River are small and probably without value for power.

PUBLICATIONS.

The following references may prove useful to those wishing further information on the geologic features and ore deposits of the region.

Reports relating to Alaskan part of Portland Canal region.

Preliminary report on the Ketchikan mining district, Alaska, with an introductory sketch of the geology of southeastern Alaska, by Alfred H. Brooks: U. S. Geol. Survey Prof. Paper 1, 1902.

The Ketchikan and Wrangell mining districts, Alaska, by F. E. and C. W. Wright: U. S. Geol. Survey Bull. 347, pp. 1–210, 1908.

Notes on the Salmon-Unuk River region, by J. B. Mertie, jr.: U. S. Geol. Survey Bull. 714, pp. 129–142, 1921.

Mining developments in southeastern Alaska, by Theodore Chapin: U. S. Geol. Survey Bull. 642, pp. 94–98, 1916.

Reports relating to Canadian part of Portland Canal region.

Portions of Portland Canal and Skeena mining divisions, Skeena district, B. C., by R. G. McConnell: Canada Geol. Survey Mem. 32, 1913.

Northwestern district (No. 1), by Geo. A. Clothier: British Columbia Minister of Mines Ann. Rept. for 1917, pp. 68–73, 1918.

Northwestern district (No. 1), by Geo. A. Clothier: British Columbia Minister of Mines Ann. Rept. for 1918, pp. 76–83, 1919.

Northwestern district (No. 1), by Geo. A. Clothier: British Columbia Minister of Mines Ann. Rept. for 1919, pp. 61–80, 1920.

Salmon River district, Portland Canal mining division, B. C., by J. J. O'Neill: Canada Geol. Survey Summary Rept., 1919, pt. B, pp. 7b–12b, 1920.

The Premier gold mine, Portland Canal, B. C., by Charles Bunting: Min. and Sci. Press, vol. 119, pp. 670–672, 1919.

The geology of the Portland Canal district, by Victor H. Wilhelm: Min. and Sci. Press, vol. 122, pp. 95–96, 1921.

The Salmon River district, B. C., by S. J. Scofield and George Hanson: Canada Geol. Survey Summary Rept. for 1920, pt. A, pp. 6a–12a, 1921.

GEOLOGY.

GENERAL FEATURES.

The Salmon River district lies on the eastern margin of the great Coast Range batholith,[2] which parallels the shore line of British Columbia and southeastern Alaska from the United States and Canada boundary nearly to the meridian of Mount St. Elias, a distance of some 1,100 miles. It ranges in width from 20 to 110 miles and is the largest batholith on the American continent. It is generally believed that this great mass was intruded in Jurassic time and probably chiefly in Middle and Upper Jurassic time.[2a]

A reference to the map (fig. 1) will show that the inland margin of the batholith is irregular and invades the volcanic and sedimen-

[2] The term "batholith" is applied to bodies of igneous rock which occupy considerable areas and which widen downward. Unlike sheets and laccoliths, they are not known to be bottomed by other rocks. R. A. Daly (Igneous rocks and their origin, p. 90, New York, 1914) proposed that this term be used for large bodies, over 40 square miles in area, and that the term "stock" be reserved for the smaller bodies.

[2a] Since the above was written Scofield and Hanson have reported the occurrence of Mesozoic fossils, probably Jurassic, in the Nass formation: Canada Geol. Survey Summary Rept. for 1920, pt. A, p. 8a, 1921.

tary formations that lie to the east. On the Canadian side of the boundary, as shown by McConnell's map,[3] there are some outliers of

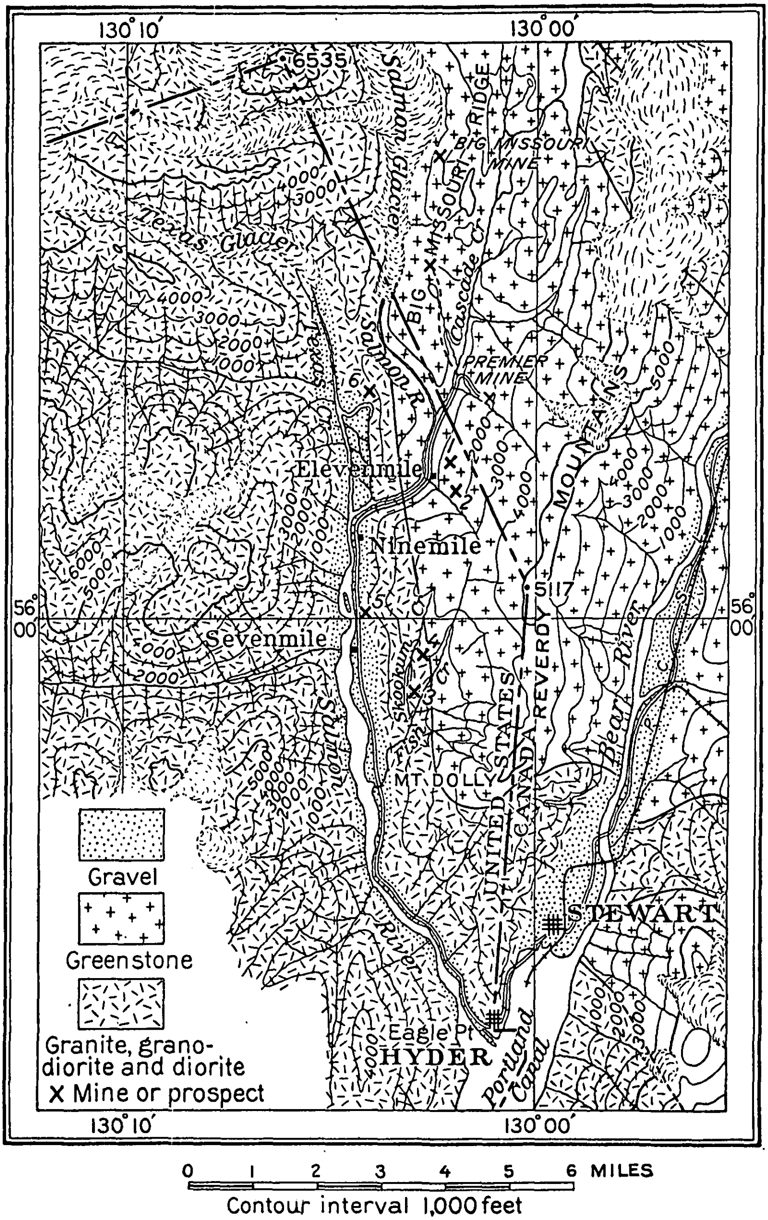

FIGURE 1.—Geologic sketch map of Salmon River district. Mines and prospects: 1, Stoner; 2, New Alaska, 3, Watson & Bain; 4, Fish Creek Mining Co.; 5, D. & A. Lindeborg; 6, Charles, Nelson & Pitcher.

granite within the area occupied chiefly by volcanic rocks and sediments.

[3] Canada Geol. Survey Mem. 32, 1913.

Only the following formations, in descending order, occur in the Salmon River district:

1. The gravel filling of the Salmon River valley.
2. Intrusive rocks of the batholith, chiefly of granitic type, with accompanying dikes.
3. A series of greenstones, which lie northeast of the batholith and, being cut by the granite rocks, are therefore older.

In the region east of the boundary McConnell has recognized three bedrock formations in addition to the intrusives. These are, in descending order:

1. Nass formation. Mostly argillites with some tuffaceous sandstones.
2. Bear River formation. Chiefly massive fragmental greenstone.
3. Bitter Creek formation. Argillites with some tuffs and limestones.

Certain greenstones on the Alaska side are regarded as the equivalent of McConnell's Bear River, with the reservation that some of the other formations may be included also.

GREENSTONES AND ASSOCIATED ROCKS.

Between the lower slopes of the Reverdy Mountains and the international boundary is a triangular area in which the bedrock is chiefly greenstone (fig. 1). The dominating rock within this area is a soft green and gray rock of indeterminate origin, but with it occur better-defined tuffs and breccias. These rocks are believed to be more or less altered volcanic rocks and from their prevailing color may be conveniently grouped together as "greenstones." On the Alaska side of the boundary the greenstones, owing to their proximity to the intrusives, are more highly altered than to the east, where their true character is more evident. It will be well, therefore, to quote McConnell,[4] who describes them as

> A series of massive and fragmental volcanics many thousands of feet in thickness, evidently representing the product of a long-continued period of volcanic activity. The rocks have a general greenish coloration, except in a few areas where they are reddened by the oxidation of their iron content.
>
> The rocks * * * have a wide range and include porphyrites of various kinds, mostly of hypabyssal origin, volcanic breccias and agglomerates, tuffs, and occasional argillaceous bands. Small areas in various parts of the district have been silicified and altered into a cherty condition.
>
> The fragmentals occur as tuffs and volcanic breccias and agglomerates. The tuffs are made up largely of feldspar crystals, often broken, quartz grains, and minute rock fragments lying in a dark fine-grained mat and are often difficult to distinguish in the field from the massive porphyrites. The breccias exhibit considerable diversity in character and probably originated in different ways. * * *
>
> Occasional dark argillaceous bands occur with both the massive and fragmental members of the Bear River volcanic group, apparently indicating that sedimentation occurred at intervals during the whole period of its accumulation.

[4] Op. cit., pp. 14-16.

The rocks of the Bear River formation usually occur in a massive condition but in places * * * have yielded to crushing, and a strong schistosity approximately paralleling the eastern edge of the Coast Range batholith and dipping towards it has developed.

The fragmental varieties * * * are seldom distinctly bedded or banded and are often remarkably uniform in composition through sections many hundreds of feet in thickness.

McConnell was able to make no close age determination of the Bear River formation other than that it was pre-Cretaceous, on the evidence that the granitic intrusives were later. In lithology the greenstones of the Salmon River district resemble certain Jurassic rocks of the islands to the west,[5] and this resemblance suggests that they are of early or middle Mesozoic age.

The different types noted by McConnell, with the exception of the porphyrites, were recognized on the Alaska side of the boundary, though with their original character more or less veiled toward the contact and obscured still more, by mineralization, at the mining prospects. Excellent tuffs and breccias, clearly recognizable as such both in hand specimens and under the microscope, are found along the international line between Elevenmile and the head of Fish Creek, and large boulders of the conspicuously marked breccia are abundant in the lower parts of the valleys heading against the divide. Throughout most of the area, however, the greenstone is a gray or green fine-grained soft calcareous rock, indistinctly banded and specked with minute grains of pyrite. Thin sections show aggregates of quartz, calcite, sericite, chlorite, and feldspar and usually pyrite and leucoxene or granular titanite. The micas are not abundant enough to give foliation.

The rock is rather uniform over considerable areas and ordinarily does not show any structure in the outcrop. Neither in the outcrop nor in the thin section is the original character of the rock to be seen. Areal variability in some thin sections suggests a tuff. There is nothing to suggest sedimentary origin. The uniformity of the rock and its mineral character indicate that it is probably either an altered tuff or a lava.

Near the mines and prospects the mineralization has been much more intense; indeed, the existence of the ores is a direct result of this mineralization. This is shown in the increase of silica to so great an extent that the rock is in places nearly a quartzite and in the abundance of pyrite, sphalerite, and galena and, in another type of occurrence, of pyrite, pyrrhotite, and chalcopyrite, the rock locally becoming an ore.

At a few points along the road above Texas Creek occur black argillites, which are clearly of sedimentary origin and which may be

[5] Chapin, Theodore, The structure and stratigraphy of Gravina and Revillagigedo islands, Alaska: U. S. Geol. Survey Prof. Paper 120, p. 86, 1918.

interbedded in the tuffs. None of the conspicuously porphyritic porphyrites mentioned by McConnell were seen, though finely porphyritic varieties are probably represented by some of the greenstones. As it is difficult to destroy the structure of a porphyry completely, the general absence of any recognizable porphyritic structure in the greenstones is taken to mean that most of them are tuffs.

On Mount Dolly, at the south end of the greenstone area, the rocks are well bedded and are apparently sedimentary rocks, which strike between northwest and west and dip 70° N. They are in part dark-gray or green fine-grained rocks with abundant pyrite, which produces the conspicuous red color that the rocks show on weathering. Toward the top of Mount Dolly and nearer the granite contact the rocks become coarser-grained banded gneisses, characterized in the different layers by varying amounts of fine-grained hornblende, biotite, and epidote. The gneiss is cut both parallel with and across the bedding planes by narrow veinlike bands of quartz, with epidote and some garnet. The relation of these rocks to the tuffs farther north was not ascertained. If they are members of McConnell's Bear River formation, it here comprises many hundred feet of sedimentary rocks, now well metamorphosed.

GRANITE OF THE COAST RANGE.

Much the larger part of the Salmon River district is occupied by the intrusive rocks. These intrusives, here collectively termed granite, range in lithology from diorite and granodiorite to granite.[6] The contact between the granite and the greenstone to the northeast (fig. 1) crosses the Reverdy Mountains and the international boundary a little south of Mount Dolly, at an elevation of 4,500 feet. Thence it can be followed with ease to a point west of Mount Dolly, where it takes a course nearly due north. From this point to the place where it again crosses into Canadian territory the contact can not be located with accuracy, in part because of a heavy cover of forest vegetation and rock slides and in part because of the occurrence in the greenstones of numerous dikes of granite porphyry, many of them wide. Where vegetation covers the more easily weathered and hence lower greenstones, it is often difficult to determine whether the rock is a

[6] The term "granite," commonly applied to the rock of this batholith, is sufficiently accurate for ordinary usage, though in a strict petrographic sense the rock is usually not a granite. In this paper the term "granite" is used for a coarse-grained plutonic rock consisting of quartz and orthoclase feldspar; "diorite" for a rock of similar physical character which may or may not contain quartz but contains plagioclase feldspar; "granodiorite" for the intermediate type which contains orthoclase and plagioclase feldspar in approximately equal amounts. In each rock the additional biotite, hornblende, and common accessory minerals are assumed. Granodiorite is then, as the word itself at once suggests, intermediate between granite and diorite. "Monzonite" has been used for the intermediate type but is not so directly expressive. This usage does not conform to that proposed by Waldemar Lindgren (Granodiorite and other intermediate rocks: Am. Jour. Sci., 4th ser., vol. 9, pp. 269-282, 1900) and J. P. Iddings (Igneous rocks, vol. 2, pp. 43, 152, New York, 1913), but it is easier to apply and, for present purposes, less confusing. In the following pages "granite" is sometimes used in the general sense in referring to the rock of the batholith as a whole. It is clear from the context when the term is so used and when it is used in the narrower petrographic sense with reference to the particular composition of a part of the body.

dike or a part of the main granite mass. The difficulty is the greater because identical porphyritic intrusive rocks occur within the area of the granite itself. The whole situation is still further complicated by local shearing, which has changed both granite and dikes to gneissoid and even schistose facies. Even along Salmon River below Elevenmile, where numerous cuts have been made in road construction, it was impossible to locate the exact contact.

Although the rocks of the batholith have a broad conformity of composition and occurrence that justifies their being mapped and described as a unit, yet there are certain local variations that merit attention.

From Mount Dolly south to Hyder the intrusive is a uniform light-colored medium-grained massive rock, specked with small black grains of biotite and hornblende. The rock varies in composition; some of it is granite, but on the whole it is best described as granodiorite. Some darker streaks and patches (schlieren) occur, as well as dikes of white aplitic granite. The contact with the greenstone across Mount Dolly is perfectly sharp, and very few dikes from the granite cut into the earlier rocks. Pegmatite dikes are practically lacking; and in this respect the east margin of the batholith stands in marked contrast with the west margin.

The intrusive north of Fish Creek, especially toward the greenstone contact, is a much more varied rock than that about Hyder. The commonest type, itself rather variable structurally, is a greenish-gray medium-dark rock of medium to fine grain. It usually shows abundant black blades of altered hornblende as much as 1 centimeter in length, which in some places lie variously oriented in a common plane. It may be called a quartz-hornblende diorite.

There are some variations from this type. Locally orthoclase occurs in porphyritic crystals 1 or even 2 centimeters in length, and the rock becomes a granodiorite porphyry.

Farther north, in the valley of Texas Glacier and west of Salmon Glacier, a lighter rock prevails, resembling that about Hyder. Along the glacier tributary to Salmon Glacier south of station 6535 (fig. 1) it is a light medium-grained granodiorite. In the valley of Texas Glacier a similar rock is found, both in dikes cutting the darker granite and as abundant boulders brought down from the granite area farther west. This rock is normally porphyritic and is a granodiorite porphyry. These porphyritic varieties of the granite form a transition to the more distinct porphyries, which occur as dikes in the greenstone but which are found also within the granite area.

The west side of Salmon River south of Texas Creek was not visited on account of the practical impassability of the Salmon. From the east side of the river it appears to be an area of light granite quite like that about Hyder.

PORPHYRY DIKES.

Many porphyry dikes occur in the greenstone area, east of the granite contact to and beyond the international boundary. These rocks range in color from light to medium gray, and some are dark gray. They usually show small prisms of hornblende and flakes of biotite against a white ground of feldspar. Feldspar phenocrysts are hardly noticeable in the lighter varieties but become more conspicuous in the darker rocks.

These porphyritic dike rocks, genetically associated with the Coast Range batholith, are intermediate in structure between the deep-seated granitic intrusive rocks and extrusive lavas. For example, one having the mineral composition of a diorite or andesite might be equally well named an andesite porphyry or a diorite porphyry. As they occur in the field with dioritic and granitic rocks, the several varieties of rocks noted can properly be classed as granite porphyry, granodiorite porphyry, and diorite porphyry.

Over a dozen large dikes with a maximum width of 1,200 feet are exposed along the Salmon River road between Texas Creek and the boundary. To judge from their contacts with the greenstone, these dikes strike from 50° to 70° NW. and dip 50°–60° SW. They are more resistant to weathering than the greenstones, so that in the timber and even for some distance above timber line the softer greenstones are largely concealed and the porphyries seem more abundant than they really are. As they closely resemble the granites, it is impossible to draw the granite-greenstone boundary accurately.

Dikes of the same character as those found in greenstone also occur within the main granite area. Boulders from them are among the most abundant rocks brought down by the Texas Glacier, and they cut the less porphyritic granites along the lower 2 miles of its course. They were also found in the granite exposed along the road south of Ninemile, where the more basic varieties are diorite porphyries showing conspicuous but small plagioclase phenocrysts, in striking contrast to a gray-black ground.

The dike porphyries described above agree in character and in range of mineral composition with the nonporphyritic granitic intrusive rocks of the batholith, which themselves locally have porphyritic facies. In the greenstone area the borders of the dikes show but slight structural evidences of chilling. In many places where identical rocks occur within the main granite area they are in dike form, and it is sometimes possible to see a distinct contact between them and the adjacent granite. On the other hand, there are many places where the porphyries grade into the adjoining nonporphyritic rock and it is impossible to fix a definite contact. These relations may best be explained on the assumption that the porphyries are an essential part of the granite intrusion following closely the formation of the main batholith. They represent slightly differentiated magmas intruded into both the greenstones and the earlier-formed granite. In the greenstones the invaded rocks were under considerable cover and perhaps were warmed by the adjoining granite, so that there was but little border chilling of the dikes. They came into the granite at a time when it was still hot, perhaps not completely solidified; hence the lack of sharp contacts in many places. The border granite is thus not simple but a rather complex intrusive body, ranging from a granodiorite or even from a rock closely approaching a granite to a diorite and structurally from a massive granitoid rock to a porphyry. The presence of these porphyries and the tendency of even the earlier massive granites to grade into porphyritic facies suggests that the cover was not very thick. This complexity is not, however, characteristic of the granite about Hyder.

ORE DEPOSITS.

CLASSIFICATION.

Both O'Neill [7] and Chapin [8] have classified the ore bodies of the Salmon River region as of two general types—disseminated deposits of low metallic content and quartz veins containing shoots of very high-grade ore.

The disseminated deposits lie in shear zones, in places without well-defined walls, and are described by O'Neill as "large deposits of ore which is a complex mixture of zinc blende, galena, chalcopyrite, and pyrite." He cites the Big Missouri property as containing examples of deposits of this type. Of the concentrated ore bodies occurring as fairly well defined fissures, that of the Premier mine, on the Canadian side of the boundary, is the best example. In view of the local interest in the Premier mine, it will be worth while to quote O'Neill's description of two specimens of ore from this property: [9]

> Pyrite, sphalerite, probably galena, and pyrargyrite are disseminated in a gangue of mixed quartz and calcite. The pyrargyrite is abundant.
>
> Pyrite, sphalerite, pyrargyrite, a little pyrargyrite with the pyrite, zinc blende, and probably galena in a gangue of quartz. I saw no calcite in this specimen.
>
> Qualitative tests on both samples showed the presence of lead, indicating galena. The soft black mineral gave much copper and antimony, with silver, indicating freibergite.

Of the occurrence of these deposits O'Neill says:

> The general regional shearing is not uniformly distributed but is concentrated in zones. Where the northwest or northeast ore-bearing veins cross such zones or where they cross one another there is an enrichment of the deposit in the form of native

[7] O'Neill, J. J., Salmon River district, Portland Canal mining division, B. C.: Canada Geol. Survey Summary Rept. for 1919, pp. 10b–bb, 1920.

[8] Chapin, Theodore, Mining developments in southeastern Alaska: U. S. Geol. Survey Bull. 480, p. 98, 1916.

[9] Op. cit., p. 10b.

silver. In some places a series of the later fissures cross a main zone at relatively close intervals, and the enrichment is spread along the zone between them. * * * Where the main zone of fissuring is wide, as on the Premier, and the cross fissures are strong, considerable amounts of very rich ore have been developed across most of the width of the main zone along the cross fissures and has spread along between the cross fissures.

Scofield and Hanson in their recent report[9a] have classified the ore bodies of the Canadian Salmon River district as follows:

1. Base-metal type: These are replacement and disseminated deposits in certain beds of tuffs and conglomerates, with some veins carrying base metals. "These deposits are roughly tabular, as they correspond in strike and dip with the beds with which they are associated." They carry pyrite, chalcopyrite, sphalerite, and galena, with a gangue of quartz.

2. Silver-gold type: "The ores of this type occur in veins and veinlike replacements in quartz porphyry and at the contact of the porphyry and tuffs. The large ore-chutes [shoots?] are lenticular in shape. The minerals present are pyrite, chalcopyrite, sphalerite, galena, tetrahedrite, freibergite, pyrargyrite, and sulphantimonides and sulpharsenides, native silver, and gold. The gangue is rather abundant and is almost entirely quartz." The Premier ore body is cited as an example of this type.

3. Gold type: "A single ore body in No. 2 tunnel of the Premier mine is of this type. This is a siliceous heavy-sulphide deposit. Quartz and pyrite are the predominant minerals. Small quantities of chalcopyrite, sphalerite, and galena are present. Assays show high value in gold, but practically no silver."

The above descriptions refer to the ore deposits on the Canadian side of the boundary. The following types have been found on the Alaska side:

1. Disseminated replacement deposits of galena, sphalerite, and pyrite, mainly in the greenstones. Example, the deposits now being opened on the New Alaska property.

2. Disseminated and lenticular replacement deposits of pyrrhotite, with minor amounts of chalcopyrite and pyrite and a very little sphalerite, in the greenstone. Example, the pyrrhotite deposits on the New Alaska property just above Elevenmile and that on the east side of the Fish Creek Mining Co.'s property, on Fish Creek.

3. Quartz fissure veins carrying pyrite, galena, sphalerite, and locally tetrahedrite and a little chalcopyrite. In places barite is associated with quartz as a gangue mineral. Nearly all the quartz veins occur in the granitic rocks. Examples, the veins on Fish Creek and near Sevenmile on Salmon River.

[9a] Op. cit., pp. 9a–12a.

Up to the present time most of the underground work has been done on the quartz fissure veins, some of which include shoots carrying much gold and silver. These quartz veins strike N. 30°–60° W. Relatively few extensive openings have been made on the disseminated deposits, which appear to trend N. 70°–80° E.

RELATION OF ORE DEPOSITS TO THE GRANITE BATHOLITH.

The Salmon River ore deposits are close to the edge of the great area of granitic rock which follows the west coast, and this position they share with all the metalliferous lodes of southeastern Alaska. Such border deposits are not limited to either side of the batholith, nor are they of any one metal. The copper deposits in the Alexander Archipelago and the gold and sllver lodes from Ketchikan north are close to either the west side of the main body of granitic rock or to the smaller intrusions that lie outside that body and still farther west. The ore deposits of Salmon River are in a corresponding position near the east edge of the batholith. The contact farther north is in Canadian territory, but metal deposits of different kinds have been reported near it.

This relation is essential, not accidental. The deposits border the batholith because the metals which they carry were derived from the igneous rock while it was still hot.

DISTRIBUTION.

The disseminated deposits are practically limited to the greenstones. The only exception noted was the deposit of disseminated sulphides of the first type on the Charles claim, on the east side of Texas Creek, which are in sheared porphyry and granodiorite of the batholith. The quartz veins are practically confined to the granite area, though in one place (locality 8, fig. 3, Fish Creek Mining Co.) a quartz vein carrying sulphides occurs in the greenstone. The reason for this practical limitation of the quartz veins to the granite and of the disseminated deposits to the greenstones is believed to lie in the nature of the inclosing rock. The softer greenstones, at the prospects mainly altered tuffs, are thought incapable of retaining open fissures, so that in them the deposit was formed by replacement along shear zones. The granite seems to have been firmer and able to retain open fissures, hence it holds the typical veins. At the depth of the deposits at the time of their formation the granite was in the zone of fracture, and the greenstone in the zone of flowage.

ORIGIN.

These deposits occur in the greenstone near the granite batholith and even in the outer part of the batholith itself because they were formed by solutions escaping from the still hot granite magma through the solidified border of the granite and into the surrounding greenstones. The common association of mineral deposits with the east edge of the batholith has long since been pointed out by Brooks.[10] McConnell,[11] without question, explains the Canadian occurrence just across the international boundary in the same way. If this is their origin, their time of formation is fixed as soon after the intrusion of the granite, probably in the Cretaceous period.

The deposits are believed to have been formed at considerable depths beneath the surface of that time and to be what Lindgren [12] has styled deposits formed at intermediate depths, by which he means at depths between 4,000 and 12,000 feet below the surface and at temperatures of 175° to 300° F. The present exposures are all less than 2,900 feet above sea level. The higher summits of the area rise to more than 6,000 feet. The Cascade peneplain has not been recognized in this district; if, however, as is likely, the rough accordance of summit levels is due to the former presence of a plain near that level, the highest of the present depo its would have been nearly half a mile below that surface. But these summits west of the Salmon are in granite, well beneath the top of the batholith; moreover, above the batholith there must have been a cover of the invaded rocks. The field relations suggest, though they do not demonstrate, that the deposits may well have been formed at a depth of more than a mile below the surface of that time. Further, the sulphides present (galena, chalcopyrite, sphalerite, and pyrrhotite) are those found in deposits formed at considerable depths. If these deposits were formed at the depth inferred it is easy to see why the softer greenstones should have been, as suggested above, below the zone of open fracture, even if the harder granites were not.

The deposits are primary sulphides laid down by solutions rising from a granitic magma. In the quartz veins and the disseminated deposits of the first type the sulphides are essentially contemporaneous. In the pyrrhotite deposits the pyrite and arsenopyrite are followed by the pyrrhotite, galena, and sphalerite, but even here the mineralization belongs to one general period. There is no evidence whatever of any enrichment by descending solutions, so that no marked change in depth is to be expected.[13] Further, there is almost no surface weathering. Here and there traces of malachite and limonite occur and the rock is slightly porous owing to the removal by solution of the more soluble constituents, but this is at the immediate surface.

---

[10] Brooks, A. H., Geologic features of Alaskan metalliferous lodes: U. S. Geol. Survey Bull. 480, pp. 44-74, 1910.

[11] Op. cit., p. 24.

[12] Lindgren, Waldemar, Mineral deposits, 2d ed., p. 546, 1919.

[13] It should be noted, however, that Scofield and Hanson (op. cit., p. 11a) believe that the native silver found in some of the ores of the Premier mine is of secondary origin. No such occurrences have been found on the Alaska side of the boundary.

OUTLOOK FOR PRODUCTION.

No productive mine has yet been developed in the American part of the Salmon River basin, and only one (Premier) on high-grade silver ores in the Canadian part. The low-grade disseminated sulphide ores on the Canadian side have not yet been successfully worked. On the American side the only considerable underground workings are on Fish Creek. It is therefore impossible to make any predictions of the future of the district. The following considerations, however, will help to indicate where deposits are likely to be found and what changes in depth are likely to have taken place.

All the American prospects and properties lie east of Salmon River and Texas Creek, and the best are either in the greenstones or in the granite near its contact. The most promising of those opened up are the New Alaska disseminated deposits in the greenstones above Elevenmile and the quartz veins on Fish Creek. From the Fish Creek Mining Co.'s property small amounts of high-grade silver ore have already been shipped. Workable deposits may yet be found in the granite west of Salmon River and Texas Creek, but the evident igneous origin of the ores and the development of prospecting and mining in the region to date suggest that paying properties are most likely to be found in the greenstones or in the granite near its contact, and that they will become increasingly improbable toward the west, in the granite..

If, as has been pointed out, the deposits are primary sulphides and show no changes due to weathering or downward enrichment,[14] whatever change in depth they show must be the result of irregularities of original deposition. The deposits can be followed downward in the belief that they will average as well in depth as at the surface, at least for considerable distances.

MINING PROPERTIES.

STONER.

H. B. Stoner has twelve claims (see figs. 1 and 2), which lie three abreast adjacent to the international line on Boundary Creek and extend from the wagon road at Salmon River to timber line. Shallow cuts have been made at several places. The owner reports small returns from a silicified and pyrrhotized porphyry at the point marked "A" in figure 2. About 200 feet to the northeast there is an opening in slightly pyrrhotized greenstone. A second opening (B, fig. 2) has been made at an elevation of 960 feet, in fractured greenstone, a greenish-gray, very fine grained calcareous rock, without banding, carrying minute grains of pyrite. Sulphides occur in the greenstone in irregular streaks, some mainly sphalerite, others galena and pyrite. The former are reported to carry a little zinc

[14] See footnote 13, p. 130.

and silver and a trace of gold; the latter to assay a little gold, 20.5 ounces of silver to the ton, and 28 per cent of lead, the total value reaching $48.90 a ton.

NEW ALASKA MINING CO.

The New Alaska property (see figs. 1 and 2) includes a group of eight claims which lie west of the Stoner claims and extend from the flat of Salmon River at Elevenmile (elevation 350 feet) southeastward up the slope to an elevation of 1,800 feet. The first claims were located in 1912–13, and intensive work on the property began in 1919.

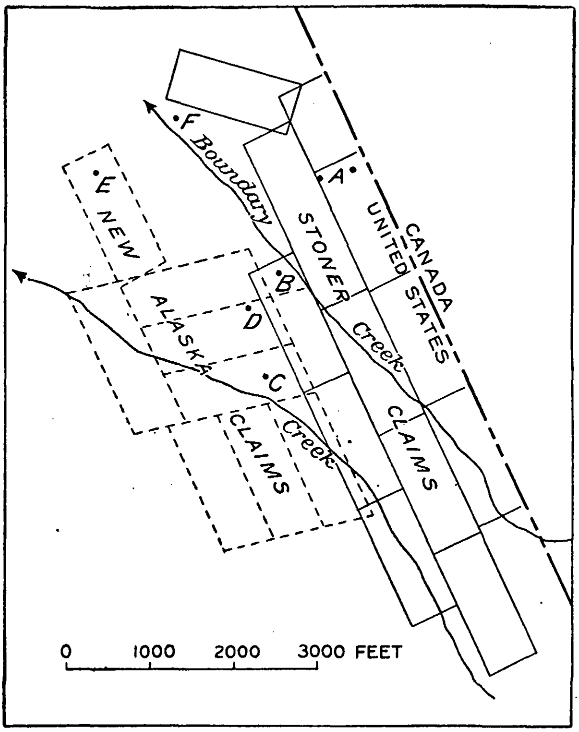

FIGURE 2.—Sketch map of Stoner and New Alaska properties, Salmon River district. See text for explanation of letters.

The main work has been done at an elevation of about 1,350 feet, on a ridge bearing N. 70° E. (fig. 2, C). A number of shallow cuts have been made, and a tunnel has been driven 114 feet across the strike of the rocks.

The country rock is a typical greenstone, probably an altered tuff or lava, and has much the same character at the different openings. It is a greenish-gray, rather soft, commonly calcareous, very fine grained rock, showing many small grains and crystals of pyrite. Hand specimens are cut by fine veins and patches of more coarsely crystalline calcite. An indistinct banded or bedded structure at some of the openings, which is perhaps a secondary structure, shows a strike between N. 45° E. and N. 80° E. and a steep dip to the northwest. The general trend of the mineralized belt is about N. 70° E., parallel to the course of the ridge. At many places the rock is shattered and broken.

Two kinds of mineral deposits occur on this property; one carries sphalerite, galena, and pyrite, and the other chiefly pyrrhotite. Only those of the first type are being developed. They lie in a system of fracturing, in which certain zones are richer in sphalerite, galena, pyrite, with a very little chalcopyrite, than the others. These richer zones carry gold and silver. The greenstone lying within the zone of fracture is lighter colored than the normal country rock and carries a large amount of introduced silica and calcite. The difference between ore and country rock is a difference in the degree and kind of mineralization. There are no well-defined walls to the deposits, and the richer portions grade into the country rock. The introduction of the sulphides and silica seems to have been contemporaneous.

The best exposure is at the tunnel, which has been carried 114 feet in a direction N. 23° W., at right angles to the trend of the structure. For the first 50 feet from the portal the rock is a light greenish-gray fine-grained rock, here more siliceous, there more calcareous, and everywhere somewhat pyritized. Then follows 27 feet of a similar rock containing bands and patches of sulphides (sphalerite, galena, and pyrite). This is followed in turn by 15 feet of less mineralized rock and 10 feet of mineralized rock. The remainder of the tunnel is in barren rock, like that at the entrance. The rock structure at the entrance strikes N. 80° E. and has a nearly vertical dip, and the indistinct banding farther in agrees with this attitude.

The Hoosier prospect (D, fig. 2), north of the present workings and 350 feet lower, is on a different greenstone belt but repeats the conditions, both of country rock and ore, already described. A 10-foot opening has been made on a silicified greenstone. No well-defined structure was noted in the country rock, nor any distinction between vein and wall. Some of the silicified rock carries the usual sulphides.

The disseminated pyrrhotite ores of the second type are encountered in going north-northeastward from the present workings toward Elevenmile. In the upper part of this traverse there are several small exposures in which the greenstone carries a little pyrrhotite, pyrite, and galena, and at one of these exposures a 10-foot tunnel has been driven from which several hundred dollars' worth of ore is reported to have been mined. Near the bottom of the hill, not more than 200 feet above the river, two openings expose small bodies of pyrrhotite in the fine-grained greenstone. A thin section of the leaner ore shows irregular areas of pyrrhotite, a little sphalerite, and a very little chalcopyrite in a ground consisting mainly of quartz and sericite, with lesser amounts of chlorite and zoisite. A polished section of the massive pyrrhotite showed pyrrhotite and a very little chalcopyrite. The pyrrhotite is veined throughout by a fine network of later pyrite. Some pyrite occurs in the hand specimens. The pyrrhotite bodies have not been seriously worked. The indefinite banding of the country rock trends between northeast and east.

FISH CREEK MINING CO.

The Fish Creek Mining Co. controls 17 claims (see figs. 1 and 3), which lie mainly on the ridge between Fish Creek and Skookum Creek but extend to either side of these creeks, particularly west of Skookum Creek. Patents have been applied for on three of the claims—the Starboard, Olympia, and Nevada. The property was acquired by the present company in 1909, and more work has been done on it than on any other in the district. It is reported that 16 tons of high-grade ore was shipped in 1916–17.

The contact between granite and greenstone crosses the property in a direction a little west of north. Most of the openings are in rock that is more or less clearly recognized as belonging to the granite. One representative specimen obtained west of Skookum Creek is a granodiorite, showing quartz, plagioclase in excess of orthoclase, biotite much in excess of hornblende, though both had gone over completely to secondary minerals (chlorite, calcite, epidote, and quartz), and accessory apatite and magnetite. Nearer the veins the original character of the country rock is in many places masked by shearing and mineralizaton. The typical greenstone occurs on the east side of the property. All the quartz veins examined, except that at locality 8 (fig. 3), seem to be in granitic country rock. At locality 8 the rock is a slaty rock, which is more properly placed in the Bear River formation.

Ore bodies of two types occur in this group of claims—(1) quartz veins which carry galena, sphalerite, tetrahedrite, chalcopyrite, and pyrite, and (2) lenticular bodies of pyrrhotite, with small amounts of chalcopyrite and pyrite. So far as yet determined the quartz veins alone are of value.

Most of the underground work so far done on the property is on the Starboard and Olympia claims, where there are a series of quartz veins striking about N. 40° W. and dipping 45°–70° NE. Two tunnels have been driven on a well-defined vein on the Starboard claim. At the portal of the upper tunnel the vein measures 27 inches in width, strikes N. 40° W., and dips 70° NE. At an opening made on the hill slope a little above the tunnel the vein dips 80° SW., the only exception noted to the general northeasterly dip. The upper tunnel has been driven about 50 feet, but the vein has not been definitely recognized throughout this distance, and it is possible that the tunnel does not follow the vein throughout its length. The vein can be traced from the upper tunnel to Skookum Creek, a distance of about 400 feet. Near the creek it has been opened by a 40-foot tunnel, in which it strikes N. 35° W. and dips 65° NE.

The quartz vein contains galena, pyrite, and tetrahedrite, with some sphalerite and chalcopyrite, and shows a little copper stain (malachite). A polished section shows tetrahedrite, galena, and a

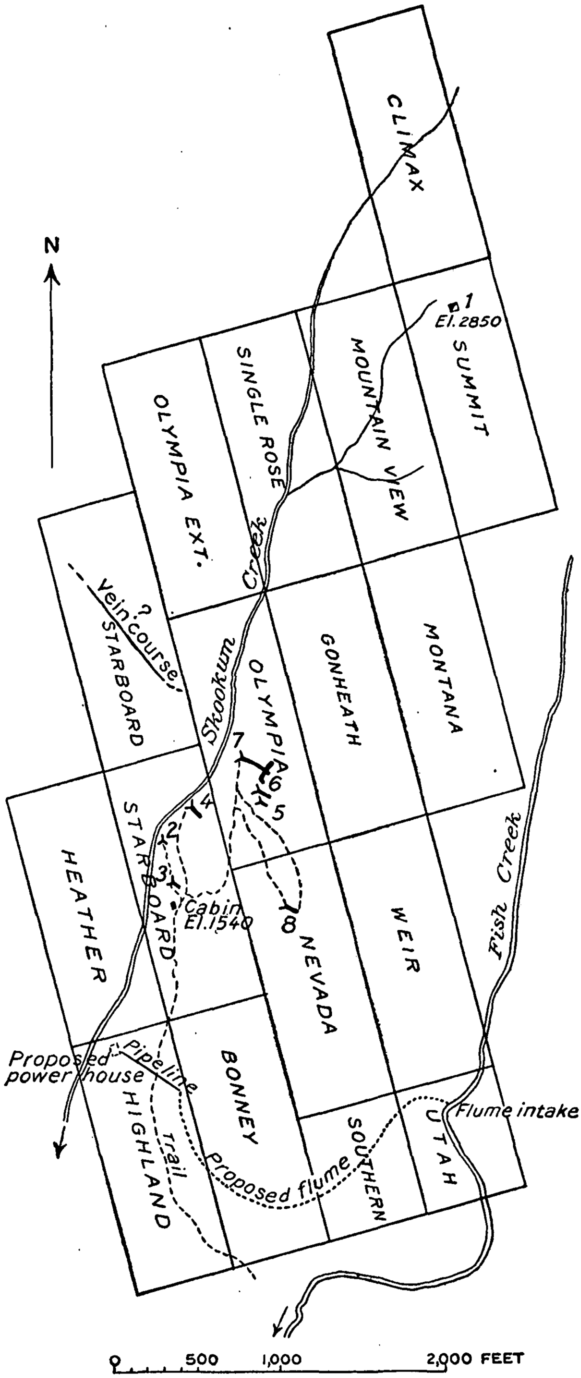

FIGURE 3.—Sketch map of Fish Creek Mining Co.'s properties, Salmon River district. See text for explanation of numbers.

little sphalerite and chalcopyrite, with no evidence of any notable difference in time of introduction of the minerals. The country rock is a sheeted porphyry with some slaty rock which bears N. 65° E. and dips 80° NW.

At locality 4, also on the Starboard claim, a 75-foot tunnel has been run in on a vein which at the entrance strikes N. 60° W., dips 65° E., and has a thickness of 3 feet 9 inches, with well-marked hanging and foot walls against broken granite. It can be followed, though not as a single vein, to the face of the tunnel and can be traced northwestward across Skookum Creek. The minerals it carries are galena, tetrahedrite, pyrite, and some chalcopyrite and sphalerite.

On the Olympia claim there are two tunnels on the same vein at localities 5 and 6. The upper one goes in 100 feet in a direction S. 55° E., to a point where the vein is lost by a fault. The strike of the fault is N. 30° E., and the dip about vertical. The lower tunnel does not go in far enough to reach the fault. The vein at the mouth of the upper tunnel is 19 inches wide, strikes N. 30° W., and dips 45° NE. The ore shows galena, tetrahedrite, sphalerite, a little chalcopyrite, pyrite, and some iron and copper (malachite) stain. Two polished specimens of the ore show tetrahedrite, with some sphalerite and pyrite and a very little chalcopyrite, in irregular areas cutting quartz. The sulphides are essentially contemporaneous.

At locality 7, on the Olympia claim, the longest tunnel on the property goes in on the vein 240 feet, to a point where the vein is cut off by a fault that strikes N. 30° E. and dips 60° NW. Drifts have been driven parallel to the fault in both directions, but the vein has not been recovered, unless a composite vein, offset about 50 feet to the southwest, is its continuation. The work had not been carried far enough to demonstrate this. From the mouth of the tunnel the vein can be followed on the surface northward perhaps 30 feet, to a point where it is cut out by a fault and broken zone that seems to have much the same direction as that at the face of the tunnel. The vein system in this part of the property is thus cut by a series of faults which run N. 30° E. and dip steeply northwest. As the rock is a massive granite or granite porphyry, it is very difficult to determine the direction and amount of displacement. This would be possible only if some of the veins could be identified on the opposite sides of the fault plane, and that has not yet been done.

The ore minerals of the vein are galena, tetrahedrite, and some pyrite. Rich specimens of the tetrahedrite ore have been found. A large specimen of high-grade ore is reported to have given 0.84 ounce of gold and 598 ounces of silver to the ton.

At locality 8 some tunnels, now caved, have been run on a quartz vein which strikes N. 70° W. and dips 55° NE. Pieces of good ore were found in the dump.

The following figures are taken from assay reports furnished by the company, representing lots of ore ranging from half a ton to 5 tons taken from tunnels on the Starboard and Olympia claims and shipped to the Tacoma Smelting Co. in 1916 and 1917.

Assays of ore from Starboard and Olympia claims.

	Gold (ounces to the ton).	Silver (ounces to the ton).	Lead (per cent).	Copper (per cent).
1	0.40	376	32.40	3.30
2	.21	161.14	18.30	1.96
3	.37	316.32	38.90	3.08
4	.15	110.36	32.50	Trace.
5	.18	103.36	a 1.51	a 21.4
6	.90	706.67	a 7.68	a 32.20
7	.30	205.40	a 13.9	a 17.40

a The copper and lead are apparently reversed in the smelter report of Nos. 5 and 6 and probably No. 7.

On the Olympia Extension a quartz vein bearing N. 50° W. has been opened by trenching for 600 feet. It shows an average width of 3 feet. The following assays were kindly furnished by the company:

Assays of ore from vein on Olympia Extension claim.

	Gold (ounces to the ton).	Silver (ounces to the ton).	Lead (per cent).	Copper (per cent).
1	Trace.	3	6.5	Trace.
2	0.36	12	....	....
3	.46	118.5	13	2
4	1.42	94.8	....	....
5	.92	72.5	14.5	2
6	1.60	23.6	....	....
7	.32	4.4	2.5	Trace.

Four additional assays of samples from the same vein show gold, 0.52, 2.10, 1.20, and 0.42 ounces to the ton, and silver, 38.20, 177.90, 166.80, and 114.48 ounces to the ton.

The assays quoted above indicate the presence of high-grade silver ores, the value of which may be enhanced to some considerable extent by gold and copper.

A body of pyrrhotite occurs on the Summit claim (locality 1, fig. 3), on the east side of the property and near its north end. Here the country rock is a greenish-gray fine-grained greenstone marked by veins of calcite and abundant small crystals of pyrite. The microscope shows it to be composed almost wholly of secondary minerals, chiefly quartz and sericite. Abundant chlorite and calcite occur along seams, with leucoxene, pyrite crystals, and a little fine-grained orthoclase. A few large rounded quartz grains resemble the phenocrysts in rhyolite and suggest that the original rock may have been a quartz porphyry. An indistinct bedding bears N. 70° E. and is nearly vertical. In this greenstone are masses of almost pure pyrrhotite. The largest measures about 5 by 12 feet at the surface and stands 6 feet above the water level in a shaft that was sunk in all 10 feet without reaching the bottom of the pyrrhotite. With the pyrrhotite there is a little chalcopyrite and quartz. A polished section of the ore shows mainly pyrrhotite, with small amounts of pyrite, arsenopyrite, chalcopyrite, and a little gangue, mainly quartz. The order of mineral formation seems to be pyrite, arsenopyrite, quartz, pyrrhotite, and chalcopyrite, the last two essentially contemporaneous. A polished section of the immediately adjoining country rock, which contains abundant sulphides, shows mainly quartz and some arsenopyrite, irregularly cut by pyrrhotite, finely veined by later pyrite, and chalcopyrite. The arsenopyrite appears to have been fractured before the introduction of the quartz and other sulphides. An assay of samples from this body was reported by the owner to give gold, 0.36 ounce to the ton; silver, 4 ounces to the ton; copper, 2 per cent.

WATSON & BAIN.

The Watson & Bain property includes five claims (No. 3, fig. 1) in lower Fish Creek valley, owned by John Hoveland and leased in July, 1920, by Hugh Watson and J. B. Bain. A sixth claim, owned by Pete Low, is included, and Mr. Low has an interest in the operation of the property. In August, 1920, work was on the point of being resumed by the lessees. The claims lie mainly between Fish and Skookum creeks, though they extend west of Skookum Creek and east of Fish Creek, as well as along Fish Creek below Skookum Creek. Three openings have been made.

On Fish Creek No. 1 claim two tunnels have been driven on a quartz vein that strikes N. 60° W. and dips 60°–70° NE. The country rock is a broken, sheared, and in places schistose rock of fine grain and undetermined origin. It may be either an inclusion of the greenstone in the granite or a zone of shearing in the granite or granite porphyry itself. The two tunnels are about 75 feet apart vertically; the upper one is 50 feet in length, and the lower one 90 feet. The vein is irregular and of variable width; at the face of the upper tunnel it is 3 feet wide. It carries galena and some pyrite in a gangue of quartz, and some specimens show free gold. Selected samples have shown a high content of gold and silver.

On Fish Creek No. 2 claim a vein bearing N. 50° W. and leading down to Skookum Creek has been opened at intervals for 500 feet. The country rock is a greenish granodiorite. It is massive at a distance from the vein, but near the vein it is broken and mashed and shows small grains of introduced pyrite. A thin section of the less-altered rock shows plagioclase, quartz, and accessory titanite, apatite, and magnetite, with secondary biotite, epidote, sericite, calcite, and chlorite. Fracturing of the rock and granulation of the mineral grains are conspicuous. At the upper opening there is one 1-foot quartz vein and several parallel veins 3 inches or less in width. Locally barite is an abundant vein mineral. The vein strikes N. 30° W. and dips 35° NE. The quartz holds scattered grains and stringers of pyrite. At 150 feet to the northwest the vein is 4 feet thick and contains pyrite, tetrahedrite, and a little copper stain (malachite). A polished section of the ore shows a gangue of quartz and barite cut irregularly by sulphides (tetrahedrite, with less amounts of pyrite, chalcopyrite, and a little sphalerite), which are essentially contemporaneous. Other openings trace the vein to Skookum Creek.

On the east side of Skookum Creek, just at its mouth, a quartz vein bears up the hill in a direction N. 23° E. and cuts an altered and somewhat pyritized greenish granitic rock. Just at the creek the vein is over 3 feet thick, strikes N. 30° E., and dips 45° SE. Farther northeast the dip is steeper; at the last point where it is opened by a shaft the strike is N. 45° E. and the dip 50° SE. The vein is here cut off by a fault, which strikes N. 15° E. and dips 85° NW. The vein at this point is 3 feet thick but splits below into two separated by a horse of country rock 1 foot wide. The ore is mainly on the footwall side. The vein carries galena. Assays of the lodes of this property are not available.

LINDEBORG.

D. & A. Lindeborg have claims east of the Salmon River road a little above Sevenmile (No. 5, fig. 1). These claims lie within the granite area, in a sheared granite porphyry. Two tunnels have been driven at different levels on a quartz vein that strikes N. 60° W. and dips 60° NE. The lower tunnel, 75 feet long, discloses a main quartz vein and some small parallel stringers of quartz in the adjacent country rock, particularly on the footwall side. The quartz carries pyrite and some galena and chalcopyrite; a little copper stain shows. A good deal of galena with some pyrite and a little chalcopyrite is found in the adjacent rock, especially on the hanging-wall side.

At the mouth of the upper tunnel a 3-foot vein of quartz is exposed. The hanging-wall half of the vein carries pyrite in fairly regular bands, some of them 3 to 4 inches thick. These general relations repeat those at the lower tunnel.

CHARLES, NELSON & PITCHER.

John Charles, Max Nelson, and Jim Pitcher hold claims on the east side of Texas Creek 2 miles above Salmon River (No. 6, fig. 1). The country rock is a greenish sheared facies of the granite porphyry of the granite area. It is cut by small quartz veins, but the sulphides (sphalerite, galena, pyrite, and chalcopyrite) do not occur in the veins but are disseminated in the silicified porphyry. Assays from an opening to the north and a little up the hill are reported to show small quantities of gold, silver, and copper. The country rock here is a granodiorite. The thin section shows plagioclase (oligoclase) in distinct crystals, quartz, orthoclase graphically intergrown with quartz, and biotite, wholly altered to secondary products, with secondary calcite, sericite, leucoxene, and quartz. Much calcite and some pyrite have been introduced.

MISCELLANEOUS PROSPECTS.

About a quarter of a mile south of the Ninemile roadhouse a 40-foot opening has been made along a broken zone in the granite. This opening exposes a quartz vein 6 to 8 inches thick, accompanied by small quartz veins in the crushed country rock. The lead bears N. 25° W. and dips 55° NE. Several prospectors were in the field in August, 1920, but no discoveries except those noted above are known to have been made.