NOTES ON THE SALMON-UNUK RIVER REGION.

Compiled by J. B. MERTIE, Jr.,

INTRODUCTION.

The Salmon-Unuk River region, in southeastern Alaska, is a trapeziform area of about 1,800 square miles, lying between parallels 55° 50' and 56° 30' north latitude and meridians 129° 50' and 131° 10' west longitude. The international boundary between Alaska and British Columbia, extending in a general northwesterly direction along the crest of the Coast Range, delimits the area on the northeast. This district is adjacent to tidewater, reaching Behm Canal on the southwest side and Portland Canal on the southeast side. On account of mining activity in the vicinity of Portland Canal, the southeastern part is referred to by Americans as the Portland Canal district and by Canadians as the Portland Canal mining division.

This portion of southeastern Alaska, along the international boundary and adjacent to the intrusive rocks on the Coast Range, has been recognized for years as favorable for the occurrence of mineral deposits, and in the last 22 years numerous more or less promising deposits have been discovered and located. The present renewal of public interest in this part of Alaska and British Columbia is due mainly to the recent successful development of some of these deposits at the head of Portland Canal, on the Canadian side of the boundary, and the promise which such development holds forth for the subsequent exploitation of similar deposits that lie along this same zone of mineralization.

A considerable amount of topographic and geologic work, both American and Canadian, has been done in this district and in the area adjoining it. The first and most essential preliminary requirement—that is, a topographic map—was prepared by the Canadian Boundary Commission in 1902, in connection with the accurate location of the international boundary; and in 1910 a topographic map of the Portland Canal mining area (map 50 A) was prepared by the Geological Survey of Canada. The later map covers mainly the area drained by Bear River, one of the headwater tributaries of Portland Canal. The accompanying base map (Pl. V) is compiled mainly from these two sources. A new map of this area is soon to be issued by the International Boundary Commission.

The principal publications by workers in the United States Geological Survey that have a bearing on the geology and mineralization of thO Salmon-Unuk River district are as follows, named in chronologic order.

Brooks, A. H., Preliminary report on the Ketchikan mining district, Alaska: U. S. Geol. Survey Prof. Paper 1, 1902.

Wright, F. E., The Unuk River mining region of British Columbia: Canada Geol. Survey Summary Rept. for 1905, Ottawa, 1906.

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

Chapin, Theodore, Mining developments in southeastern Alaska in 1915: U. S. Geol. Survey Bull. 642, pp. 94-98, 1916.

The Skeena and Portland Canal mining divisions include that part of the Salmon-Unuk River region that lies in British Columbia. Notes on the progress of mining in these divisions have been published annually for a number of years by the British Columbia Bureau ot Mines. The latest ot these reports dealing with the valley of Salmon River are as follows:

Clothier, G. A., Portland Canal mining division: British Columbia Bur. Mines Ann. Rept. for 1917, pp. F68–F73, 1918.

Jack, P. S., Portland Canal mining division: Idem, p. F84.

Clothier, G. A., Portland Canal mining division: Idem for 1918, pp. K80–K83, 1919.

Investigations have also been carried on by the Geological Survey of Canada in these mining divisions, and this work is still in progress. Four reports have so far been published, and a fifth is in course of publication. The published reports are as follows:

McConnell, R. G., Portland Canal district, British Columbia: Canada Geol. Swey Summary Rept. for 1909, pp. 59–89, 1910.

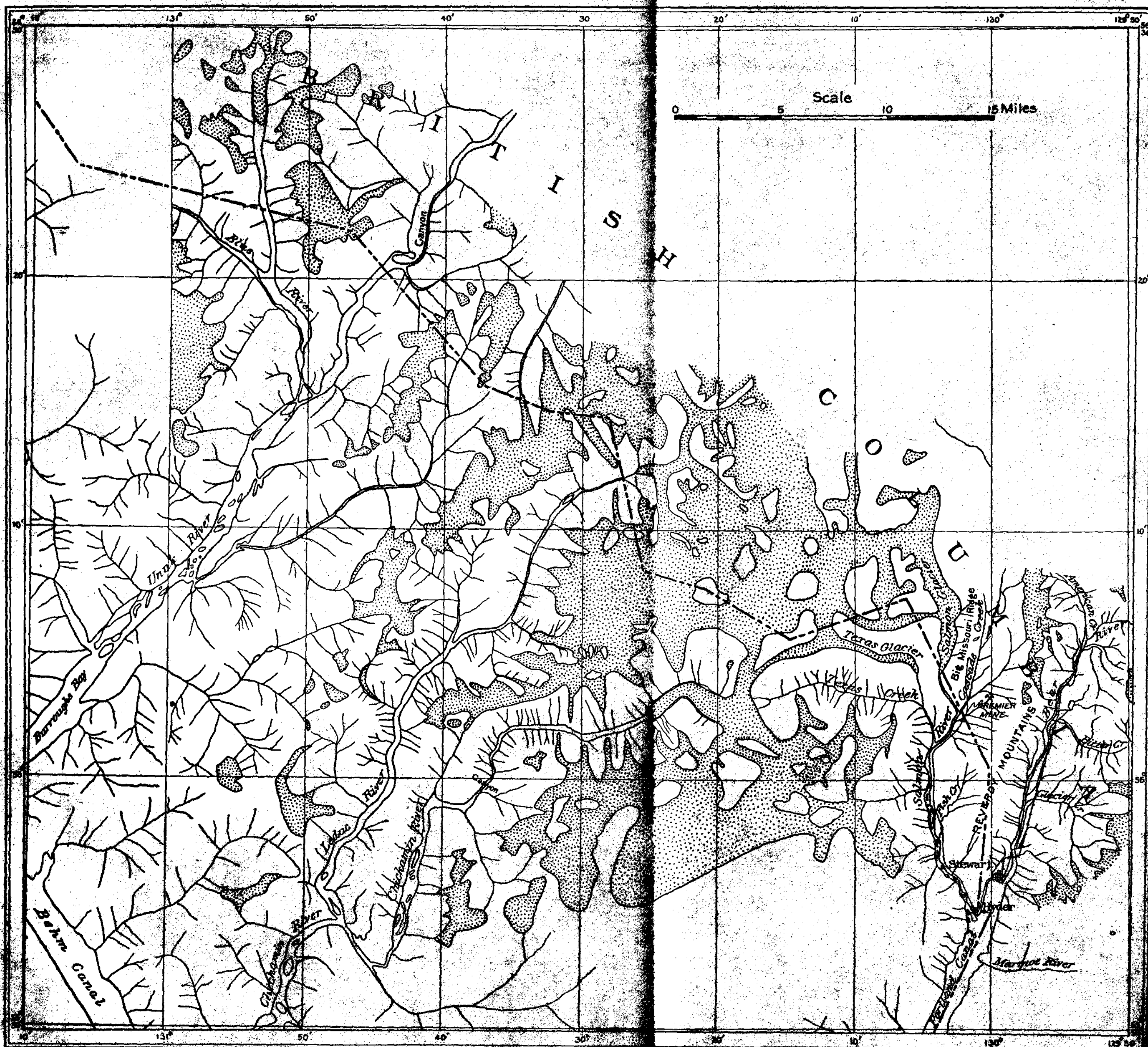
McConnell, R. G., Salmon River district, British Columbia: Idem for 1911, pp. 50–56, 1912.

McConnell, R. G., Portland Canal district, British Columbia: Idem, pp. 56–71.

McConnell, R. G., Portions of Portland Canal and Skeena mining divisions, Skeena districts, British Columbia: Canada Geol. Survey Mem. 32, 1913.

The last named of these four publications is essentially a compilation from the three earlier summary reports.

The present report represents no original work whatever on the part of the writer. It is essentially a brief compilation of the work of earlier American and Canadian workers, prepared to meet the demand for a statement of the available information on the area beginning at Portland Canal and extending northwestward. The only qualification of the writer for the preparation of such a statement is a general familiarity with the country gained by geologic field work in southeastern Alaska. The latest work by the United States Geological Survey was done in the Portland Canal district by Theodore Chapin in 1915, and his report is cited above.



From surveys by the International Boundary Commission

MAP OF SALMON-UNUK RIVER REGION.

PHYSICAL AND ECONOMIC GEOGRAPHY.

RELIEF.

The Salmon-Unuk River region belongs in large part to the Coast Range province of southeastern Alaska and is therefore an area of considerable relief. The area included in this report extends from tidewater at Behm and Portland canals to the crest of the Coast Range and therefore lies mainly in the western half of the Coast Range. The range in this area is about 100 miles wide and has rather poorly defined crest line. Many of the peaks of the range attain elevations of 6,000 to 9,000 feet, but within this area none exceed 8,000 feet. The mountain summits are more uniform in elevation in this western portion of the range, within the area of granitic rocks, than on the east side, where argillites and greenstones occur.

Some of the larger streams in this vicinity, such as Stikine, Nass, and Skeena rivers, cut completely through the Coast Range, and the smaller streams are in general deeply incised, resulting in the development of a marked relief. Thus Unuk River at the international boundary flows at an elevation of 600 feet above sea level, and a peak a short distance northwest rises to 6,200 feet. Similarly, Salmon and Bear rivers have their upper basins adjacent to mountains of 7,000 to 8,000 feet in elevation and reach tidewater within a distance of about 15 miles.

In addition to marked relief, this area is further characterized by very precipitous slopes, caused mainly by intense glaciation. The higher peaks are sharp and serrated, owing to crest-line sapping by the glaciers. Below 5,500 feet the hills were overridden by flowing ice and the crests are smooth and rounded, but the valley walls have been oversteepened by glacial scouring and are everywhere very precipitous and in places sheer, unscalable cliffs.

DRAINAGE.

The principal streams that drain this area, named in order from northwest to southeast, are Blue, Unuk, Leduc, Chickamin, Salmon, and Bear rivers. Of these, Blue River is tributary to the Unuk and Leduc River to the Chickamin. Unuk River enters Burroughs Bay, an inlet from Behm Canal, and Chickamin River enters Behm Canal. Salmon and Bear rivers enter Portland Canal at its head. Both Unuk and Chickamin rivers rise within the Coast Range and flow through more or less canyon-like valleys in their upper courses. In their lower courses, however, the valleys of these two streams broaden out and are characterized by wide, gravel-covered bottoms. At the head of Unuk River, about 60 miles from Burroughs Bay, a narrow divide leads over to a branch of Iskoot River, through the valley of which it is possible to enter the inland plateau of British Columbia.

Salmon and Bear rivers, though shorter than the Unuk and Chickamin, are of the same general character. Salmon River heads in Salmon Glacier and flows 13 miles to Portland Canal. Its principal tributaries are Texas Creek from the west and Cascade Creek from the north. Big Missouri Ridge, on which are some of the chief mining properties of the district, lies between Cascade Creek and Salmon Glacier, and Bear River Ridge is the divide between Bear and Salmon rivers.

Bear River is a swift mountain stream about 18 miles in length that enters the upper end of Portland Canal. It heads against Strohn Creek, a tributary of Nass River, in a low pass comparable with the pass at the head of Unuk River.

GLACIERS.

The upland areas of this region are covered with snow above an elevation of about 5,000 feet, and these snow fields form the reservoir or collecting ground for numerous glaciers that extend down into the valleys. At least one-fourth of the region here described is thus covered with snow and ice. The glaciers are of the valley or alpine type, and few of them extend far down into the valley bottoms. Practically all the major streams head against the terminals of these ice lobes. This present condition of alpine glaciation is an aftermath of the greater piedmont glaciers which at an earlier period covered all the mountains of this area and formed a continuous sheet of flowing ice that extended from sea level up to an elevation of about 5,500 feet.

CLIMATE.

This region has the characteristically wet climate of the western flank of the Coast Range, though the precipitation is not so great as at some other localities in southeastern Alaska, being probably about 100 inches a year. The summer climate is cool, with considerable rainfall, and the least precipitation occurs late in the spring and early in the summer. The winter climate is comparable with that of Juneau, and the thermometer seldom falls below zero. Snow falls in the valleys from November to March. Snowslides from the steep slopes are of common occurrence late in the winter and in the spring.

TIMBER AND VEGETATION.

The region is heavily forested up to an elevation of about 3,500 feet, and stunted timber grows in places 1,000 feet higher. In the valley bottoms, where the best timber is found for mining purposes, hemlock is the most abundant as well as the most valuable tree and furnishes good timber for mining and structural uses. Sitka spruce and cottonwood are also well represented in the valleys. Balsam and mountain hemlock are more abundant on the higher slopes. In

addition to trees, a thick mantle of other vegetation, including moss and brush of several varieties, covers the bedrock exposures, except at high altitudes and on unscalable cliffs. This mantle makes prospecting difficult and accounts in part for the slow development of the mining resources.

WATER POWER.

Water powers should be available at many localities in this region, owing to the large size and steep gradients of the streams. In summer, as is the general rule in an area of high precipitation, with streams fed by melting snow and ice, water is usually plentiful. In winter, however, the supply is much less, for the precipitation is in the form of snow, and glacial melting is at a minimum. Careful measurements of the minimum run-off in winter should precede the establishment of power plants. Two power plants have already been established in Canadian territory, on Glacier and Lydden creeks, tributaries of Bear River.

SETTLEMENTS.

The two important settlements are Stewart and Hyder, the former in Canadian and the latter in American territory. Stewart, the distributing point for the Canadian part of the mining district, is at the head of Portland Canal, at the mouth of and on the west side of Bear River. It had a population of about 250 people in the fall of 1919. Hyder, the American distributing point, is about 2 miles from Stewart, at the mouth of and on the east side of Salmon River. In the fall of 1919 it was said to consist of 30 to 40 houses and was supplied with a wharf.

MEANS OF COMMUNICATION.

Hyder and Stewart, being on tidewater, are connected by steamship and gas-boat service with Prince Rupert and Ketchikan. A railroad starting from Stewart has been built up Bear River for a distance of about 12 miles, and a wagon road has also been constructed up the Bear River valley. Another wagon road has been built up the east side of Salmon River from Hyder for 11 miles, and a trail continues up onto the ridge between Salmon Glacier and Cascade Creek as far as the Big Missouri mine, a distance from Hyder of about 20 miles. A good wagon road has been built from Elevenmile up to the Premier mine, a distance of 5 miles. Another good road connecting Stewart and Hyder is nearing completion. During the summer of 1920 a road will probably be built from Elevenmile up Big Missouri Ridge. The Salmon River road is the only feasible means of egress from the Canadian mining properties along the west side of Bear River and on Big Missouri Ridge.

Another means of entrance to this region is by way of Unuk River. In 1905 a wagon road was built up Unuk River for a dis-

tance of 42 miles to a mining prospect, but portions of the road are now washed oat.

GEOLOGY.

SALIENT FEATURES.

Little geologic work has been done in the American part of the Salmon-Unuk River region, chiefly because the rocks are mainly intrusive and afford little information regarding the geologic history of the region. On the Canadian side, however, a considerable amount of geologic study and mapping has been accomplished, chiefly by R. G. McConnell, of the Geological Survey of Canada, whose reports are listed on page 130. Subsequent work has been done by J. J. O'Neill, of the same organization, but the results of his investigations have not yet been published. The writer has merely compiled a condensed summary of the geology, so far as known at present.

The Coast Range batholith of granitic rocks is bordered on the east in the vicinity of Portland Canal by two series of sedimentary rocks, mainly of argillaceous character, between which lies a volcanic complex of massive and fragmental igneous rocks, usually of greenstone habit. All three of these formations are cut by intrusive rocks. At some localities Tertiary lavas are also present. Overlying the hard rocks are surficial deposits of alluvial, estuarine, and glacial origin. These six rock units, named in order from oldest to youngest, are the Bitter Creek formation, the Bear River formation, the Nass formation, the granitic rocks of the Coast Range, the Tertiary lavas, and the surficial deposits. The Bear River formation is a complex of volcanic rocks, in which has occurred the mineralization on Bear River and Big Missouri ridges, where mining developments are now progressing so rapidly.

BITTER CREEK FORMATION.

In the vicinity of Portland Canal the Bitter Creek formation is not known to occur west of Bear River, and therefore it will probably not be seen along the international boundary, where present mining interest centers. The formation consists mainly of argillite, which in places has developed a slaty cleavage, usually parallel with the original bedding planes. Some beds of much altered greenstone of tuffaceous origin and small nonpersistent beds of crystalline limestone are interstratified with the argillite at certain localities. This series of rocks as exposed east of Bear River dips southwestward under the other formations and is considered older. These rocks are either Paleozoic or Mesozoic; their exact age is not known. In the valleys of Glacier and Bitter creeks, eastern tributaries of Bear River, quartz veins and other mineralized zones are present in the Bitter Creek formation.

The upper 25 or 30 miles of Unuk River drains a schist-argillite belt, which begins about 4 miles upstream from the international boundary and is probably, at least in part, the equivalent of the Bitter Creek formation as known east of Bear River. It is likely that the schistose members in this belt have been developed by dynamic metamorphism caused by the intrusion of the Coast Range batholith. This belt of argillite appears to parallel the granite of the east from British Columbia to Skagway, and is characterized along its whole extent by the occurrence here and there of silver and gold bearing veins in the vicinity of the granitic rocks. Placer gold and lode deposits of silver, gold, and lead have been found in the upper valley of Unuk River, on the Canadian side of the boundary.

At least two narrow bands of schist cross Unuk River below the international boundary, and a somewhat wider band follows along the east side of Behm Canal. These schistose rocks are believed to represent metamorphosed phases of the sedimentary series of rocks east of the Coast Range batholith.

BEAR RIVER FORMATION.

Overlying the Bitter Creek formation is the Bear River formation, which crops out along the east side of Salmon River in Alaska and continues northeastward into British Columbia. This formation is the main country rock of the Salmon River valley, where a number of promising mining properties are situated. It is a complex made up chiefly of massive and tuffaceous volcanic rocks. The massive rocks are in general of andesitic nature and are called porphyrites. In general they are porphyritic, though this feature is not noticeable in all hand specimens, and they show a flow structure in many thin sections. Plagioclase feldspar in two generations is the chief constituent and is accompanied by subordinate amounts of augite or hornblende, iron oxides, and apatite. Secondary minerals, including chlorite, calcite, epidote, leucoxene, and hematite, are sufficiently common to impart to the rocks as a whole a greenstone habit. The fragmental rocks consist of tuff, volcanic breccias, and agglomerates and evidently indicate that sedimentation played a considerable part in the formation of this complex. This inference is further borne out by the presence of some thin intercalated beds of argillite.

Along the east side of Salmon Creek, in American territory, where this series of rocks abuts against the granite of the Coast Range, the greenstones are intensely sheared and metamorphosed and have developed into coarse greenish and grayish schists, in which the schistosity roughly parallels the greenstone-granite contact. The rocks dip steeply toward the granite, and in general the metamorphism increases in intensity in that direction.

NASS FORMATION.

Little need be said of the group of rocks that constitute the Nass formation, for they are not known to occur in Alaska and have not been found to be mineralized. Like the Bitter Creek formation, the Nass consists of a thick series of argillite, with some coarse clastic beds. In the upper Salmon River valley, within British Columbia, isolated bodies of such rocks overlie the Bear River formation.

GRANITIC ROCKS OF THE COAST RANGE.

The intrusive rocks that compose the Coast Range batholith range from granite to diorite and even to gabbro. Quartz-hornblende diorite, however, is the predominating type. The major part of the Salmon-Unuk River region is occupied by granitic rocks.

Within the central part of the granitic batholith the granite is of rather uniform texture, but at the edges, particularly along the west flank, variations are seen. Thus along the shores of Behm Canal pegmatite and aplite dikes form an intricate network of white strands at the edge of the granodiorite, and in the adjacent schist several generations of such dikes may be observed. At a distance this complex of granodiorite, schist, and dikes resembles a breccia. The granodiorite is also commonly gneissoid, and the included fragments of schist merge into rocks resembling basic differentiation products. As a result of this condition, brought about by intrusion at great depth, the contact between the granite and other country rock is indistinct in many places along the western flank of the batholith. This condition is less apparent along the eastern flank, although dike rocks are also present there.

The typical quartz-hornblende diorite of the Coast Range is composed essentially of plagioclase, feldspar, quartz, biotite, hornblende, and orthoclase, named in the order of abundance. Titanite, magnetite, and apatite are accessory minerals, and small amounts of seaondary products such as epidote, sericite, calcite, and chlorite also occur in the central part of the batholith.

These granitic rocks are the source of the mineralizing solutions that have produced the ore deposits in this district, but the methods of formation of the deposits have been devious, and the resulting ores show wide differences in location, character, extent, and mineral content. It is noticeable, however, that important mineralization does not appear to have occurred within the main batholith but was confined to the edges of the granitic rocks and the adjacent sedimentary rocks. This is due to the fact that the mineralizing solutions found their easiest upward course along the fractured zones near the contact. The practical importance of this generalization is that the best hope of finding ore deposits on the American side of the Unuk-

Salmon River district is along the east side of Salmon River, where the Bear River formation occurs.

TERTIARY BASALT.

The Tertiary basalts of this region are gray-green to black porphyritic rocks ranging in composition from basic andesite to normal basalt, composed essentially of plagioclase, pyroxene, and magnetite,, with a little olivine or quartz. Some alteration has taken place, but as a rule these rocks are very fresh in appearance. These beds of lava have been little disturbed since their formation and in most places lie almost horizontal. Some tuffaceous layers are interbedded with the lavas. Postglacial basaltic lavas are found in the lower valley of Blue River, just above its junction with the Unuk.

SURFICIAL DEPOSITS.

The surficial deposits are chiefly of three types, glacial, estuarine, and alluvial. The glacial deposits consist of till, glaciofluviatile material, and boulder clay, collected in deposits of many types. Estuarine deposits similar to those now being formed in the heads of the fiords are found on the hillsides at a height of 350 to 500 feet above the present sea level and point unmistakably to a postglacial uplift. Alluvial deposits composed of silt, sand, and gravel occur in the valleys and are due to aggradation by the present streams. Lacustrine deposits are also present in small areas.

MINERAL RESOURCES.

GENERAL LOCATION.

The mineralized zone of the Salmon-Unuk River region lies mainly along the east flank of the Coast Range granite batholith and is therefore largely in Canadian territory, except in the valley of Salmon River, at the head of Portland Canal. Prospecting and mining have been done at two general localities, one around the headwaters of Unuk River and the other at the head of Portland Canal, in the valleys of Salmon and Bear rivers. A zone of mineralization, however, lies along the east side of the granite batholith in British Columbia, and it is very likely that other mineral deposits will be found along this zone. It is significant that mineral deposits have been found at both the localities mentioned, which, as before pointed out, are the two natural passages through the range from the west in this particular district: The Portland Canal area is the more advantageously situated, for Portland Canal cuts completely through the granite and brings tidewater almost to the mines. The renewal of interest in mining in this district is due to the successful development of the Premier mine, and other properties of similar character

in the upper valley of Salmon Creek. Most of these properties are on the Canadian aide of the boundary, but it is not unlikely that others worth while will ultimately be located on the American side.

UNUK RIVER.

Placer gold was reported in the Canadian part of the Unuk Valley during the Cassiar excitement in the early seventies but received little attention. In the early eighties gold-bearing gravels were discovered on Sulphide Creek, and some placer gold was mined. Subsequent to the rush of 1898 lode deposits were located on Sulphide, Canon, and Bowlder creeks, tributaries of Unuk River, and on the North and South forks of the Unuk. On Sulphide Creek two quartz veins in particular were prospected—one a 2 to 8 inch vein of high-grade ore and the other a 20 to 30 foot vein of lower-grade ore. The high-grade ore from the narrow vein consisted chiefly of tetrahedrite (gray copper), pyrite, sphalerite, galena, and native silver. About 100 tons of ore from this vein was milled in a small stamp mill in 1901 and is reported to have given high assay returns, particularly in silver. The ore minerals of the other vein consisted of pyrite, galena, sphalerite, and chalcopyrite, with a little native gold in the oxidized parts of the vein. The remoteness of these lodes from the coast and the difficulties of access, even after a road was built up Unuk River, have caused a loss of interest in this mineralized area, and of late years no work has been done in this vicinity. It is admitted that a low-grade property would be of little value at that distance from the coast, but further prospecting along the east side of the granite batholith, north and south from Unuk River, with the purpose of locating lodes of high-grade ore, might be well worth while.

SALMON RIVER.

GEOGRAPHY.

Salmon and Bear rivers, at the head of Portland Canal, particularly the former, are the centers of the present mining interest in this district. Bear River flows entirely in British Columbia, but Salmon River lies partly in British Columbia and partly in Alaska. On this account, and because interest canters in this locality, only the conditions in the valley of Salmon River will be discussed here.

Salmon River rises in Salmon Glacier and flows about 13 miles to Portland Canal about 2 miles below Stewart. All of Salmon River proper lies in Alaska. Cascade and Texas creeks axe the two important headwater tributaries. Cascade Creek rises in British Columbia and flows about 6 miles southward to join Salmon River about 2 miles below the glacier. Texas Creek lies entirely in Alaska,

is about 10 miles in length, and flows in a general easterly direction to Salmon River about 4 miles below the glacier. The main ridge between Salmon and Bear rivers is known as Bear River Ridge, and the smaller ridge lying between Salmon Glacier and Cascade Creek is called Big Missouri Ridge. (See Pl. V.) The properties now under intensive development lie in the valley of Salmon River along the west side of Bear River Ridge and on Big Missouri Ridge.

AREAL GEOLOGY.

The country rock along the east side of Salmon River and Salmon River Glacier is mainly the andesitic greenstone of the Bear River formation. To the west lies the granite of the Coast Range. The contact between these two formations, however, is irregular and is marked by Salmon River only in the most general way. Isolated areas of granodiorite are present in the Bear River formation east of Salmon River and in fact are the immediate sites of a number of the ore deposits.

The greenstone near the granitic rocks is sheared and at places rendered schistose, the schistosity trending north and dipping toward the granite. The shearing and fissuring that are related to the ore deposition, however, cut transversely across the earlier structure, as may be seen at the Premier mine. Dike rocks of a variety of types, ranging from granite to more basic rocks, together with other intrusives of similar composition but of a fine-grained porphyritic character, are found in the Bear River formation. Some of these dikes are connected with the intrusion of the Coast Range batholith; others are no, doubt more closely related to the andesitic greenstone sequence. It is presumed that the mineralization is connected with the intrusive igneous rocks of the Coast Range.

TYPES OF DEPOSITS.

Two general types of lode deposits may be found along the east side of the Coast Range batholith, within the Salmon–Unuk River region. These may be designated vein deposits and replacement deposits. The vein deposits consist of metallic minerals, usually with quartz, which have been laid down in open fractures, with a minimum of replacement of the country rocks. Where such deposits fill epening of regular form, such as openings along fault or joint planes, true veins are developed. Where the infiltration and deposition have occurred in irregularly fractured areas, something akin to a brecciated ore zone results. The replacement deposits are those which have been formed in zones of shearing and fissuring, with or without gangue minerals but accompanied by much replacement of the country rock. Naturally these two types are not mutually

exclusive, and both types may be found in close association at some localities. It appears that the lodes along the east side of the Coast Range have been deposited at shallower depth than those along the west side, as at Juneau, and in contradistinction to the lodes of Kasaan Peninsula they show little or no evidence of contact-metamorphic origin.

Deposits of both the types mentioned are found in the Salmon River valley. The low-grade ores are chiefly impregnation and replacement deposits of considerable size lying along zones of fissuring and shearing. They are characterized by indistinct rather than sharp boundaries. The ore minerals are usually pyrite, sphalerite, galena, and chalcopyrite, and the valuable constituents are gold, silver, zinc, and to a smaller extent copper. Pyrrhotite is present at some localities, but it carries little gold, as the gold is apparently associated for the most part with pyrite. At and in the vicinity of these impregnated zones the country rock is much silicified and altered to calcite, chlorite, and sericite. In places the gangue material consists solely of such altered country rock. Considerable oxidation has taken place, as is indicated by the discoloration at the surface outcraps, and there is reason for the belief that downward enrichment may have played some part in the formation of some of the lodes.

The high-grade deposits are essentially rich silver and gold ores, occurring both as veins and as replacement deposits, many of them within zones of lower-grade ores. These higher-grade ores have not been studied in detail, and their exact relation to the lower-grade ores is not definitely understood, though the evidence available points to their formation at a somewhat later period. The silver minerals present in the high-grade ores include argentite (silver glance), argentiferous tetrahedrite, native silver, pyrargyrite, and proustite, and possibly stephanite and other silver minerals. Little native gold is seen, and ores with high gold content are characterized by much pyrite.

LODE PROPERTIES.

The properties at present being prospected or developed include the Premier, Mineral Hill, Big Missouri, Bush mines, Forty-Nine, Indian mines, International, Payroll, Yellowstone, Boundary, Northern Light, Cascade Forks, Spider, Hercules, Silver Tip, Bunting, Unicorn, Lake & O'Leary, New Alaska, Knobhill, and other groups of claims. All these are in British Columbia. The International, Premier, Bunting, and Bush mines properties lie along the west flank of Bear River Ridge, but the Indian, Boundary, Payroll, Mineral Hill, Big Missouri, Hercules, Forty-Nine, and Yellowstone groups of claims stretch northward up Big Missouri Ridge.

The Premier mine is at present considered the most promising of these properties. A description of the history and development of

this mine is given by Charles Bunting.[1] This property, which originally consisted of two claims, lies along the west side of Bear River Ridge and was discovered and staked in June, 1910. These and adjoining claims later passed into the hands of O. B. Bush, who organized the Salmon-Bear River Mining Co. This company and others to which the property was successively bonded carried on development work until the spring of 1919, when the potentialities of the property were finally recognized and demonstrated by R. K. Neill, of Spokane. Partial ownership and financial control have now passed into the hands of the American Smelting & Refining Co.

The lode is reported to consist of three low-grade ore bodies and one of high grade, which appear to be of the replacement type above described. The country rock is the Bear River formation, or andesitic greenstone, greatly sheared, fissured, and fractured. The high-grade deposit, on which the most work has been done, is an ore zone in the fractured porphyry and follows a shear zone of fissuring and fracturing which strikes N. 80° E. and dips 60° S. The gangue is chiefly the silicified country rock. The ore minerals are reported to be argentite (silver glance), argentiferous tetrahedrite, stephanite (brittle silver), pyrargyrite, proustite, native silver, apd pyrite carrying much gold. A little pyrrhotite is present, but it carries only a small percentage of gold. Small stringers in the larger ore body are reported to carry wonderfulspecimens of the silver minerals. Though classed as a rich silver mine, the ore is valuable for both gold and silver, the latter predominating. A sampling of all the present workings and openings is reported by Bunting to have given an average value well over $30 a ton in silver and gold. The 512 tons that has so far been shipped gave smelter returns of $168,000.

Less is known as yet of the possibilities of the low-grade deposits, on the Premier property, hut it is assumed that like other low-grade deposits near by, they consist of silicified zones in the andesitic greenstone,, impregnated with sulphides, chiefly pyrite, galena, sphalerite, and chalcopyrite, carrying both gold and silver.

The big Missouri, Mineral Hill, and Bush properties are also being developed.

With regard to mining properties in the Alaska portion of the Salmon River valley the following notes by Chapin[2] give some idea of what had been accomplished up to 1915:

A group of claims extending from Sevenmile, on Salmon River, to Fish Creek, has been located, but only two of them have been developed. On the Riverside claim a tunnel 100 feet above the river flat has been driven for 140 feet along a strong fissure vein. The vein averages about 4 feet in width but pinches to 18 inches and in places widens to 6 feet. Both walls are well defined. The wall rock is somewhat

[1] Bunting, Charles, The Premier gold mine, Portland Canal, British Columbia: Min. and Sci. Press, Nov. 8,1919, pp. 670–672.

[2] Chapin, Theodore, Mining developments in southeastern Alaska, 1916: U. S. Geol. Survey Bull. 642, pp. 97–98, 1916.

altered but contains little gouge. The vein filling is quartz with abundant sulphides. Pyrite is the most abundant along the hanging wall and occurs in solid bunches and in disseminated particles associated with chalcopyrite. On the footwall galena is the most plentiful sulphide. The country rock is crystalline schist. On a parallel lode of much the same character the Riverview claim is being developed. The vein strikes N. 60° W. and dips about 60° NE. An adit has been driven for 17 feet, exposing a vein that varies from 1 foot to 4 feat in width. At the mouth of the opening it is 2 feet wide on the roof and widens to 4 feet on the floor of the adit. At the face it is from 12 to 18 inches in width. Although the vein swells and narrows from place to place, the walls are well defined.

At Elevenmile a little prospecting has been done, and several claims have been located. On the Elevenmile and Iron claims a number of open pits have exposed an iron-stained lode that follows a brecciated zone filled with veins of quartz carrying chalcopyrite, sphalerite, and galena. Stringers of sulphide form shoots of very rich ore with high silver content. On the Iron claim a ton of this high-grade ore has been sacked ready for shipment. The lode strikes northeast and dips steeply northwest. On the hillside above Elevenmile, at an altitude of 1,500 feet, the Bertha and Western claims are being developed on a northeastward-trending lode. One surface cut shows the lode to be at least 15 feet in width. It consists of silicified schistose green tuff of the "Bear River formation," with disseminated pyrite, chalcopyrite, galena, and sphalerite. A number of claims have been staked on a zone of disseminated deposits exposed along Salmon River at Eightmile and Ninemile, but only a little work has been done.

Some promising fissure lodes have been located by Murphy & Stevenson on Fish Creek and its tributary, Skookum Cheek, where more than the necessary amount of assessment work has been done. Near the mouth of Skookum Creek an adit was driven for 25 feet along a fissure that had been traced by surface trenches far 2,000 feet The vein is 4) feet wide, strikes N. 40° E., and dips about 55° SE. The quartz gangue carries galena, chalcopyrite, tetrahedrite, sphalerite, and pyrite in veinleta and irregular patches. It is being exploited mainly for its gold and silver content.

Near the head of Skookum Creek, st an altitude of 1,600 feet, a fissure vein has been opened by an adit 320 feet in length and several crosscuts and inclines. The gangue is quartz. Metallic sulphides present are tetrahedrite, chalcopyrite, galena, sphalerite, and pyrite in blebs and veinlets penetrating the quartz, and the richest ore occurs in veinlets of tetrahedrite and galena. The country rock is porphyry and schistose tuff of the "Bear River formation." The lode strikes N. 55° W. and dips 45° SW. At the portal it is about 18 inches wide. At 70 feet from the portal only a part of the vein is exposed, as the ore has been removed ta a wall within the vein. At this place the vein is 3 feet wide plus an unknown width in the wall of the adit. At various places portions of the vein said to be very rich have been stoped out. At 300 feet from the adit mouth the lode is abruptly cut by a vertical fault trending nearly perpendicular to the lode, and short drifts along the fault plane in both directions had not shown the position of the faulted lode. Samples of ore said to come from a near-bp prospect, which was not visited, contain particle of free gold in siliceous gangue.

Several claims have been staked on Texas Creek. The ore bodies are reported to be quartz veins carrying seams of tetrahedrite penetrating granite and pegmatite. Little work has been done in this locality.