

GEOLOGY OF BRITANNIA MAP AREA

WITH REFERENCE TO THE COAST RANGE BATHOLITH.

by.

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Reference to map in text*

PREFACE.

In the preparation of this essay, an attempt has been made to give a few of the general relations of the geology of the comparatively small area dealt with. The material therefore, has been drawn from many sources; also on account of the inability of the writer to see all the structures and conditions noted, his indebtedness is in consequence, obvious.

Acknowledgments are therefore due to the following authors: Mr. P. D. Wilson, Mr. E. M. Warren, and Mr. C. P. Browning.

Special thanks are due to Dr. S. J. Schofield for the loan of material, and also to Mr. H. T. James, for his kindness during the summer and for views upon this subject.

Works upon the subject consulted by the writer include the following:--

Britannia Map Area.

Geological Survey of Canada. Summary Report 1918 Part B.

Dr. S. J. Schofield.

The Britannia Mines: British Columbia.

University of British Columbia.

Dr. S. J. Schofield.

General Mining and Milling Practice at the Britannia Mine,
Howe Sound, B. C.

Institute of Mining and Metallurgy. January 1922.

Mr. C. P. Browning.

The British Columbia Batholith and Related Ore Deposits.

Transactions of the American Institute of Mining and Metallurgical
Engineers. August 1922.

Messrs P. D. Wilson and E. M. Warren.

Everett J. Lees.

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GEOLOGY OF BRITANNIA MAP AREA

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Introduction

Britannia map area is situated in the Coast Range about twenty miles north of Vancouver City. The route by water from Vancouver, is up Howe Sound, one of those irregular fiords, which cuts far back into the mountains, and is so typical of the waterways of British Columbia.

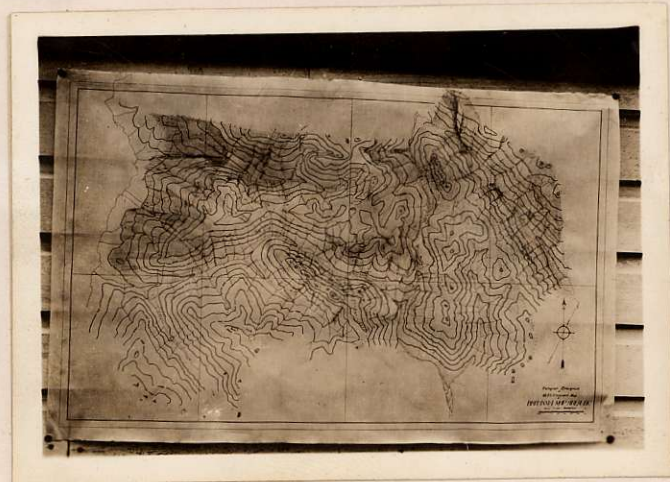
The map area extends eastward from the shore of the sound to the ridges beyond Indian River, a distance of about thirteen miles. Tops of high ridges to the north side of Britannia Creek, and a line continued easterly from them, form the northern boundary. The extent to the south is about five and one-half miles. The area is roughly rectangular and includes about seventy-two square miles.

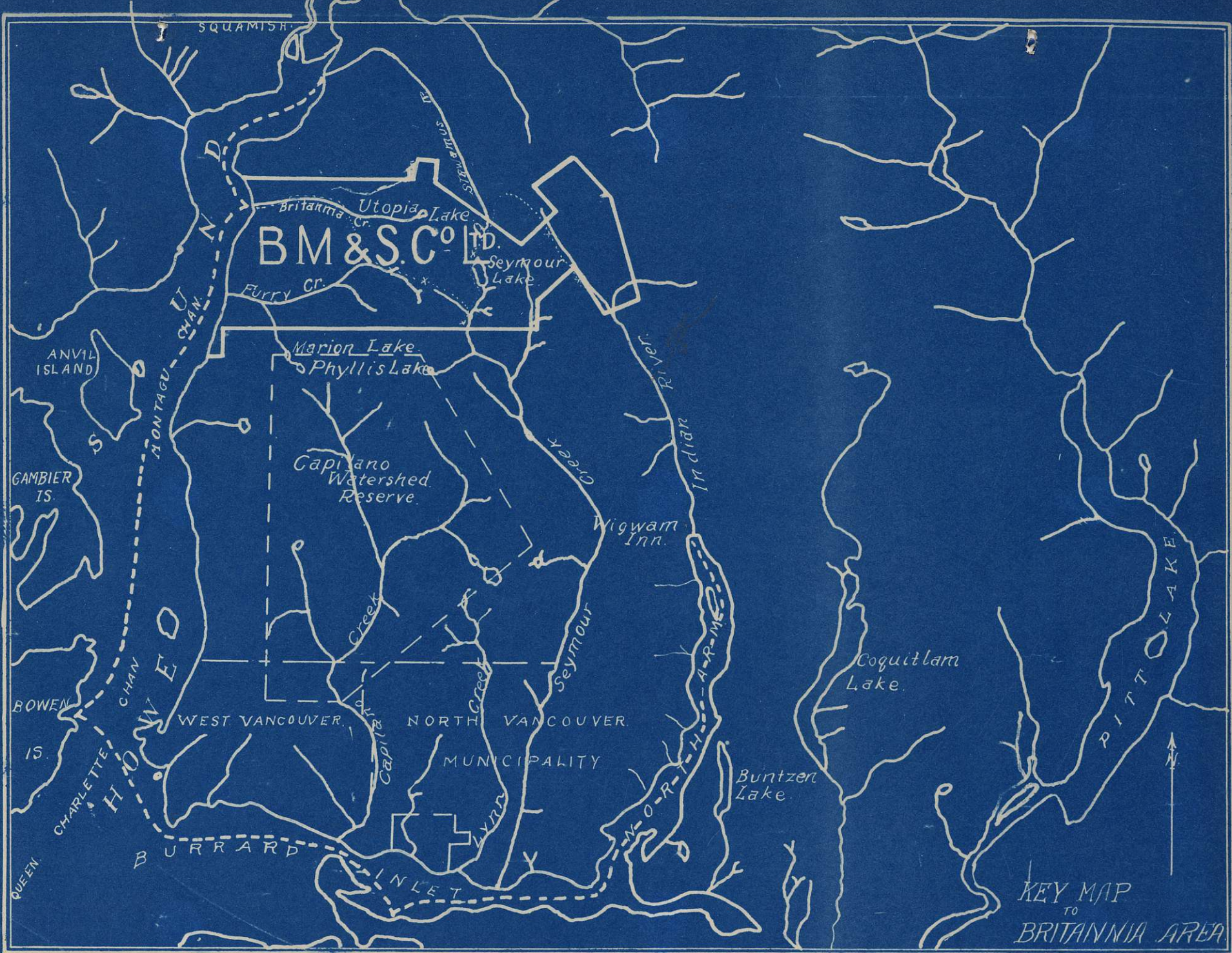
Field Work in this region had been previously undertaken by the Geological Survey of Canada, and was renewed during the summer months of nineteen hundred twenty-five by Mr. H. T. James and two assistants. The work undertaken by him consisted in mapping the structure by the aid of an aneroid, a Brunton compass, and a one hundred foot interval contour map on a scale of one inch equal two thousand feet.

Contour Map.

Britannia Map Area.

500 foot interval.





KEY MAP
TO
BRITANNIA AREA

The procedure in the field was to follow up all small creeks to the tops of the mountains; in this way an endeavor was made to cover the region with traverses about fifteen hundred feet apart or nearer if necessary.

SUMMARY.

The region is in a youthful state of erosion, and heavily forested in places. Phases of igneous rocks varying from granite to gabbro blend into each other and may be classified as belonging to the great coast range granodiorite batholith. This plutonic body contains remnants of an old roof pendant, that has undergone severe metamorphism. Large igneous sills occur in the inclusion. A shear zone, several miles long crosses these and appears to be the centre of a wide spread mineralization which is of low grade, but whose wide extent has made possible one of the largest copper mines in the British Empire.

TOPOGRAPHY.

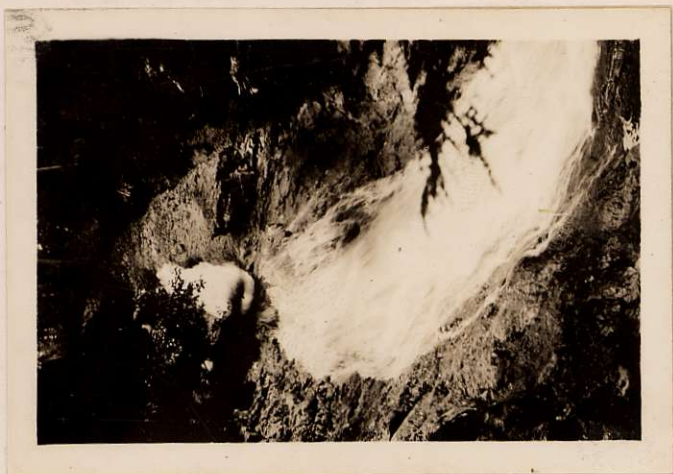
The topography is rugged; the mountains even though well wooded have numerous rock outcrops. The summits are nearly all



View From Seymour Divide.

bare of trees, but the tops of the ridges are frequently covered with moss and marsh flowers. This region is the source of many

streams and small rivers. Small creeks stretch like silver bands down the precipitous sides of the mountains with scarcely any channel yet worn in the rock.



Stawanus Creek.

Beautiful lakes such as Seymour and Stawamous occupy the divides. Seymour, or Loch Lomond, as it is sometimes called, is a narrow shallow lake over a mile in length. The shores slope gently up to the foot of the mountains on two sides. A slight rise separates it from Stawamous Lake on the north and it slopes down to Seymour Valley on the south. Small low peninsulas, bays and islands, give it a winding appearance. From soundings taken through the ice by a prospector, it is shown to be of not greater depth than one hundred and sixty feet.



Seymour Lake.

Lakes of another type are also common. Their situation on the sides of steep mountains and cup like appearance of their

surroundings suggest a glacial origin. Excellent examples of such lakes, of which data obtained by the Vancouver Water Works Investigation Survey is at hand, occurs just south of the Britannia map area. Burwell Lake, one of these, is somewhat less than a mile long and over one-half mile wide. The shore line is very regular. Rock walls rise rapidly from the waters edge and the gradient below water level is almost as great as that above. It has a depth of two hundred feet at six hundred feet from shore and a maximum depth of two hundred and twenty-five feet. Palisade ridge, separating Burwell from Upper Palisade Lake, is very rough and steep and would suggest that the plucking action in the berges chrund of a glacial cirque had taken place there.

Burwell Lake.



The lower courses of the streams which rise in the Britannia map area show further evidences of glacial action. These have a ("U") shaped cross-section and the streams flow into fiords with marked precipitous walls and facettted spurs. One writer has described the fiords as belonging to two systems, one paralld to the north south trend of the mountain ranges, and the other at right angles. to these. These, he claimes to be the remains of old river systems with valleys gouged out

below sea level. It is questionable whether the land has sunk some and aided the sea to fill these valleys.

Besides these evidences of glacial action, very conclusive ones are to be found in the form of glacial erratics. On the top of Goat Mountain at the north boundary of the region, are numerous coarse grained granite boulders lying on a dark rock that appears to be of a bomb structure, or at least is volcanic in origin.

PETROLOGY.

Plutonic rocks of the batholith vary from granite to diorite, and are, as a whole, spoken of as granodiorite. The contact, with the inclusion at Britannia, is sharp along the east. It can be seen a short distance up Britannia Creek, from the beach. In this place, the granite is coarse grained and white or grey in color. As the lower slopes of the western end of Goat Mountain are ascended, the granite becomes finer grained, and pink in color. It extends at least to an elevation of three hundred feet which is reached about a mile from the beach. South of Furry Creek, and also between Seymour Creek and Indian River, other great masses of granite occur.

The principal rocks of Goat Mountain, east of the granite, are dark volcanics; mainly tuffs and agglomerates. Frequently these are amygdaloidal.

On the top of the mountain, the structure seems to be composed of dark volcanic bombs imbedded in finer lighter grained material of probable volcanic origin. This structure



Bomb Structure.

Goat Mountain.

may have been derived from the Gariboldi volcanic region which lies a few miles north.

Interbedded with the sedimentaries of the central part of the region are intruded igneous bodies, mainly in the form of sills of quartz diorite porphyry and similar rocks. In general, they have been much metamorphosed, and occur as chlorite schists and mica schists, becoming fissile or sericite where the metamorphism has been most intense. In the chlorite schist, films of chlorite occur as large as one inch square. These have probably been derived from the shearing and squeezing action on chlorite crystals. The schists are the most conspicuous rocks of the Britannia region.

The sedimentary rocks have been altered to black argillites, with conchoidal fracture and no slaty cleavage. They thin out towards the south-east and occur at Indian River, and beyond, as scattered patches in the igneous rock.

STRUCTURAL GEOLOGY.

The structure is a minute part of the Cordillera, or great mountain region, occupying the western side of North America and extending from the Andés of South America, which are some-

times grouped under this name, to northern Alaska. The Cordillera in British Columbia is over four hundred miles wide at the international boundary. It is characterized by parallel north-south ranges separated by long narrow lake valleys and river channels. Of this system, the Coast Range, the farthest west on the mainland, is eighty or ninety miles wide in the southern part of the province and decreases to fifty or sixty miles near the Yukon Alaska line. * "It is almost wholly composed of coarse granitoid rocks which vary from granite to gabbro in composition, but are in a large part granodiorite. The rocks are so closely related that the mass may be considered as one gigantic batholith." This body of plutonic rocks is bounded on the east by older sedimentaries of the Interior Plateau, and to the west by the stratified rocks exposed on Alexander Archipelago, Queen Charlotte and Vancouver Island.

Many inclusions of the older sedimentary rocks are present in the batholith, especially along the western border. One of these, a roof pendant, is located centrally in the Britannia map area. The inclusion has a width of about two miles and a length of over seven miles in an east-west direction. A tilting of about seventy degrees to the south seems to have taken place. The contact with the granite is sharp on the west, but the sedimentary rocks thin out and leave scattered fragments and projections on the east.

*Willson P. D. and Warren E. M. The B. C. Batholith and Ore Deposits. Transactions of the American Institute of Mining and Metallurgical Engineers. ----- August 1922.

Intruded into this inclusion are igneous sills, known locally as the "Britannia Sills" that are probably in two or more divisions, conforming in dip and strike with the slates. They are believed to have a total thickness of eighteen hundred feet or more. Nearly all the ore bodies are contained by the sills except the Jane which occurs in the sedimentaries.

A large fault, traceable for five miles, cuts through the sills approximately parallel to the long axis of the inclusion. The shear zone varies from five hundred feet, to probably half a mile in width.

Gabbro, diorite, quartz, calcite, barite and other forms of dykes occur and seem to be of later date than the other intrusions and faulting mentioned.

HISTORICAL GEOLOGY.

It is very difficult to determine the age of the rocks from an examination of the Britannia region only. This is due primarily to the severe metamorphism. The sedimentaries have, in a large part, become the so called black slates. As a result of this the fossils have nearly all been destroyed and although a careful watch was kept for them by the Geological survey of 1925, none of any value were found, in fact, to the best of my knowledge, no good ones have yet been discovered.

The Goat Mountain formation of volcanics is considered by Dr. S. J. Schofield to be the oldest formation in the Britannia area.

The sedimentaries have been placed by some writers as Palaeozoic. This is very probable, as the Jurassic was a great period of igneous activity and mountain building in this part

of British Columbia. It seems very likely that this activity must have been in progress also in the Triassic, the first of the Mesozoic periods, so that they must have been formed before this time.

The conformity of the Britannia Sills with the sediments in dip would indicate that these had been intruded before the tilting had taken place. This tilting very likely resulted when the roof pendant was cut off by the molten magmas of the incoming batholith.

The period of the formation of the batholith may be considered settled. Such a great structure, occupying a large and important part of the province has been given careful study by many geologists, and has been placed as Jurassic in age.

MINEROLOGY.

The mineralization, throughout British Columbia, seems to be closely connected with this great batholith. All the mines of importance occur along its borders or in the inclusions. The silver and gold in commercial quantities seems to be along the eastern contact; the copper and iron along the west side of the batholith.

A theory related to this differentiation is that the silver and gold crystallized out higher in the magma than the copper and iron. These minerals penetrated the metamorphosed zones forming the important ore bodies found along the contacts. Later, it is believed, tilting to the west has taken place and either the upper layers to the west have been eroded away or are under the sea, leaving the copper and iron section uncovered. The silver and gold deposits on the east however are not eroded away.

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The mineralization of Britannia, being that of the west, is chiefly pyrite and chalcopyrite. It is very extensive but of low grade, the copper values rarely run over three per cent, and are generally from one to two per cent. Just at present some fair ore of zinc is being brought to light by diamond drilling and it may prove to be in payable quantities. Galena, bornite and Molybdenite, also occur in minor quantities. Gold and silver in small quantities occur in the copper ore. Deposits of gypsum and sulphur have also been noted and studied.

ECONOMIC GEOLOGY.

There are at least five main ore bodies and about these the Britannia Mining and Smelting Company have staked over five hundred and sixty claims. Mr. Browning, general manager of Britannia Mining and Smelting Company, has described them as follows: "The Jane which was the first (ore body) to be exploited on a commercial scale is roughly a diamond shape, extensively mineralized for three hundred feet, east and west and over a width of two hundred fifty feet. Commercial ore has not been found at a greater depth than three hundred feet.

The Bluff deposit nine hundred feet north-east of the Jane has a maximum length on the twelve hundred level (i. e. at an elevation of thirty one hundred feet; the outcrop of the Fairview at an elevation of four thousand three hundred fifty feet, being taken as the zero for the mine) of five hundred feet east and west and a width of two hundred fifty feet north and south, extends to a known depth of sixteen hundred feet.

The Fairview to the east is fifteen hundred feet long and five hundred feet wide, with a known depth of twenty two hundred

feet.

Again to the east of the Fairview is the Empress with an ore body of a maximum length one thousand feet and width one hundred feet.

Further still to the east is the Victoria, the dimensions or boundaries of which have not been fully determined. Apparently it is an ore body which will compare favorably with the others."

The ore bodies occur along the shear zone. The Bluff, Fairview, Empress, and Victoria occur in the schists, while the Jane is situated in the adjoining slates. Lens shaped masses are the usual mode of occurrence. No fixed natural boundaries exist; mineralization is disseminated through nearly all of the schists in minor quantities. In parts of the mine the occurrence is of vein formation. These occur generally with a dip of about seventy degrees to the south.

Analysis of the ore varies from amongst the ore bodies. Average values run from 2% to 4 $\frac{1}{2}$ % copper. 5% to 15% iron, under 1% zinc, from about .01 to .06 ounces of gold and about .25 ounces of silver per ton.

The pyrite appears to be of later mineralization than the chalcopryrite. It has been found that the pyrite crystals separate easily from the chalcopryrite on crushing. 2

In the mining operations, ^{the} over-hand shrinkage stoping system is used, ore is drawn off by shoots, of which, there are about three per hundred feet. On the top level the stope system in combination with "gloryhole" methods on the surface are used. Transfer raises lead to the main ore raise, which

delivers the ore to a jaw crusher on the seventeen hundred level and crushed to six inches. On the eighteen hundred level this product is crushed by means of gyratory crushers to two and one-half inches. After crushing it drops to the twenty-two hundred or bottom level of the mine.

The main entrance or haulage tunnel is upon the twenty-two hundred level. This tunnel runs under the bluff section into the Fairview, a total distance of four thousand two hundred feet to the bottom of the main shaft, which connects the twenty-two hundred level to those above, as far as the one thousand feet level. It extends in an easterly direction for a further distance of about forty-five hundred feet, through the Express and Victoria, and into the Princess Fraction claim so that on the twenty-two hundred level all the sections are connected up. Rock raises lead to the twenty-two hundred from which the ore is transported by electric trains, a distance of three and one half miles down a three per cent grade narrow gauge switch-back railway to the adit on the twenty-seven hundred foot level. An incline tramway continues on down to the beach but the ore is no longer transported down it. It is now dumped down a fifteen hundred foot rock raise to the adit on the four thousand one hundred foot level. From here it is drawn four thousand feet through this lower adit and delivered at the receiving bins of the concentrating mill, which is situated at sea level against a steep rock outcrop.

The mill is of modern design and is a recent structure. Concentration is on a basis of one ton of concentrates to 13.3 tons of ore.. The resulting product averages about 21% copper



Concentrator at Britannia Beach.

and 27% iron, and small gold and silver values which are not given by the company. These concentrates are shipped to a smelter in Tacoma city.

A few extracts from the annual report of the Howe Sound Company for the year 1924 will indicate the large scale of the operations. Continued twelve months production yielded 26,398,539 pounds of copper; 4684 ounces of gold and 125,687 ounces of silver. Mine tonages show, reserve ore, 5,719,211 tons of 2.1% copper. Of this tonage 1,529,208 tons are broken in the stopes. These reserves do not include new ore disclosures in the Bluff section and in the country to the east of the Victoria division.

The future mineral prospects seem to be good. Some good zinc ore is being prospected in parts of the working. Fair showings of chalcoppyrite are being opened up by private prospectors in the Indian River valley, and the Britannia Company have now a survey party there. It appears probable that this part of the field may be opened up by a tunnel driven from the other workings or by a new outlet, either by way of Squamish, or the North Arm of Burrard Inlet.