92G/11

802143

R. V. KIRKHAM

The Geology and Development of the No. 8 Orebodies, Britannia*

By W. T. IRVINE†

Introduction

THE Britannia Orebodies occur in Mesozoic schists which form part of a roof pendant in the Coast Range Batholith of B. C. The deposits are located on the east side of Howe Sound, some 20 miles north of Vancouver, B. C. The camp is served by two settlements, one at Britannia Mines Townsite, approximately three miles from the water's edge at an altitude of 2100 feet, and the other at Britannia Beach on Howe Sound. The first discovery was in 1888 and the orebodies were first exploited in 1905.' From the start of production in 1905 until the end of 1944, the property has produced 732,414,420 pounds of copper and 261,126 ounces of gold. This production has been from the various orebodies: Victoria, Empress, No. 5, Fairview, Bluff and Jane. In 1937 the No. 8 Orebody was discovered by diamond drilling from the 4100 level, some 300 feet above sea level. From that time until the present this orebody has been in the process of development. Up to the end of 1944, upwards of 1,000,000 tons of ore were developed, containing values in gold, copper and zinc. There has been little stoping in this orebody as yet, most effort having been directed towards development. Ore has been delimited from the 3800 to the 4950 levels and a shaft has been sunk, extending from the 4000 level to the 5250 level. In the near future mining efforts will be directed towards production and also towards development and exploration at depth.

General Geology

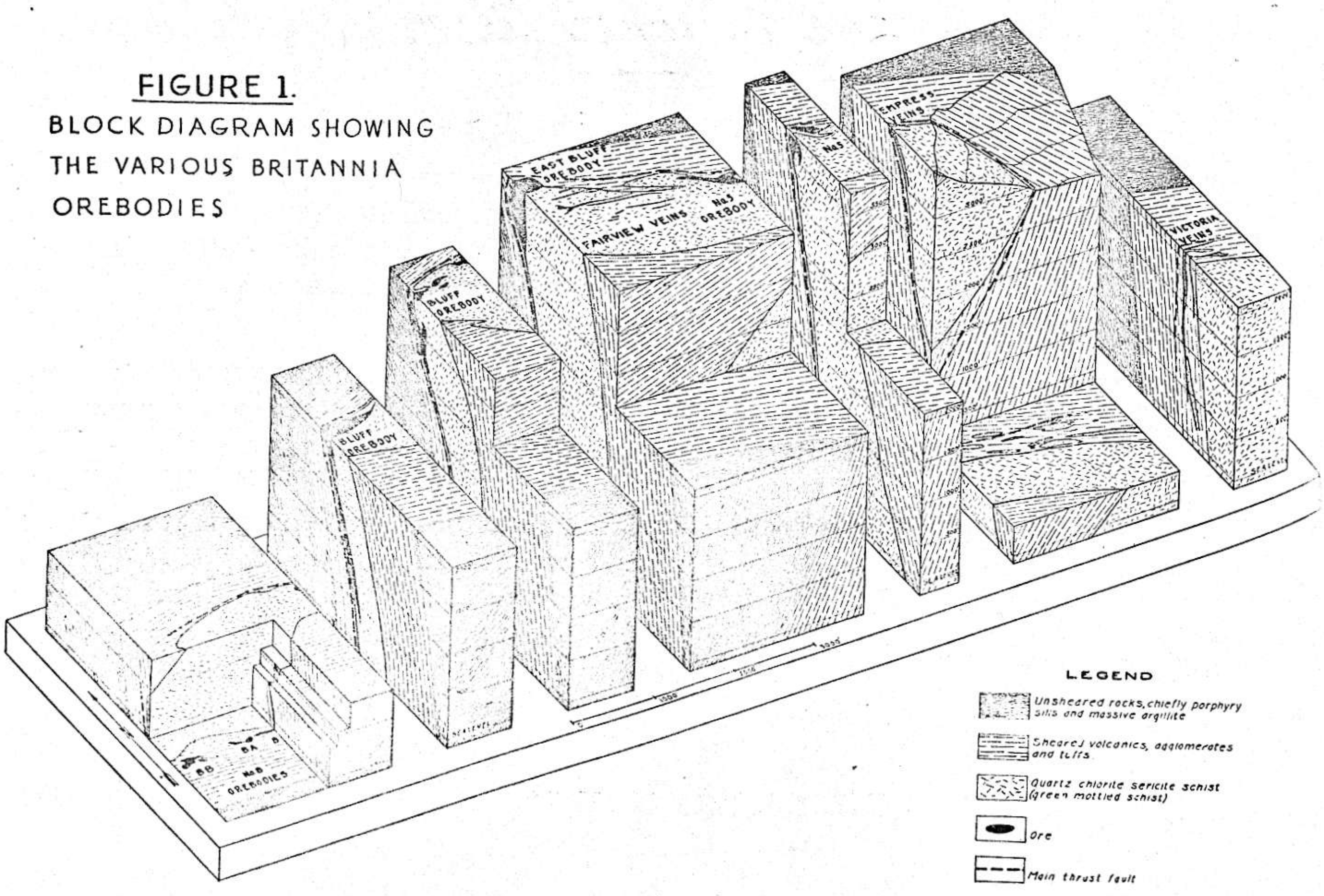
The Britannia roof pendant, sev... square miles in area, is compose... sedimentary and volcanic rocks of ... Britania Group, Triassic or Jurassi... age. The orebodies ocur in rocks ... the lower formation of the group, ... Britannia formation.(1)

These rocks consist of argillac... slate, fine to medium grained t... fragmentals and volcanic flows. T... formation has been steeply tilted a... has been locally folded and sheared.

The outline of the roof pendant h... been traced on the surface, but to da... none of the workings or drill ho...

*A paper to be presented at the Geology sessio... Annual Meeting, B.C. Division, C.I.M.; Va... couver, October 25, 1945.
†Geologist, Britannia Mining and Smelting Co., Ltd.

FIGURE 1.
BLOCK DIAGRAM SHOWING THE VARIOUS BRITANNIA OREBODIES



have encountered the bottom of the pendant and no information is available as to its probable depth.

The major structural feature of the area is a broad, steeply dipping shear zone which is roughly parallel to the strata and which has been traced for a number of miles along its strike. The Britannia orebodies, a series of eight separate replacement deposits of varying types, occur at intervals in the shear zone. They have been localized in fracture zones in competent rocks which occur along the hangingwall of a strong thrust fault which parallels the zone of shearing. The No. 8 orebodies are the most westerly and deepest of the known orebodies.

Mine Geology as Related to the No. 8 Orebodies

The steeply tilted Britannia formation has as its footwall, or more northerly member, a thick series of argillaceous slate. Immediately to the hangingwall of this lie several hundred feet of highly sheared tuffs, fragmentals and flows. A thick series of quartz chlorite sericite schist adjoins this on the hangingwall, and is again succeeded to the south by a series of sheared tuffs and fragmentals. A thick band of argillaceous slate occurs to the hangingwall of these sheared rocks.

The argillaceous slates are smooth textured, uniform black to dark bluish grey rocks, having in general, well developed cleavage. The slates are well fractured along planes which intersect the cleavage faces.

The sheared rocks to the hangingwall of the footwall slates vary in texture from smooth, fine grained schist, to one in which small mottling has imparted a rough texture. This variation in texture represents the range from fine grained tuffs to fragmentals and agglomerates. These rocks now consist of quite fissile chloritic to sericitic schists which form an incompetent band, in which is located the main thrust fault.

Lying to the hangingwall of these schists there is a distinctive chlorite sericite schist known locally as the "green mottled schist." This schist, properly described as a quartz chlorite sericite schist, has a felsitic ground mass and lenticular chloritic mottles of varying sizes and frequency. James(2) and Schofield(3) have considered the green mottled schist as a sheared felsite porphyry sill. Ebutt(4) considers the green mottled schists to be volcanic in origin. In recent years the schist has been widely exposed by means of extensive diamond drilling and it has been possible to study its character and relationship to a degree never before possible. The many examples seen of typical green mottled schist blending into fragmental types, with the mottles becoming more or less elongated chlorite fragments in the felsitic groundmass, suggest to the writer that the green mottled schist is a sheared fragmental rock, probably of volcanic origin.

The green mottled schist owes its importance to the fact that it has been the host rock for most of the Britannia orebodies. The schist forms a thick band extending from east of the Victoria orebody to just west of the No. 8 orebody. Here it pinches out, forming a nose, which has been traced from the surface to the 4100 level, and has a westerly plunge of 45°. To the footwall of the No. 8 orebodies this schist has a thickness of 500 feet.

The No. 8 orebodies lie to the hangingwall of the green mottled schist, in a series of sheared tuffs and fragmentals. The three main lenses lie in a silicified and mineralized zone which approaches the green mottled schist at the 3800 level, but in general dips away from it at depth. The most prominent rock in the region of the orebody consists of a grey to greenish grey schist having small mottling. The mottling appears to be caused by small chloritic lenses which in some cases grade into relatively unsheared small fragments. There is little variation in the size of the fragments or mottles in the region of the orebodies, although farther to the hangingwall there are less mottled, more fragmental rocks with larger sheared fragments visible.

Interbedded with the fragmental rocks there are relatively thin layers and lenses of extremely fine grained rocks, apparently tuffs. These are light to medium grey in colour, and are frequently somewhat cherty.

Elongated lenses of soft slatey schist, usually dark grey to black in colour, occur interbedded with the tuffs and fragmentals in the region of the ore zones.

Dykes

Three distinct types of dykes occur in the No. 8 area. The earliest of these consists of a number of extremely sheared and drag-foiled chloritic dykes, which have been correlated with the andesite dykes identified by James,(5) occurring in the upper part of the mine. They occupy a set of north - westerly trending fractures which cut indiscriminately through the ore zone, a fact which would indicate that these dykes were post ore. The dykes are in places well mineralized, however, and it is possible that they were injected in between two periods of mineralization.

In addition to these andesite dykes there are a large number of felsite porphyry dykes in the area. They have been injected into a set of fractures which trend from due east-west to slightly north-west, and which have a flatter dip than the formations which they cut. On the lower levels, the felsite dykes are to the hangingwall of the green mottled schist, but their flatter dip brings them closer to that schist on succeeding higher levels, until on the upper No. 8 levels they cut well into the green mottled schist. The dykes vary in width from a few inches up to twenty or more feet. Each individual dyke may be traced for hundreds of feet along the strike and dip, and are continuous except for occasional "windows."

The dykes are typical felsites, which may be identical in composition with

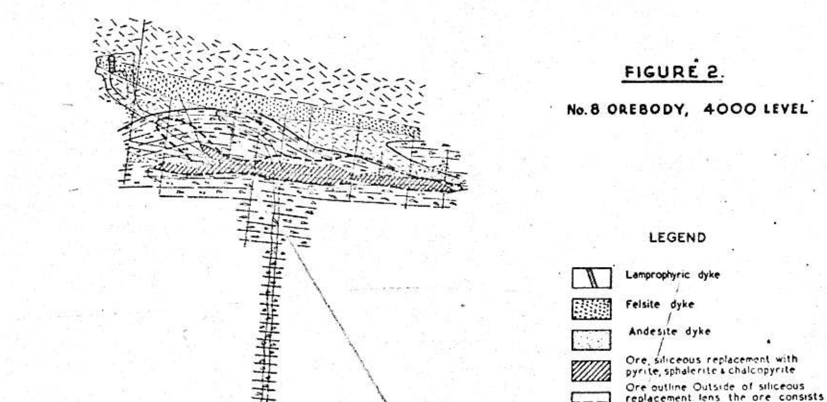


FIGURE 2.
No. 8 OREBODY, 4000 LEVEL

the albite dacite dykes identified by James.[6] They are medium to fine grained porphyries, varying in colour from green to pale cream, with sometimes a faint pinkish tinge. The finer grained phases present a somewhat cherty appearance, and their porphyritic character may be determined only under a microscope. The felsite dykes have been subjected to little shearing, and are hard and brittle in character.

The relationship between the felsite dykes and the ore presents an interesting problem to which a positive solution has not yet been provided. The felsite dykes are flatter in dip than the orebodies, although roughly parallel to them in strike. Individual dykes may be traced upward into the hangingwall of an orebody, and through the ore to the footwall, which they may leave several hundred feet higher than the hangingwall intersection. The dykes thus appear to cut right through the ore, and since there is no difference in character or quantity of ore to footwall or hangingwall of each dyke, there has been no apparent damming of solutions, indicating that the dykes were post ore. In addition, chilled margins may be observed against the ore, showing that there has been little or no replacement by mineralizing solutions at the edges of the dyke. On the opposite side of the scale, however, it has been noticed that chalcopyrite stringers, when approaching the dyke contact, will change in strike or dip to conform with that of the dyke. Apparently, therefore, fractures which controlled this mineralization were influenced by the dykes which must thus have preceded the mineralization. Recent development has also revealed that on at least one level the dyke is not continuous where it occurs in the ore, but consists of a series of disconnected lenses of dyke material, arranged along the strike of the dyke. This might possibly explain why there was no damming of solutions. It is hard to explain, however, the very slight amount of mineralization in these dykes. Although the ore contains heavy concentrations of sphalerite, no sphalerite has been observed replacing dyke material, or filling fractures in the dykes. There has, however, been a slight amount of chalcopyrite occurring as blebs and small stringers in the dykes. An explanation may be that the dykes were injected after the sphalerite mineralization, and before the chalcopyrite. Information revealed by further stoping, coupled with laboratory work, may bring a positive answer to this problem.

In addition to the foregoing dyke occurrences, the No. 8 area is traversed by a number of narrow lamprophyric dykes which strike northwesterly, and dip steeply to the west. These dykes are later than all of the mineralization, and intrude all other dyke formations. In places a slight displacement of the dyke walls has been noted, the rock to the hangingwall having moved upward relative to the footwall side.

Structure

General

Briefly, the apparent structural sequence in the Britannia roof pendant may be described as follows. The formations were up faulted and steeply tilted by orogenic movements accompanying the invasion of the Coast Range batholith. Compressive stresses acting along a north-easterly direction created a strong zone of shearing, the major shearing axis being in a north-westerly direction. As a preliminary to shearing there was local buckling and folding along the strike of the shear zone, the later shear cutting indiscriminately across the limbs of the folds. The thrust movement was accentuated along a less competent horizon in the shear zone, and a strong thrust fault developed possibly contemporaneously with some of the shearing. Compressive stresses acted intermittently, spaced between periods of mineralization, and these stresses caused local shear and tension fractures to develop in competent areas adjacent to the main thrust fault. This period of compression and thrust faulting was followed by a period of relaxation during which steep, north-westerly striking normal faults developed.

Shearing

The most evident structural feature at Britannia is the main shear zone, an area of sheared and foliated rocks occurring within the roof pendant. The zone is steeply south dipping, with a westerly to north-westerly strike. It has been traced for a number of miles along its strike, and is several thousand feet wide in the eastern part, but narrows towards the west, reaching a point some 10,000 feet to the west of the No. 8 orebodies. The shear zone is approximately 1,000 feet in width in the region of these orebodies, which occur centrally with regard to its footwall and hangingwall.

Faulting

The shear zone is traversed by a large scale thrust fault which parallels it in strike and dip. This fault is closely related to the shearing within the zone, and has probably been caused by the same stresses. The fault was localized along a zone of incompetent slates, tuffs and fragmentals lying just to the footwall of the competent green mottled schist. The footwall rocks have been moved a considerable distance to the west, and slightly upwards in relation to the rocks to the hangingwall of the fault. This thrust fault parallels the green mottled schist in general, and lies to the footwall of it, except at depth, where a reverse dip in the green mottled schist places it to the footwall of the fault zone.

The Britannia orebodies have all been deposited in favorable zones adjacent to, and to the hangingwall of, the main thrust fault. Mineralizing solutions have ascended either up the fault zone, or along openings produced

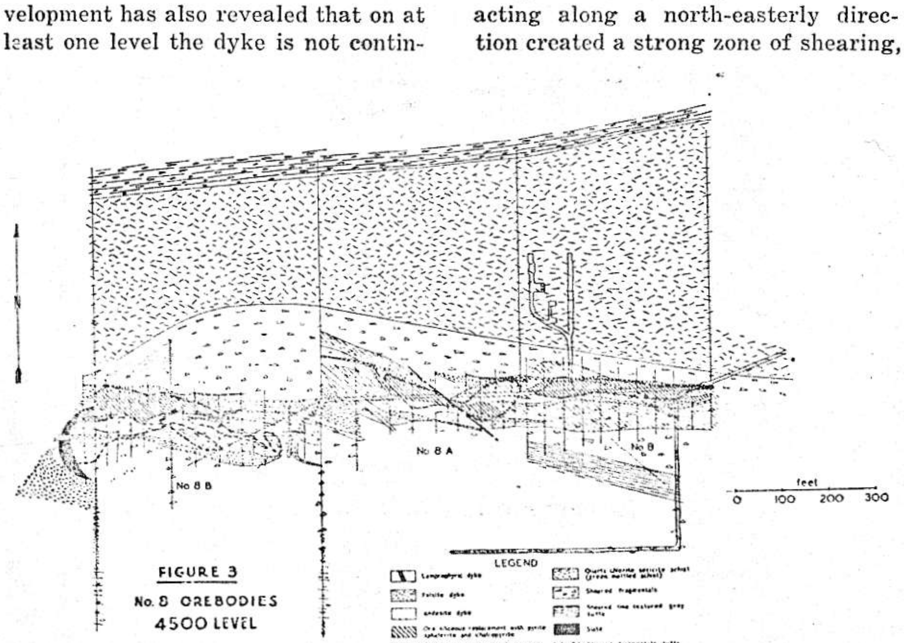


FIGURE 3
No. 8 OREBODIES
4500 LEVEL

by movement along the fault. The No. 8 orebodies lie several hundred feet to the hangingwall of the main thrust fault, near where it cuts through to the hangingwall of the green mottled schist.

Only one post ore fault is known to exist in the No. 8 orebody. This fault may be observed on the 4350 and 4500 levels, intersecting the 8A orebody in the middle of its length. The fault has a general north-westerly strike which swings towards the north as the fault crosses the ore zone. The fault dips steeply towards the south. There has been a horizontal displacement along the fault of approximately 50 feet, the south side having moved towards the west with respect to the north side. The fault is a normal one, indicative of the relaxed conditions usually associated with post ore movements.

Folding

Some of the early folding which developed as a result of pre-shearing stresses has been revealed in the region of the No. 8 orebodies by the mapping of distinctive horizon markers.

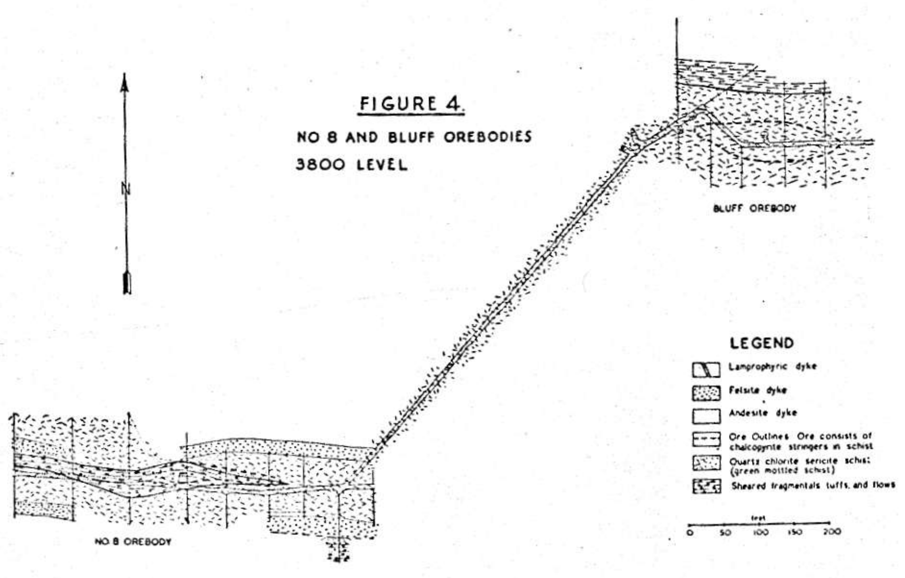
A large scale gentle fold is revealed in the mapping of the hangingwall contact of the green mottled schist. This contact has been mapped in sufficient detail to have indicated this fold on the 3500, 4000, 4100 and 4500 levels. On the 3500 level the fold is to the east of the upward projection of the ore zone, but it can be seen occurring further to the west by successive lower levels. On the 4000 level the eastern limb of the fold can be seen just to the west of the No. 8 orebody proper. (See Fig. 2.) On the 4500 level, the apparent crest of the fold is just west of the 8B orebody. (See Fig. 3.) This indicates a plunge to the west at 30 degrees to the horizontal. There are not sufficient horizon markers in the sheared tuffs and fragmentals to the hangingwall of the green mottled schist, to be able to map folding of these schists on each level. On the 4500 level, however, there are indications that these schists have been folded similarly to the green mottled schist.

On the 4500 level a large fold has been revealed by the mapping of a lens of dark slatey schist near the west end of the 8B orebody. (See Fig. 3.) Here the slate has been folded into a large crescent with the open side of the crescent facing east. This fold has been of economic importance as mineralization has been concentrated within the fold in sufficient strength to form an ore shoot of the No. 8B orebody. As this fold has not been mapped on any other level its plunge is not known.

Mapping on the 3800 level has revealed a lens of fragmental or tuff having a common axis with the No. 8 orebody on that level. This lens is bounded by a narrow strip of green mottled schist to the hangingwall, and it is succeeded to the hangingwall by a thick series of fragmental and tuffaceous rocks. (See Fig. 4.) In section, as shown by the block diagram and by Figures 5 and 6, this structure appears as an apparent fold or overlap of the green mottled schist. There is no evidence which would indicate the plunge of this structure, which has had an apparent important control over the No. 8 mineralization.

Fracturing

Due to the effect of compressive stresses, fracturing has developed in certain brittle formations in and near the ore zone. The strongest fracturing is in silicified schists and in competent tuffs. These racks have fractured under stress, while adjoining softer schists have absorbed movement along the planes of schistosity. The fracturing has taken place in several periods. Early fracturing opened the way for the invasion of quartz resulting in the silicification of large portions of the ore zone. Later fracturing gave access to mineralizing solutions which deposited quartz and sulphides in the fractures. These later fractures have been mapped in detail where they have been exposed by workings. In general they have a north-westerly strike, a minority of the fractures striking in a north-easterly direction. Mineralization of ore strength is confined to zones of north-westerly striking fractures which are distributed throughout the ore zone, and adjoin highly silicified and replaced ore lenses.



Silicification

There has been silicification of certain bands and zones in the tuff fragmental series in the region of the orebodies. This zone of silicification constitutes what has been described as the ore zone. This ore zone has been exposed completely on the 4500 level, where the silicification is more intense and of greater extent than on higher levels.

The strongest silicification consists of a complete replacement of certain lens shaped bodies surrounded by recognizable tuffs and fragmentals. The replacement is so complete that the host rock is difficult to recognize. There are, however, a few unreplaced fragments which may indicate a fragmental host rock. These replaced zones are occupied by heavy ore mineralization. (See Fig. 3.)

Towards the west end of the 8B orebody, enclosed by a fold of slate, (Fig. 3), there is a body of silicified fragmental rock in which the host rock has been "soaked" with quartz, that is, there has been a partial replacement, with an absence of quartz stringers, but with a very high percentage of quartz. At the same time the original texture of the rock is well preserved and its character may be easily recognized.

Surrounding, and adjacent to these silicified bodies there is a general zone containing a series of small, close quartz stringers following an irregular fracture pattern in sheared tuffs and fragmentals. This zone of stringers occupies the major proportion of the ore zone. The outlines of this zone are clear cut. It is parallel to the general trend of the ore shoots and is somewhat wider. Towards the west end of the 8A ore shoot the zone breaks up into fingers, one of which contains the western end of this oreshoot and continues past the ore as an elongated tapering finger. These fingers play out several hundred feet to the west of the No. 8A mineralization, and are succeeded towards the hangingwall by another series of fingerlike lenses of silicified rock which continue to the west, and which contain, or are closely associated with the ore shoots of the 8B orebody. (See Fig. 3.)

Mineralogy

The No. 8 mineralization is of mesothermal type, and the minerals represented all occur in one or another of the Britannia orebodies. The sequence in which the various minerals were introduced cannot be accurately determined without a detailed study of polished sections. Even without this study, however, certain deductions may be made from field work and from hand specimens.

The following minerals have been identified in the No. 8 orebody: pyrite, sphalerite, galena, chalcopyrite, gold and quartz. Alteration products or original rock forming minerals present in partly replaced host rocks have been omitted.

Pyrite

Pyrite occurs typically as fine to medium grained cubes disseminated throughout the ore zone, and is found both in ore shoots and in the surrounding schists. A small proportion of the pyrite is present in pyritic stringers occupying fractured zones in or near ore shoots. Pyrite is by far the most abundant mineral in the No. 8 ore zone. As shown by an examination of lightly polished sections it is in part earlier than sphalerite or chalcopyrite, where it occurs in the chalcopyrite sphalerite lenses. A later phase of the pyrite has accompanied chalcopyrite mineralization occupying later fracture zones.

Sphalerite

Sphalerite is present in irregular disseminations occupying lenses of complete siliceous replacement only. The mineralization is irregular enough so that individual 5 foot core samples within the lenses, though always showing zinc values, will vary in zinc content from 1% to over 20%.

The sphalerite is generally fine to medium grained, and steel grey in colour, although many examples of brown sphalerite may be seen. Picked samples of sphalerite, however, are generally quite low in iron. It is commonly closely associated with fine crystallized pyrite, and where pyrite mineralization is heavy it is sometimes difficult to recognize the sphalerite in a hand specimen, although assays may give unexpected high zinc values.

Sphalerite is the most localized of the sulphide minerals, and this localization, together with its relatively uniform distribution, may be due to a single period of deposition. From an examination of lightly polished sections, the sphalerite is quite definitely later than the heavy pyrite mineralization accompanying it. From hand specimens examined megascopically and from field observation, the chalcopyrite is apparently later than the sphalerite, as it may be seen veining masses of that mineral.

Galena

Small amounts of galena are present in the No. 8 orebodies, invariably associated with sphalerite. The galena is present as short narrow stringers or in compact small lenses, and occurs as medium grained crystals. The average lead content of the ore is about one half of one per cent, and at no place have individual five-foot samples averaged higher than 3% lead.

Chalcopyrite

Chalcopyrite, the principal commercial mineral, occurs as massive veinlets, as small stringers or as irregular disseminations. It is in general rather intimately associated with varying amounts of pyrite. In some places small stringers of almost pure yellow chalcopyrite have been noticed, but they are the exception rather than the rule. The distribution of chalcopyrite within the ore shoots is quite regular, individual samples rarely running under 1.0% or over 4.0%.

Chalcopyrite is more widely distributed than the sphalerite, occurring with it in the chalcopyrite, sphalerite lenses, and also outside these lenses in fractured zones. There is no direct evidence to show that in these localities of deposition the chalcopyrite is contemporaneous. It is a fact, however, that some of these fractured zones adjoin and merge into the chalcopyrite sphalerite lenses. Other such zones, although separated where observed on a level, may join these lenses at a lower elevation. It is quite possible, then, that the chalcopyrite bearing solutions, having exhausted the possibilities of deposition in the already heavily replaced lenses, have overflowed into receptive adjoining formations.

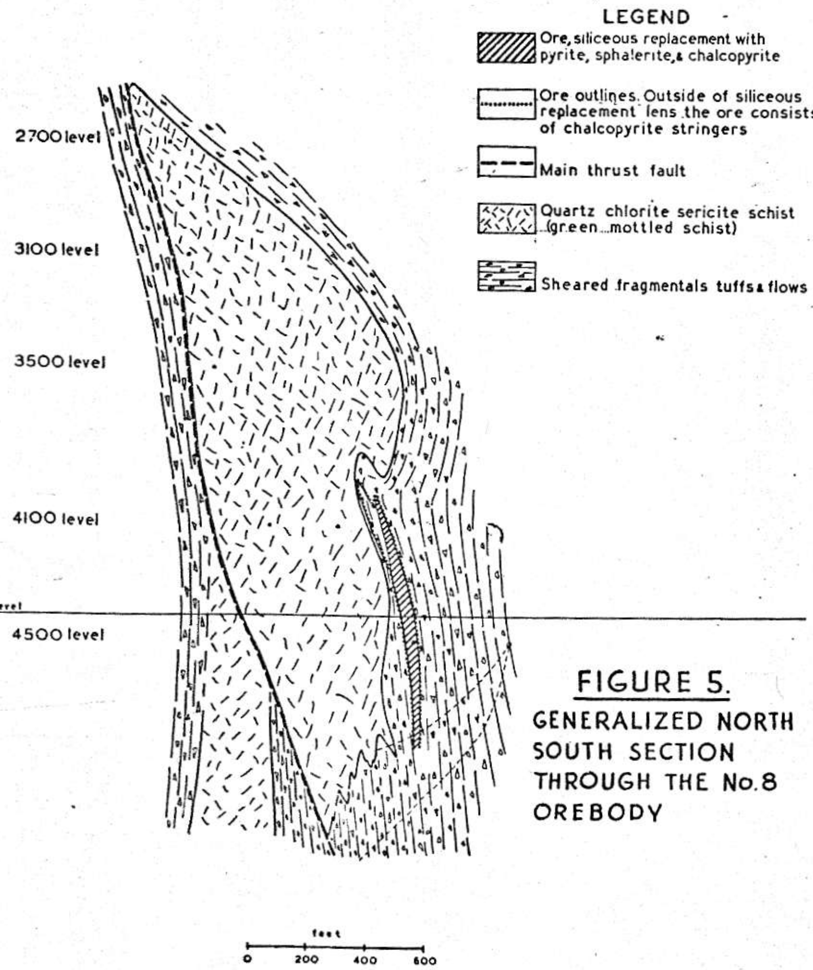


FIGURE 5.
GENERALIZED NORTH SOUTH SECTION THROUGH THE No. 8 OREBODY

Quartz

Quartz occurs abundantly in the orebodies and surrounding zones. The quartz in the replacement lenses is massive and dark with a glassy lustre. The quartz occurring in small fractures throughout the ore zone is quite white and stands out sharply against the surrounding darker background.

Quartz is the most abundant mineral in the orebody, and apparently overlaps all of the other mineralization. The earliest phase of the quartz is probably represented in the quartz soaked rocks seen in the 8B orebody. Contemporaneous with this, or possibly later, was the complete siliceous replacement of certain lenses in the ore zone. This replacement was possibly a continuation of the quartz soaking, which for various reasons had continued to a greater degree in certain localities. This silicification was generally earlier than the chalcopyrite and sphalerite mineralization occupying these lenses, but was later than some of the pyrite. Quartz, filling the many small fractures almost universally present throughout the ore zone, is presumably later than these earlier phases of silicification. In places, though not generally, these quartz filled fractures occur within the replaced lenses. A later phase of the quartz is contained in the small gold bearing quartz stringers occupying late fractures in the No. 8 orebody proper.

Gold

In the lenses of siliceous replacement, and especially in the most easterly of these, the No. 8 proper, there are isolated gold shoots with an average gold content of from one half ounce to one ounce to the ton. In specimens of ore of this grade, gold may be seen with a hand lens. The gold consists of small irregular blebs or short narrow stringers occurring in small white quartz veinlets which cut all the surrounding minerals. The gold is not noticeably associated with any of the sulphide minerals.

Small quantities of gold are more or less uniformly distributed throughout the orebodies. The mineral association of this gold is not known. From this it would appear that the gold is of two ages, the earlier one being of general distribution, the later one being confined to local shoots.

Relationship of Ore to Rock Types

The No. 8 solutions definitely preferred certain rock types. The orebodies are confined almost entirely to tuffs and fragmentals lying to the hangingwalls of the green mottled schist. The green mottled schist, a rock which had been the host of most of the Britannia ore, is definitely unfavorable in the case of the No. 8. The apparent cause of this is that favorable structure has not developed in the green mottled schist. Due to the relative lack of brittleness of this schist in the No. 8 region, deforming stresses have been absorbed mainly along planes of schistosity, leaving only short discontinuous fracture zones to be occupied by mineralizing solutions.

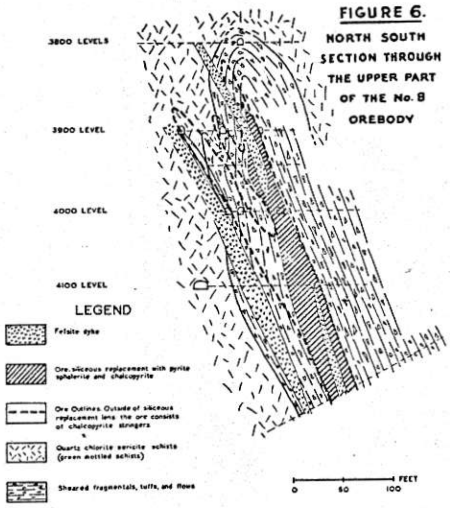


FIGURE 6. NORTH SOUTH SECTION THROUGH THE UPPER PART OF THE No. 8 OREBODY

In general, ore mineralization has been strongest in fragmental rocks of medium texture. The coarser fragmentals are not favorable, and the fine grained tuffs, although not necessarily unfavorable, are not common in the ore zone. Although the rocks in the ore zone have been sheared, the shearing is not as intense as in the rocks to footwall and hangingwall. The conclusion is that rocks in the ore zone have been preferentially silicified at an early period, due to their relatively greater porosity. Subsequent deforming stresses have fractured parts of the siliceous ore zone, and the less competent unsilicified rocks to the footwall and hangingwall have absorbed the movement, which has contributed to their greater schistosity.

Concentration of ore in shoots and lenses of distinct mineralization within the siliceous ore zone is difficult to ascribe to the controlling influence of rock types only. In the chalcopyrite sphalerite lenses the replacement has been so complete that the original rock type is hard to identify. In places remnants of thin bedding may be seen, but these occurrences are so local that it is probable that they represent scattered replaced len[...] slate. Such slate lenses are [...] outside of these replacement [...] From detailed observation, how[...] it would appear that the replace[...] consisted mainly of a medium gr[...] fragmental.

The chalcopyrite mineralizati[...] cupies fracture zones in either me[...] grained fragmentals or fine gra[...] tuffs. These fragmentals have [...] rendered competent by silicifica[...] and the tuffs, although not necessar[...] silicified, are sufficiently compete[...] character to contain fracture zon[...]

Structural Control of Ore Deposition

The general location of the No. [...] orebodies is due to their proximity [...] the main thrust fault. Fractures wh[...] developed to the hangingwall of th[...] fault guided the ascending solutio[...] until a zone favorable for deposition was reached. Porosity of fragmental beds was a factor in the primary localization of mineralized bodies. Distinct structural features, however, were responsible for the final positioning of individual orebodies, and also formed local controls which cut off and terminated ore lenses at their extremities.

As mentioned previously, pyrite, sphalerite and some quartz were deposited early, forming replacements in porous zones. As a result three distinct siliceous lenses were formed, containing appreciable amounts of pyrite and sphalerite, disseminated throughout. Later fracturing of these siliceous masses enabled copper rich solutions to form chalcopyrite stringers within the original lenses, to produce lenses of copper-zinc ore. Although most of this fracturing was confined to the competent siliceous lenses, some fracture zones developed in the partially silicified schists surrounding these lenses. Where these fracture zones merged with the replaced lenses they were subject to mineralization by the copper rich solutions whose course had been mainly confined to these more deep seated and continuous lenses. As a result, small chimneys and irregular shoots of chalcopyrite stringer-lode type were formed, surrounding the more massively mineralized sphalerite - chalcopyrite lenses.

Folding has previously been mentioned as having had an important effect on ore deposition. Actually, the folding has apparently not affected primary location of orebodies, but has, in places, caused the abrupt termination of ore shoots.

The wide crescentic fold of slate mapped near the west end of the 8B orebody on the 4500 level, has abruptly terminated a hangingwall chalcopyrite ore shoot at its western extremity. To the west of the slate fold, or hood, there is barren schist, while to the east, within the hood, a considerable concentration of sulphides has taken place. Fracturing has developed in quartz soaked fragmental rock, within the hood, the most intense fracturing having taken place, not against the slate, but a short distance from it. As a result, the sulphide content increases, going away from the slate, towards the centre of the ore shoot.

The flat plunging fold which has caused a hood of green mottled schist to be superimposed above the course of the No. 8 mineralizing solutions (see Fig. 6) has had an appreciable control on ore deposition in the No. 8 orebody proper. Below the green mottled schist, chalcopyrite stringers of ore grade occur in a siliceous fragmental rock. As the mineralized zone passes upward into the green mottled schist, there is a marked decrease in the mineral content, and ore terminates at or near the contact. Apparently fracturing has not developed to as great an extent in the green mottled schist as it did in the fragmental formation just below it, and due to this, circulation of solutions and mineral deposition continued to a greater degree in the lower formation.

The flat plunging fold mentioned above has been mapped on the 3800 level, using the hangingwall contact of the green mottled schist as a horizon marker. Stoping operations carried on just above the 3900 level have revealed this fold at a lower horizon. Here, distinctive narrow slate lenses have been mapped in vertical section as forming a hood which has produced a sharp contact over heavy sulphide mineralization. Directly below the slate hood, and in contact with it, is massive, fine grained pyrite replacement. Below the pyrite there is massive fine grained sphalerite mineralization, with fingers of sphalerite projecting into the pyrite zone. Chalcopyrite and quartz stringers intersect the pyrite and sphalerite mass. The uniformity of the heavy pyrite and sphalerite mineralization, together with the fine texture of these minerals, indicate the possibility that a porous host rock allowed circulation of solutions and complete replacement, aided by the damming action of the slate hood. The chalcopyrite mineralization, as elsewhere in the No. 8 orebodies, followed a period of fract... produced a zone of string... control of this slate hood ... cal is shown by the fact t... pyrite stringers occur ... hangingwall of the limbs of ... as well as above it. This in... the later chalcopyrite min... by-passed a control which ha... most, or all, of the earlier ... The reason for this is undoub... cause the fracturing which ... the later solutions to circul... place over a greater width ... of the early ore channel.

Depth Considerations

The Britannia ore has a kno... tical range of close to 5,000 fe... ing it one of the deepest, if ... deepest ore occurrence in Brit... lumbia. It is interesting to no... the mesothermal character of t... eralization has persisted w... change from the Fairview, the ... orebody, to the lowest portion ... No. 8, at the bottom of the know... occurrence. The No. 8 itself is ... eralogically very similar to the ... orebody, one of the Britannia or... ies which occurs at an elevation ... feet higher. No mineral may be ... to be characteristic of the deeper ... tannia orebodies. Sphalerite is perh... the most characteristic No. 8 mine... but in the Jane orebody, sphale... occurs in equal abundance, and sp... erite occurs abundantly in the No... orebody, one of the highest of the B... tannia orebodies.

The granitic source of the Britan... ore solutions underlies the roof pe... ant, and one would expect to encou... ter higher temperature minerals ... the granite is approached below ... present known limits of the ore. T... bottom contours of the roof penda... are unknown, no granite having be... encountered in any of the undergrou... workings, and the depth of old... sheared rock between the present o... and the top of the granite is thus n... available. Some pyrrhotite mineraliza... tion has been encountered, howeve... about 5,000 feet west of the No. 8 ore... bodies, at the 4100 level. As no pyr... rhotite is known to ocur in the No. 8 zone, or to the east of it, this possibly indicates that the granite is shallower under the pyrrhotite occurrence, deepening towards the No. 8 zone.

It seems quite probable, at any rate, that a considerable depth of sheared pendant rocks occurs beneath the existing ore. A current geological problem is to determine whether, in this zone, there is a downward extension of the known No. 8 ore, or a recurrence of similar orebodies at depth.

In considering this problem it was noted that the No. 8 orebody bottomed quite suddenly, the vertical change from heavy sulphide mineralization to barren schist being abrupt. If the bottoming of the ore had been due to a change in temperature and pressure affecting deposition from ore solutions, the decrease in mineralization going to depth, would have been much more gradual. In addition, recent geological information gained from diamond drill holes, though meagre, has indicated that the bottoming of the ore is accompanied by a sharp change of dip in the enclosing schists. Since there is no evidence from the mineral content of the No. 8 ore, that the bottom of a mesothermal zone has been reached, there is no reason why, given proper structural conditions, more ore of the No. 8 type may not be encountered below the known ore lenses.

Development

Discovery

Britannia orebodies have been developed by main adit tunnels connecting with vertical or inclined shafts from which secondary levels have been driven. (See Fig. 8.) The lowest of the main adit tunnels is the 4100 tunnel. This was started just above the Beach Camp, some 300 feet above sea level, and was so laid out as to drive longitudinally through the Britannia shear zone, and eventually connect with the Victoria shaft.

As this tunnel opened up potential ore horizons in the lower part of the shear zone, it was decided to do systematic drilling from the tunnel, exploring the shear zone at this horizon by long diamond drill holes, drilled across the strike of the formations. The drill holes were so laid out as to prospect for ore in the green mottled schist and in the rocks adjacent to it, on the hangingwall and footwall.

In the summer of 1937 a long 20° up hole, drilled in a southerly direction from the 4100 tunnel, encountered interesting mineralization just to the hangingwall of the green mottled schist. The mineralization of chalcopyrite stringers in silicified grey schist, separated by barren schist from a narrow siliceous band containing heavy sphalerite mineralization with accompanying chalcopyrite. This drill intersection was at an elevation of 450 feet, some 140 feet above the 4100 tunnel at this point, and 350 feet to the south of it.

Initial Development (See Fig. 9)

Due to the fact that the new discovery lay some hundreds of feet south of existing workings, it was n... to drive long crosscuts to expl... sible upward and downward ... tion of the mineralization in ... tail. Accordingly crosscuts driven towards the hanging... the 3500 and 3800 bluff workin... from the 4100 tunnel.

At the 3500 level, on the u... projection of the original discov... mineralized zone was encou... which was explored by means of ... ing and short diamond drill hole... mineralized zone was found to c... of short disconnected stringe... chalcopyrite and pyrite in sili... green mottled schist. This zone approximately 50 feet wide and ... eral hundred feet long. The mine... zation was not sufficiently concent... ed to constitute ore.

Short up holes from the 3500 l... disclosed promising widths of min... alization above the level, and a r... was driven with the purpose of expl... ing the ground at the 3400 elevati... Here drifting and diamond drilli... disclosed mineralization similar ... that in the 3500 level, and similarl... insufficiently concentrated to mak... ore.

On the 3800 level, the downward projection of this mineralized zone was encountered at the end of a long diagonal crosscut, and exploring of the zone was commenced by means of drifting and diamond drilling. The mineralization as on the 3500 level, consisted for the most part of discontinuous pyrite and chalcopyrite stringers in siliceous green mottled schist. As drifting proceeded to the west, however, a long lens shaped area of grey schist was encunotered, and in, and apparently influenced by the schist, there was a concentration of chalcopyrite stringers of sufficient intensity to constitute ore. Sphalerite was absent, and gold values were exceedingly low or absent. Altogether on this level, a lens of ore averaging 15 feet in width with a length of 170 feet was developed. This was later proven to be very close to the top of the No. 8 orebody.

On the 4100 level, a diagonal crosscut of main haulage dimensions was driven to a point in the footwall of the downward projection of the mineralized zone. Diamond drill holes were drilled from several points in this crosscut so as to intersect the projected zone. These holes encountered strong mineralization, and in order to explore the zone more thoroughly, a drift was collared at the face of the cross-cut and was driven to the east, parallel to the strike of the mineralized zone and some distance to the footwall of it. Further drill holes spaced along this drift revealed a compact mineralized zone some 300 feet long and with an average width of 35 feet. The lens was enclosed by grey schist and lay some 50 feet to the hangingwall of the green mottled schist. The mineralization consisted of chalcopyrite, sphalerite and pyrite in a highly siliceous zone. Although no special significance was given at the time, it was noticed that the sphalerite mineralization was concentrated in the hangingwall of the lens. Some gold values were encountered in this hangingwall mineralization.

By this preliminary phase of the exploration and development a fairly comprehensive picture of the upper part of the No. 8 orebody was given. It was known that there was definitely mineralization of commercial grade and dimensions on the 4100 level and that this mineralization extended upward with uniform copper content but with diminished values in zinc and gold, to the 3800 level. On the 3500 level and higher, however, there was no ore.

Preliminary Development of Ore Below 4100 Level by Deep Diamond Drilling

The point was now reached where development could follow a log... quence. It was desirable to d... by the most efficient means ... there was an appreciable am... ore lying below the 4100 level.

The decision was made to drill as a preliminary to possib... sinking and deep level develop... was decided to drill from the ha... wall of the ore, as the attitude ... enclosing schists was considered ... favorable for hangingwall dr... Diamond drill holes tend to cur... wards a direction normal to th... tude of the schists. The schist... at from 60° to 70° to the south ... and it was feared that holes dr... from the footwall of the ore would be deflected upward too qui... and would not give sufficient dept... information.

In order to drill from the hang... wall side, a long crosscut and hang... wall drifts were necessary to g... access to drill stations. Certain d... culties made this work undesirabl... the 4100 level. The existing workin... on this level, being of main haula... specifications, had three foot gau... track and were served by large 6-t... cars. In the interests of economy ... was desirable to drive small siz... workings which would be served b... small one-ton cars on 2-foot gaug... track. The transfer of muck to th...

larger cars constituted an obvious problem. Accordingly it was decided to establish the 4000 level, some 70 feet above the 4100, which would serve to develop the ore and also provide for the hangingwall diamond drill holes. The muck from this level was to be disposed of on the 4100 level by means of a chute raise. Therefore a raise was driven from the 4100 level, to pass into the footwall of the projected ore zone just below the 4000 level. This raise was collared midway along the length of the orebody as it has been outlined on the 4100 level.

A station was established on the 4000 level, and from here the ore zone at this horizon was partly developed by drifting to east and west, and by short diamond drill holes. As on the 4100 level, a concentration of sphalerite, chalcopyrite and pyrite was observed near the hangingwall of the ore, with irregular chalcopyrite mineralization to the footwall.

From a central point along the length of the orebody, a long crosscut was driven 350 feet to the hangingwall and drifts were driven to the east and west from the end of the crosscut. (See Fig. 2.) Diamond drill stations were cut along the drifts at 125-foot intervals and down holes drilled from each station.

In order to obtain two intersections evenly spaced with the 4100 information, it was decided to drill two down holes from each station. The holes were drilled with dips of minus 57° and minus 80°. In order to ensure an accurate projection of possible ore intersections, the holes were surveyed with a Carlson compass.

Results of the Drilling

The diamond drill holes drilled from the end of the crosscut, and from the two stations immediately to each side, intersected strongly mineralized siliceous zones containing chalcopyrite and sphalerite in commercial ... ties. The holes drilled to the ... west of this showed low grade ... alization or barren schist.

As a result of this drilling ... possible to project the No. 8 ... ization down to the 4500 level ... zon, and to be assured that it ... changed appreciably in size or ...

Using the surveyed diamond ... holes as a guide, an ore outli... drawn on the 4500 level plan. ... was to be used to guide future d... opment on that level.

Development Between 3800 and 4000 Levels

Having roughly delimited a siz... block of ore below the 4100 level ... was now decided to do more deta... development on the ore above the 4... level. The 4000 level was partly ... veloped at this time, and it was ... sired to finish development on th... level, and also to investigate the ... between the 3800 and 4000 levels.

To initiate development above the 4000 level a raise was located centrally in regard to the orebody an... was driven to connect the 4000 and 3800 levels. The raise was in chalco... pyrite sphalerite mineralization at the collar, and continued in this until 50 feet below the 3800 level, where the sphalerite played out, and the last part of the raise cut a series of chalcopyrite stringers.

Short north and south diamond drill holes were drilled from two stations spaced respectively at one-third and two-thirds of the 3800-4000 interval. These holes indicated relatively uniform widths of ore between the levels, with, however, varying widths of chalcopyrite mineralization to the footwall. In order to obtain a closer picture of the ore outlines and to reconcile the difference in mineral content of the ore as outlined on the 3800 level as compared with the heavier sphalerite bearing ore on lower levels, it was decided to develop a level midway between the 3800 and 4000 levels at the 3900 level.

Accordingly a station was cut at the proper elevation in the raise, a short crosscut driven towards the footwall of the ore, and drifts driven to east and west from the crosscut. The crosscut penetrated heavy chalcopyrite and sphalerite mineralization which gave way to a zone of chalcopyrite stringers near the footwall. The east-west drifts were driven in this zone of chalcopyrite stringers, and short diamond drill holes from the drift indicated an area of sphalerite chalcopyr-

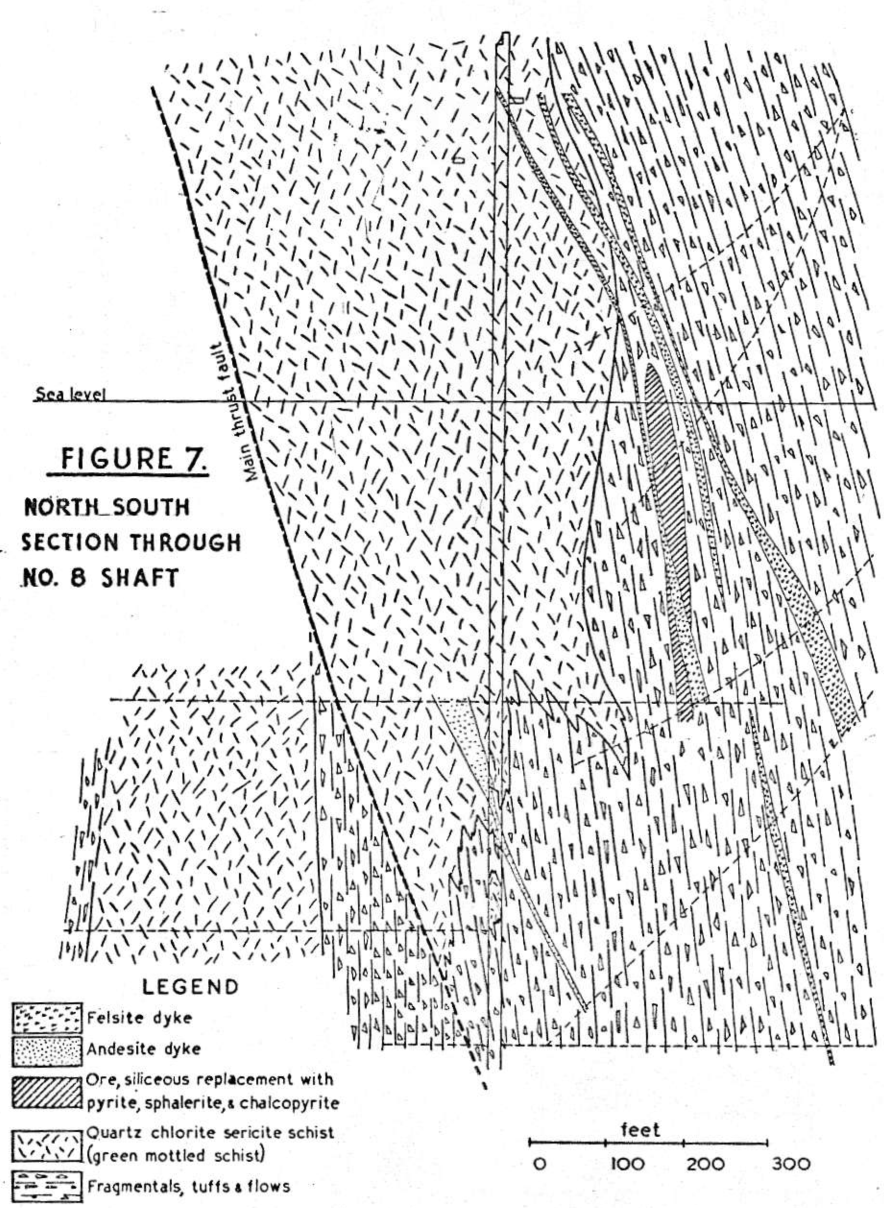


FIGURE 7.
NORTH-SOUTH SECTION THROUGH NO. 8 SHAFT

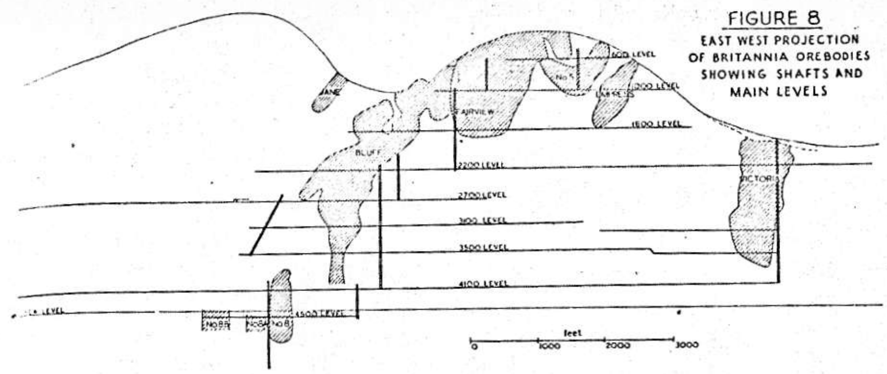


FIGURE 8
EAST WEST PROJECTION OF BRITANNIA OREBODIES SHOWING SHAFTS AND MAIN LEVELS

ite mineralization towards the hangingwall with irregular zones of straight chalcopyrite mineralization towards the footwall.

At this stage of the development, this much was made clear as to the nature of the ore between the 3800 and 4000 levels:

(1) The ore was continuous from the 3800 to the 4000 level, and the ore outlines were irregular, varying from level to level.

(2) The area of ore outlined on the 3800 level was much smaller than on the 3900 and 4000 levels.

(3) There was a concentration of sphalerite in the hangingwall region of the orebody, and this sphalerite mineralization disappeared entirely some 50 feet below the 3800 level.

The chief problem now was the development of the oreshoots in sufficient detail to prepare for mining operations. This detailed development was to wait, however, while development on the 4500 level was proceeding. The 4500 development would later give the clue which enabled final development on the upper levels to be planned so as to complete the ore picture.

4500 Development, No. 8 Orebody

After the diamond drill holes from the 4000 level had indicated ore at the 4500 elevation, it was proposed to carry out development on the 4500 level.

There were two possible methods of carrying out this development. One was to sink a shaft at a favorable spot near the ore, and carry out development from it. This shaft would also serve eventually to hoist ore from the levels below the 4000 and thus would have to have three compartments, and be equipped with a large hoist capable of handling a potentially large daily production. The capital expenditure involved in a shaft of this nature was considerable and after due consideration it was decided to carry out further investigations involving less cost before deciding on the eventual location and type of hoisting shaft. Fortunately there was another shaft, the No. 6, located 1,000 feet east of the No. 8 orebody, which could be used for this proposed development.

The No. 6 shaft had been sunk originally to investigate the lower Bluff mineralization and the Homestake showing. (See Fig. 9.) It was a two-compartment shaft inclined towards the south at minus 60°, and reaching from the 4000 level to the 4200 level. The shaft was equipped to handle development muck which would be trammed on the 4100 haulage tunnel, and hoisting equipment was sufficient to hoist muck from the 4500 level. With the purpose of doing development work on the 4500 level only, the No. 6 shaft was deepened and a station cut and dumping installations made at the 4500 level. The shaft was in firm green mottled schist throughout.

A drift was collared off the 4500 station, and was driven to the west, aimed directly at the east end of the No. 8 orebody, as outlined at the 4500 elevation. The work was advanced by three shifts and progress was rapid. At 1100 feet from the collar typical No. 8 mineralization was encountered. As planned, the drift had angled into the footwall of the orebody a short distance from its eastern end.

The drift was advanced a few rounds into the ore, then turned and continued in a due westerly direction. As indicated by the projected ore boundaries this would keep the drift in ore for the length of the orebody.

The principal object of this drift was to expose ore, and to act as a base for short diamond drill holes which would give full information as to the strength and character of the ore at this elevation. As the drift advanced in ore, sampling indicated values substantiating those shown by the down diamond drill holes. In addition, unexpectedly high values in gold were encountered along the drift, within the ore zone. Subsequent diamond drilling would be necessary to outline completely these gold shoots.

As the drift continued to the west it passed out of the west end of the ore and was stopped in low grade siliceous schist. It was now decided to drill short north and south drill holes at 40-foot intervals along the orebody. These holes outlined a lenticular ore zone 340 feet long and averaging 33 feet in width. The copper and zinc values were similar to those at the 4100 level, while gold values were somewhat higher. The gold was concentrated in a lens shaped shoot in the eastern part of the orebody. Intermediate holes were drilled to outline this heavier gold concentration. The main ore lens developed on the 4500 level was uniformly mineralized with chalcopyrite, sphalerite, and pyrite.

It was now apparent that the No. 8 orebody had continued with undiminished size and strength to the 4500

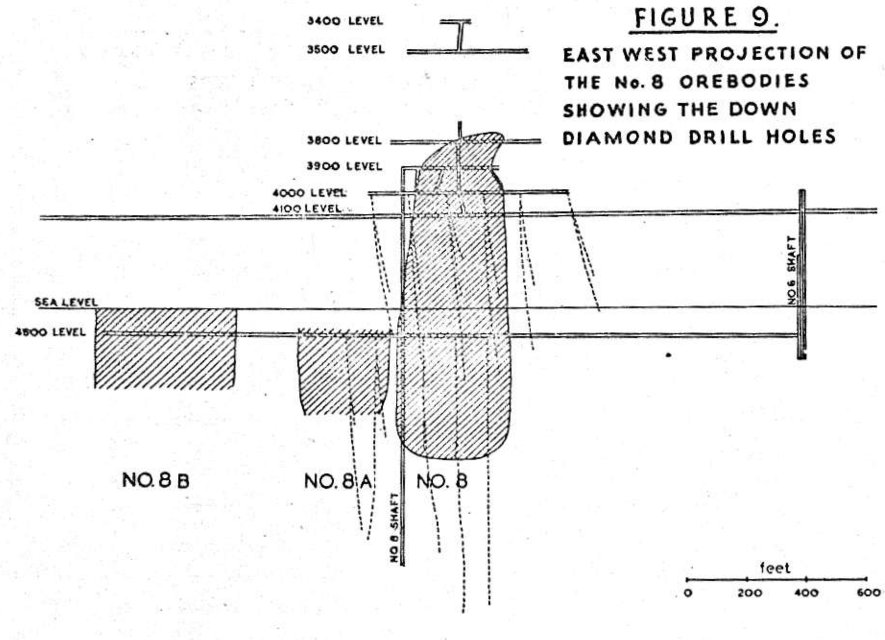


FIGURE 9.
EAST WEST PROJECTION OF THE No. 8 OREBODIES SHOWING THE DOWN DIAMOND DRILL HOLES

level. The gold ore shoot within the boundaries of the orebody had been well defined at the 4500 level, and could be related to lower grade gold shoots on the 4100 and 4000 levels.

Development of the No. 8 Orebody Below the 4500 Level

In order to obtain further information as to the depth of the ore and the available tonnage, it was decided to crosscut to the hangingwall on the 4500 level, drive a hangingwall drift, and drill steep down holes into the ore zone.

A crosscut was collared from the development drift, near the east end of the orebody, and driven 350 feet to the hangingwall. From here a drift was driven to the east, parallel to the orebody, and drill stations cut at 110 foot intervals. Down holes were planned following the pattern of those drilled from the 4000 level.

A down hole drilled at minus 80° was intended to intersect the orebody at 550 feet below the 4500 level. Instead the hole intersected the ore at a surprisingly low collar distance, and Carlson compass survey of the hole revealed that the hole had flattened abruptly and had intersected the ore zone only 350 feet below the 4500 level. The fact that this hole had flattened so much more than similar holes drilled from the 4000 level could be attributed to the fact that the 4500 hole had encountered soft fissile schist in its early portion, and that this had caused an upward deflection of the hole.

The problem now presenting itself was to drill a down hole which would gain more depth. It was realized that a hole dipping towards the orebody at minus 85° would be the steepest which could be drilled to ensure a trend towards the orebody. It was necessary, however, to have the initial 300 feet of drill hole in as straight a line as possible. This was obviously out of the question with the "E" or 1-5/16 in. rods which had been used previously, so "A" rods, 1⅝ in. in diameter, were used for the first 300 feet of the new hole. The reasoning behind this was that these rods, being stiffer than the "E" rods, would not bend as much, and would result in a straighter hole. The results were fully justified. Acid tests showed that the hole had flattened only 3° in the first 300 feet. This portion of the hole was then cased, and "E" rods were used for the remainder of the hole. Surveying showed that these rods caused the lower portion of the hole to flatten and to intersect the projection of the ore zone some 900 feet below the 4500 level.

The three flatter holes drilled from the 4500 level intersected ore of similar width though lower grade than on the 4500 level. These three holes indicated ore to a depth of at least 400 feet below the 4500 level.

The three steeper holes, although drilled well through the downward projection of the ore zone, were completely barren. There was also a noticeable lack of silicification or alteration in the schists below the ore. (See Fig. 7.)

This work showed that the No. 8 orebody proper extended from the 3800 level to the 4900 level, a vertical depth of 1100 feet. Some detailed development would still be necessary to clarify the more intricate ore pattern on the upper levels of this orebody. Further exploration and development on the 4500 level were to help in clarifying this pattern.

Development of the 8A Orebody (See Fig. 3)

The exploration drift on the 4500 level, which had penetrated the length of the orebody, had been stopped in well silicified ground with interesting though sub-commercial mineralization. Due to this fact it was decided to prospect to the west by drifting ahead on the same line. A short distance to the west of the No. 8 orebody, a series of heavy chalcopyrite stringers were encountered. The stringers occupied a zone of fracturing in siliceous schist. This mineralization was of commercial grade and was continuous for 100 feet along the drift, when it faded into barren grey schist. This continued for 65 feet, at which point the drift went through a well defined north westerly striking, steep dipping fault. To the west of this fault, and bounded by it, there was heavy siliceous replacement accompanied by chalcopyrite and sphalerite mineralization of ore grade. This ore was distinctly different in character from the chalcopyrite stringers first encountered in the drift, and closely resembled the chalcopyrite sphalerite mineralization of the No. 8 orebody proper. This ore was continuous in the drift for 95 feet, then played out into well silicified schist with scant sulphides.

Short north south diamond drill holes spaced at from 25 to 50 foot intervals were drilled along the mineralized portions of the drift. These holes indicated an orebody 300 feet long and averaging over 30 feet in width. This new orebody was called the No. 8A.

For the first time it was realized that the distinction between the chalcopyrite sphalerite type of mineralization and the zones of chalcopyrite stringers was sharp and clear cut, and that the siliceous lenses containing chalcopyrite and sphalerite were in effect separate orebodies having irregular zones of chalcopyrite stringers branching from them at intervals. In the No. 8A orebody, the siliceous lens had a length of 260 feet and average width of 30 feet. To the east end of this lens there was a wide fracture zone 100 feet in length and 50 feet in width, which adjoined the lens on the footwall side. This zone contained chalcopyrite stringers of commercial grade. The No. 8A orebody as developed on this level was low in gold but had copper and zinc in similar amount to the No. 8 proper.

Some efforts were made to delimit the top and bottom of the No. 8A orebody. Down and up holes were drilled from a westward extension of the 4500 hangingwall drift which had served for previous down holes. A series of down holes indicated that orebody extended to about 240 below the 4500 level, then appar- played out as abruptly as had the No. 8 lens. An up hole from the drift intersected the upper proje of the ore zone 200 feet above the level, and encountered nothing barren schist.

From the work done on the 8A orebody it was possible to lay out a bl of probable ore, extending from short distance above the 4500 level, the depth indicated by diamond drilling.

Detailed Development of No. 8 Oreshoots, 3800 to 4000 Levels

The knowledge that the chalcopyrite sphalerite mineralization was concentrated in distinct and clear cut lenses of siliceous replacement was a great aid to further development. It may seem that this was too obvious a fact to have been overlooked. It had remained unnoticed chiefly because the zinc had not been ordinarily considered an ore mineral at Britannia, and zinc assays did not receive much attention. This neglect was soon remedied, however, and in the No. 8 orebody proper the chalcopyrite sphalerite lens was mapped and studied on the various levels.

Below the 4100 level the orebody was wholly made up of a chalcopyrite sphalerite lens approximately 300 feet long and averaging 35 feet in width. At the 4100 level a footwall zone of chalcopyrite stringers was adjacent to this lens, and passing upward through the 4000 and 3900 levels, the chalcopyrite sphalerite lens narrowed, and the chalcopyrite stringers formed a greater proportion of the ore until the chalcopyrite sphalerite lens pinched out 50 feet below the 3800 level.

Little was known as yet of the details of the chalcopyrite stringer ore shoots to the footwall of the main lens. On the 3900 and 4000 levels, the ore shoots were in the form of two large fingers, detaching themselves from the main chalcopyrite sphalerite lens midway along its length, and spreading out towards the north west. (See Fig. 6.) It was decided to drift out along these fingers towards their extremities on both of these levels, and to connect the corresponding drifts by raises extending from level to level.

These short "spur" drifts were driven and revealed further information on this type of ore. The chalcopyrite stringers comprising the ore occupied a series of northwesterly striking fractures in siliceous tuff and fragmental. The most easterly of these fingers was found, when exposed by drifting, to be detached from the main body on both the 3900 and 4000 levels. The diamond drilling done on the 4100 level indicated that this upward pointing finger of ore rejoined the main lens somewhere between the 4000 and 4100 levels.

A raise was driven up at the western extremity of the more westerly shoot to connect the 4000 and 3900 levels. Diamond drilling midway up this raise showed continuity of ore mineralization between levels. Another connecting raise was driven from the 4000 level to the 3900 level, through the easterly finger or chimney of ore. This raise is shown in Fig. 6. Diamond drilling from this raise showed continuity of mineralization and uniformity of area in this chimney.

This work brought the development in ore of the No. 8 proper up to its present state. In order to exploit the orebody, level development will be necessary on the 4200 and 4350 levels, and at the proper intervals below the 4500 level. For the time being, however, it is felt that sufficient knowledge has been gained of this orebody by means of level development and long down diamond drill holes to warrant laying out blocks of ore of appropriate categories. (See Fig. 9.)

Discovery and Development of the 8B Orebody

As part of the 4500 development program, in order to prospect a zone extending 500 feet to the footwall of the drift and 500 feet to the hangingwall, systematic long hole drilling was done from the main development drift. (See Fig. 3.) These 500-foot horizontal holes were spaced at 450-foot intervals along the length of the ore zone. At the time that the development work had finished on the 8A orebody, a pair of these holes was drilled from a station some 150 feet to the west of the 8A orebody. The south hole encountered 60 feet of partially silicified fragmental rock, assaying 0.4% Cu. This indicated a possible zone of mineralization to the south of the 8A orebody. Diagonal holes were drilled to the southwest from the same station and mineralization of apparent ore grade was encountered. It was felt that this mineralization might represent a chalcopyrite stringer ore shoot which would be associated with a third chalcopyrite sphalerite lens, and that if the new mineralization zone were traced far enough, this lens might be encountered. Accordingly, a diagonal crosscut was driven southwesterly to follow up one of the fanned diamond drill holes. The values in the crosscut were disappointing, representing about one-third of those given by the diamond drill core. Careful investigation showed that the drill hole and subsequent crosscut had encountered a zone of stringers, some of which were parallel to the hole, and that the core had not been representative of the mineralization. Thus in actuality, no ore had as yet been encountered in this zone. It was decided, however, to drift from the diagonal crosscut, in a due westerly direction to pick up mineralization which had been cut by another fanned diamond drill hole. This drift was driven 250 feet, in which distance three chalcopyrite stringer zones were encountered. In these the mineralization occupied north westerly striking fractures in zones 20 to 30 feet wide and spaced at 40-foot intervals. From the face of the drift a diamond drill hole was drilled horizontally to the north, and at 48 feet from the collar a silicified zone containing chalcopyrite and sphalerite mineralization was encountered. This mineralization had a width of 50 feet and was identical in appearance and tenor with the chalcopyrite sphalerite mineralization in the No. 8 and No. 8A orebodies.

It appeared now that a possible new lens of chalcopyrite sphalerite mineralization had been encountered. A crosscut was driven to intersect this and drifting and drilling along the strike revealed such a lens, having a length of 300 feet and average width of 35 feet. The average grade of this lens was similar to that of the 8A orebody, gold values being low.

Short diamond drill holes revealed the three chalcopyrite stringer zones encountered in the drift to be parts of lens shaped oreshoots. These lenses had a general northwest strike, and were similar in size and character.

To the hangingwall of the chalcopyrite sphalerite lens and adjacent to it, a large pyritic zone was encountered, partly enclosed in a large fold of slate to the west. This zone was exposed by diamond drill holes which had been drilled to develop the chalcopyrite sphalerite lens and which were deepened when the new zone was encountered in the ends of the holes. The pyrite was disseminated in a quartz soaked fragmental, and distributed throughout the zone were very small, close stringers of chalcopyrite. Sphalerite was noticeably absent. The chalcopyrite stringers were uniformly distributed and of such an intensity that an ore shoot 200 feet long, averaging 50 feet in width could be developed.

From the collar of the crosscut which had been driven to investigate the chalcopyrite sphalerite zone, a series of short holes were drilled at plus and minus dips to investigate the above and below the level. This showed continuity of ore mineralization for 125 feet above the level and 200 feet below it.

In summary, development to date has revealed three distinct orebodies, of which one has been completely delimited, while the two others have been fully developed on a single level only. As a result of this work, well over 1,000,000 tons of ore have been indicated. Development on intermediate levels is proceeding at the time of writing.

Acknowledgements

The writer is grateful to officials of the Howe Sound Company, and the Britannia Mining and Smelting Company, for permission to release the material contained in this paper. In addition he wishes to thank Mr. G. C. Lipsey, former Superintendent at Britannia Mines, and Mr. E. C. Roper, present Superintendent, for their thorough and constructive criticism.

(1) H. T. James. Britannia Beach Map Area, British Columbia G.S.C. Memoir No. 158
(2) James, H. T. Britannia Beach Map area, British Columbia G.S.C. Memoir 158.
(3) Schofield, S. J. The Britannia Mines, B. C. Econ. Geol. Vol. 21. P. 271.
(4) Ebutt, Frank. Relationship of structure to ore deposition at Britannia Mines. C.I.M.M. Vol. 38, pp. 123-133, 1935.
(5) Loc. cit.
(6) Loc. cit.