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A New Type of Gold Deposit in British Columbia

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DURING the summer of 1945 members of a prospecting party, headed by the author, discovered a vein which appeared most unattractive but which yielded, nevertheless, two samples that ran well over an ounce in gold and ten ounces in silver. The vein was re-sampled and closely examined. Panning of crushed vein material had not revealed any gold so another sample from where the richest assay had originated was crushed and panned: no speck of gold was observed but a sulphide tail of what resembled pure pyrite was assayed and found to run many ounces of gold and more than fifty ounces of silver. This paper deals briefly with the mineralogy of this new discovery, which will hereafter be referred to as the Charlie Group, and with the mineralogy of two other occurrences which not only happen to have similar mineralogical relationships but also were being developed at the very moment when the Charlie vein was discovered. Samples from all three occurrences were investigated at the Geological Laboratories of the University of British Columbia during the winter of 1945-6. Tellurides were found in many samples.

Further investigations during the winter of 1946-7 on larger collections made the preceding summer showed that British Columbia may now add a new type of gold deposit to her already varied list.

General Geology

Three properties show similar mineral assemblages and are discussed in this paper. They are: (*a*) the Harrison Group, five miles west of Whitesail Lake in the Omineca mining division. This group is being developed by Pioneer Gold Mines of British Columbia Limited. (*b*) The Hido Group and related claims six miles south-west of the south end of Taseko Lake in the Clinton mining division. These claims are being developed by Pellaire Mines Limited, a subsidiary of Quebec Gold Mining Corporation of Ontario. (*c*) The Charlie Group about five miles south-west of Taseko narrows in the Clinton mining division and about seven miles north of the Hido Group. The Charlie Group is being developed by Conwest Exploration Company Limited of Ontario.

The Harrison Group lies some 240 miles north-west of the Charlie and Hido Groups, which in turn are situated about 140 miles north of Vancouver.

All the showings on these claims lie close to the eastern margin of the Coast Range batholithic rocks which run in a general north-westerly direction, and are bounded on their northerly flank by a mixed assemblage of Mesozoic formations most of which are, in the vicinity of the showings under discussion, a complex of volcanic rocks, the bulk being Triassic.

At the Harrison and the Hido claims the veins are in plutonic rocks but at the Charlie Group they are in volcanic ones. In all cases the contact between the plutonic and volcanic rocks lies close to the veins which are being developed.

The veins range from a few inches in size to over several feet and can be traced from a few hundred to well over a thousand feet along their strike. The veins in general appear to be narrower but richer in the volcanic rocks than they are in the plutonic. The veins have dips ranging from vertical to about forty-five degrees. As yet too little work has been done to make profitable any attempt to correlate any changes in value with changes in the dip and strike of the veins. In mode of occurrence the veins do not vary in most features from the better known veins of the Bridge River district to the south-east. Mineralogically, however, these veins differ from any so far described on the eastern flank of the Coast Range batholith.

The Mineralogy of the Deposits

In general the veins are composed predominantly of quartz with a content of less than 3 per cent of metallic lustred minerals. In places, notably on the Charlie Group, a carbonate is conspicuous and a deep brown stain, usually associated with surface showings of this carbonate, suggests that it contains manganese. Such underground work as has yet been accomplished, has encountered still only a small amount of vein material which is fresh. Fortunately fresh samples have been obtained making it possible to determine the bulk of the metallic minerals, which, in approximate order of abundance, are as follows: pyrite, chalcopyrite, galena, sphalerite, arsenopyrite, tetrahedrite, hessite, altaite, pyrrhotite, magnetite, bornite, gold, tetradymite, cosalite, antimony, and wehrlite. Several secondary minerals can be readily observed, particularly limonite, hematite, azurite, malachite, and doubtfully identified manganese and lead minerals.

As this paper is intended to be neither a final report on, nor an economic appraisal of, these interesting deposits, but merely a pre-

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liminary outline, only a few words will be said about each of these minerals.

Pyrite. Pyrite is by far the most abundant and most conspicuous of all the metallic minerals in each of the deposits. Usually it is subhedral but in many places it is euhedral. It is commonly fractured and may be filled or replaced by any of the other minerals except arsenopyrite which appears to be of the same age as the pyrite.

After obtaining as clean pyrite as possible either by panning or by means of a Superpanner, it is common for the pyrite from each of these deposits to assay as much as ten ounces of gold and one hundred ounces of silver per ton. Silver assays range from five to thirty times as high as gold but the silver to gold ratio, although varying in the different deposits, is fairly uniform for each deposit. Examination of numerous polished sections of pyrite reveals the presence of hessite so frequently that it now seems reasonably safe to assume that its presence accounts for the precious metal content of the pyrite.

Chalcopyrite. Although quantitatively it is present only in small amounts, as are all the succeeding minerals, it is of considerable interest as hessite is closely associated with it in many Pellaire samples. Chalcopyrite occurs both as scattered grains in quartz, tetrahedrite, and sphalerite, and as veinlets in quartz.

Galena. Experience in other British Columbian gold mines having shown that good gold values frequently occur in association with galena, it was half expected that such would be the case at these properties. Some high assays have been obtained from samples high in galena, but it is now known that this association is fortuitous. Hessite may, or may not, occur in galena and consequently galena may or may not contain important amounts of gold and silver. One sample of galena in quartz, showing some limonite but no evidence of any other metallic minerals, assayed as follows:

Pb	42.5	per cent	
Te	.8	"	
Au	.04	"	(or 13.8 oz. per ton)
Ag	1.35	"	(or 393.74 oz. per ton)
Fe	3.49	"	
Sb	.86	"	
Cu	.38	"	
S	4.35	"	

Later on, when many polished sections had been studied, it was noted that galena frequently carried both altaite and hessite. The latter mineral now is considered to be responsible for most, if not all, of the gold and silver found in the galena at these properties.

Sphalerite. Although no sphalerite was seen in any Pellaire samples it occurs erratically on the other claims, usually as scattered disseminations or as shapeless masses in quartz. In one vein it is found irregularly scattered in massive tetrahedrite. In many mining camps good gold values are associated with sphalerite and an attempt was made to make a similar correlation in these veins. Apparently no such correlation exists. Indeed one vein, relatively richer in sphalerite than any others, contains much lower than average amounts of gold. Sphalerite in some places contains chalcopyrite but in rather smaller amounts than is usual in British Columbia.

Arsenopyrite. Arsenopyrite occurs sparingly in samples from both the Charlie and Harrison Groups but none was seen in those from Pellaire. It does not seem to have any effect on the grade of the ore but occurs erratically scattered through massive tetrahedrite or in close association with pyrite. Arsenopyrite, like pyrite, is often euhedral, much fractured, and undoubtedly was one of the earliest minerals to crystallize.

Tetrahedrite. So far tetrahedrite has only been observed in the Charlie veins where, however, it is quite widespread, usually as inconspicuous disseminations in quartz. In one vein it can be seen in masses up to eight inches in thickness along the foot-wall. In view of the frequency with which highly argentiferous tetrahedrite is found in British Columbia it was hoped that this tetrahedrite might run high in silver but hand-picked samples only ran gold .24 oz. and silver 255 oz. Even four selected Superpanner products only ran:

	+ 70 mesh	.24 Au. oz.	307.0 Ag. oz.
– 70	+ 100 mesh	.24 " "	306.0 " "
– 100	+ 150 mesh	.32 " "	333.8 " "
– 150	+ 200 mesh	.28 " "	332.6 " "

A careful examination, both of sections of massive tetrahedrite and of Superpanner tips, reveals the presence of small amounts of chalcopyrite, pyrite, and arsenopyrite but not any other silver-carrying mineral. In all the sections of tetrahedrite which have been examined, only one particle of gold, and that particle only about five microns in diameter, has been seen. This suggests, although it does not prove, that although this tetrahedrite is auriferous as well as argentiferous, it is unimportant as a source of gold in this ore.

Hessite. The author himself has only seen some half-dozen specimens containing hessite particles large enough to be recognized megascopically. Apparently nobody else working on these claims has yet recognized this mineral in hand samples. Nevertheless it is now certain that this mineral is the most important, and one of the more widespread, minerals in these ores. Where present, the vein material is apt to be ore and where it is absent values are usually not commercial. Scores of analyses from each property have shown, beyond doubt, that the hessite is auriferous and that its gold by weight, relative to silver, ranges from one to five at Pellaire, to one to thirty at the Harrison Group.

When observed under crossed nicols the hessite from all these ores shows marked anisotropism in bluish grays and bornite pinks. This feature together with a commonly exhibited confused cross twinning makes the mineral easy to identify under the microscope.

Hessite occurs veining quartz, pyrite, and chalcopyrite, and as disseminations in these minerals and in galena, tetradymite, and wehrlite.

When it occurs as veinlets, it rarely exceeds ten microns in diameter but these veinlets are in places quite persistent and continue unbroken for many centimetres. Where it occurs as disseminations, it is quite erratic both in size and in dimensions but egg-shaped particles ranging from twenty to a hundred microns in their longest diameter are most typical. Smaller particles are also common but the largest yet seen by the author was a horn-shaped mass about six millimetres in length growing in a vug.

Apparently hessite weathers more readily than any of the other metallic lustred minerals and in many polished sections hessite may be seen to be much more altered than galena, altaite, and pyrite with which it may be intimately associated.

In view of this tendency of hessite to alter there was a possibility that residual and secondary enrichment accounted for some of the high assays which occur on all these properties. This was carefully investigated. In some instances, high assays may have been caused by supergene agencies. High surface assays must always be suspect in veins of this type. Fortunately there is abundant evidence that many of the high assays are from primary samples in which hessite is fresh and unaltered. Some of the best assays yet obtained come from the deepest pits where virtually unaltered ore has been obtained and from samples which, even after fine grinding and careful superpanning, have yielded not a trace of native gold.

Hessite frequently contains inclusions of native gold and these inclusions are undoubtedly hypogene.

Polished sections of samples taken from close to the surface and showing evidence of weathering do show hessite breaking down, and native gold may be seen with limonite and other secondary minerals. Some of this gold represents the native gold previously occurring in the hessite. Just what has become of the tellurium and silver formerly in the hessite is not yet explained. However, it is known that hessite where it contained no native gold has, on weathering, left a product from which no colours can be obtained by panning. The whole problem of the weathering of hessite needs to be carefully studied. So far as is known to the author, no person at any of these camps is yet prepared to say after an examination of a weathered outcrop whether or not that outcrop was formerly a carrier of hessite. It has been possible on these veins to get negligible assays from a limonitic surface outcrop and yet find good values in primary ore only six feet below the surface. This is in contrast to many gold-bearing veins in British Columbia where owing to residual enrichment surface- outcrops frequently give high assays which are misleading.

Altaite. This telluride is not as easy to spot as are the bismuth tellurides and is not recognized as frequently as they are. Altaite is, nevertheless, probably just as common, if not more so, than any of the bismuth tellurides. It is readily recognizable in hand samples and any one familiar with it in any particular ore can soon spot it even without a hand lens. It has not yet been identified on the Harrison claims but it is relatively common on the Charlie Group and has been tentatively identified in many samples from the Hido claims. Altaite tends to occur in association with other tellurides and with galena as disseminations in quartz. Altaite may contain inclusions of galena and vice versa. Altaite and hessite are often closely associated but the altaite being somewhat more abundant it can be seen more readily in a hand specimen whereas hessite is usually only seen under the microscope. Altaite, hessite, and galena usually contact each other along smooth rounded boundaries and are probably more or less contemporaneous in age.

All attempts to isolate enough pure altaite to obtain a chemical analysis have so far failed, so whether or not this altaite is auriferous or argentiferous is not known.

Pyrrhotite, Magnetite, Bornite. These minerals have so far been found only as occasional isolated grains in quartz. The bornite has been noted as a coating on some fragments of chalcopyrite.

Gold. As may well be appreciated this mineral has been the object of much study. Native gold is rare in all the suites of ore available for examination. All the gold so far observed shows one of three modes of occurrence. Most commonly gold is found associated with and veining unaltered hessite. Here particles with a maximum dimension of two hundred microns have been observed but particles as large as this are rare and normally veinlets of gold in hessite have widths more like five to ten microns. Veinlets of hessite in pyrite, chalcopyrite, and quartz may be accompanied by minor amounts of gold. No large particles of gold have been found removed from hessite except where hessite has been removed by weathering. As has already been noted, little gold had been present in the surface outcrops of any of these deposits. Even careful superpanning of infrasized material has revealed only relatively unimportant amounts of native gold. After gold had been seen in polished sections its limited occurrence in even superpanned products was a little surprising. It is thought now that a partial answer to this puzzle has been found. Polished sections of each product of the Superpanner were made. These sections reveal that minute sausage-like grains, which had been noted visually in some of the coarse products, are actually little rolled particles of hessite. These rolled particles often carry gold in the same manner as does the hessite observed in polished sections of the ore. It seems that the sectility of the hessite is great enough to cause it to form these minute sausage shapes rather than shatter when subjected to crushing, grinding, or mortaring. Thus gold remains locked with hessite after ordinary crushing as it would not do if hessite were brittle, as are the other precious metal tellurides. At this juncture, it might be pertinent to note that Dana (1944) reports hessite as being "somewhat sectile." This may well be technically correct. On the author's admittedly somewhat limited field experience with hessite, he would prefer to call it sectile. A needle can readily be pushed into hessite and moved without the hessite breaking. There would thus seem to be a useful contrast between the cohesion of hessite and of altaite, the latter mineral being, in the opinion of the author, more appropriately described as "somewhat sectile" or "slightly sectile." Actually in any suitably sized particles of altaite which the author obtained from these suites it was possible, by drawing a needle over it, to scratch altaite without shattering it. However, a needle could not be pushed into it deeply and then bent without the mineral shattering.

The second mode of occurrence of gold is as a residual product in cavities and in veinlets where it is now associated with a secondary mineral, usually limonite. From its form and general relationships it is clear that this gold was formerly intimately associated with hessite which has now been removed by weathering. Just what has become of the gold and silver which was a part of the hessite is at the moment unknown.

The third and least observed mode of occurrence of gold is as rare disseminations in other minerals, notably pyrite. One small particle, five microns in diameter, was observed in tetrahedrite. The particles observed in pyrite are all small. Their relative importance is not known but the evidence, presently available from superpanning and polished section examinations, suggests that this disseminated gold is of minor importance.

To sum up these remarks on gold, one may say that in these cases the bulk of it is primary. Some gold is residual and has been left behind in veins and pockets after the hessite with which it was formerly associated has been altered and removed. There is no microscopic evidence to suggest that any gold is the result of either chemical or physical concentrations of transported gold.

Tetradymite. This bismuth telluride has as yet only been positively identified in samples from the Harrison Group but it also occurs in the Taylor Windfall claims only a few miles east of the Charlie and Hido Groups.

Tetradymite in the Harrison Group is invariably associated with hessite with which it most commonly occurs as smooth rounded grains. Galena and more rarely chalcopyrite and sphalerite are also found associated with tetradymite. The tetradymite is probably later than all its associates except hessite with which mineral it appears to be contemporaneous.

Cosalite. This relatively rare mineral has only been observed in one specimen from the Harrison Group. In this specimen it was intimately mixed with tetradymite. It was mistaken in the hand specimen for bismuthinite which in this particular specimen it closely resembles. One fragment when tested on a Berman Density balance showed a specific gravity of 6.80 which is very close to the specific gravity of bismuthinite and a little below that generally prescribed for cosalite (Dana, 1944). An x-ray powder photograph revealed the true identity of the mineral. Cosalite had until this discovery been authenticated only in the Cariboo mining division. There it usually occurs in aggregates of fine needles and in individual needles rather than in the form of stubby bladed crystals as is the case in this specimen from the Harrison Group. The author cannot recall a similar occurrence of cosalite and tetradymite elsewhere but the association seems to be a likely one.

Antimony. This mineral was found by a lucky chance in one specimen from the Hido Group. It was missed entirely in megascopic examinations. A mineral was found closely associated with hessite in one section. It was thought to be a telluride, largely on the basis of its association with the hessite. No other section showed this mineral and so little was available that only an x-ray powder photograph was attempted by way of identification. The photograph was a success and clearly showed that the mineral was native antimony. Beyond the fact that in this one section it is closely associated with hessite nothing more is known of this interesting occurrence.

Wehrlite (Bi_2Te_3Bi—Ag). Until 1945 this rare silver-bearing bismuth telluride had only definitely been identified from Deutsch-Pilsen, Hungary (Warren and Peacock, 1944). Since then it has been determined to be present at the White Elephant Claim (Warren, 1945), at the Marble Bay Mine (Warren, 1946), at the Little Billie Mine (Warren, 1946), all in British Columbia, and at the Mago, Hull, and Cartwright properties near Painkiller Lake, Beatty Township, Ontario (personal communication from R. M. Thompson). Thus this occurrence of wehrlite on the Charlie Group is probably only the sixth to be recorded. Four of the six are in British Columbia.

It was first found in the Clinton mining division in a sample from the Charlie Group. The author was searching a suite primarily for hessite when he saw a very small fragment which was taken to be tetradymite or a related bismuth telluride. A polished section showed up the occurrence clearly and an *x*-ray powder photograph showed that the mineral was actually wehrlite.

Wehrlite occurs as laths in altaite and in close association with galena and hessite. It is older than altaite which in places has the appearance of replacing it.

The secondary minerals. Little of interest can be said about the secondary minerals. The depth to which alteration persists varies from a few inches to at least a couple of hundred feet depending on the minerals concerned, the degree of shattering to which the vein has been subjected, and the general physiography.

Available evidence suggests strongly that hessite is the first mineral to be affected by weathering, followed by altaite and galena. The position of the other minerals is not yet established.

In these deposits as in many other areas in British Columbia azurite may usually be counted on to have originated from tetrahedrite whereas malachite comes from chalcopyrite.

Paragenesis

The more important or interesting minerals give evidence of having been deposited in five stages with probably some overlapping. These stages were as follows: (1) pyrite, arsenopyrite, quartz, and a little gold; (2) tetrahedrite, sphalerite, chalcopyrite, and quartz; (3) wehrlite, galena, altaite, hessite, tetradymite, cosalite, gold, and quartz; (4) gold, quartz, calcite, and some hessite; (5) the secondary minerals.

The Significance of the Tellurides

Hessite contains approximately 60 per cent of silver and has been reported to carry as much as 5 per cent of gold (Dana, 1944). Obviously very little hessite is needed to make a deposit valuable. Although wehrlite only carries between 4 and 5 per cent of silver (Warren and Peacock, 1944) it is clear that small amounts of this mineral will add worth-while amounts of silver to an ore.

Hessite is by no means a rare telluride, but at no other mining area in Canada has it been the most important source of gold. Its tendency to weather readily and rapidly apparently into a product too fine to be recovered by normal panning suggests an obvious problem for the prospector: no longer can he count on estimating the value of a weathered outcrop by panning.

Prospectors will also have to learn to recognize hessite when they find it. The author has already prepared some advice for prospectors, and given some general clues as to how to recognize these deposits in the field (1944) so they need not be repeated here. Unfortunately some at least of these telluride veins look much like the normal mesothermal veins of other districts, particularly those of the neighbouring Bridge River district.

Comparison with Other British Columbia Deposits

Quite apart from mineralogical differences the Harrison-Charlie-Hido deposits differ markedly from other precious metal occurrences in British Columbia.

In the first place they are noticeably low in metallic minerals in contrast to the deposits of the Portland Canal, Cariboo, Zeballos, Ymir, Sheep Creek, Hedley, and Boundary districts. In this they resemble the Pioneer and Bralorne Mines in the Bridge River district. However, the Bridge River mines have from nine to ten times as much gold as they have silver, whereas the Harrison-Charlie-Hido deposits all have conspicuously more silver than gold, ranging from five to one in the case of the Hido to as much as thirty to one in portions of the Harrison showings.

Summary and Conclusions

In the area to the west of Whitesail Lake and south-west of Taseko Lake three groups of claims contain veins unlike any previously described in British Columbia. These veins carry less than 3 per cent of metallic minerals and hessite is the only precious metal carrier of major importance. Although there is some residual native gold in the oxidized portions of the veins the greater part of the small portion of native gold which occurs in the ore is indubitably primary and is closely associated with hessite.

Whether or not these deposits will prove to be commercial has yet to be determined. Fortunately for the author, the economic aspects of these deposits are not being discussed. Without breaking faith with any of the companies concerned, it is probably proper to say that with ordinary good fortune there is a reasonable hope that at least one hessite-bearing vein will be exploited successfully in the not too distant future.

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Dr. R. M. Thompson with the permission of Dr. M. A. Peacock of the Department of Geological Sciences, University of Toronto, kindly undertook all the x-ray powder photographs. The Department of Mining and Metallurgy and the Department of Physics of the University of British Columbia made available some equipment.

The assaying was done in part by the students mentioned above and in part by Mr. A. C. Affleck of the Metallurgy Department and R. N. Williams of J. R. Williams and Son. The Cariboo Gold Quartz made available two scholarships for these studies, and Dr. M. Y. Williams, Dean Daniel Buchanan, and the Board of Governors made available needed funds. To all of the above and to his many colleagues who by advice and criticism assisted in this work the author expresses his thanks.

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