REPORT ON
MICROSCOPIC EXAMINATION
OF ORE FROM
MINTO GOLD MINES

by

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INTRODUCTION

This paper records the work done by the writer on a number of samples of ore from the Minto Gold Mines, Bridge River District, British Columbia.

The samples selected were from various levels of the mine. Each specimen was prepared for microscopic examination in the following manner: it was cut into the necessary size with the diamond saw, imbedded in a bakelite briquette, and then polished on the super-polisher.

The various minerals comprising the section were identified mainly by etch tests, which were supplemented, where necessary, by microchemical tests, carried out on a particle of the mineral removed from the section.

Following is a description of the sections examined, discussion of various points arising from them and the conclusions arrived at.

Location.

The Minto Mine is situated in the Bridge River District of British Columbia. Communication is by motor road from Vancouver or by P. G. E. to Shalath and thence by stage up the valley to the mine, a distance of 25 miles. The road is open the year round except after very heavy snowfall.

History.

The earliest development at the mine was done by the Consolidated Co., who took an option in 1929 and continued work until 1931, when the option was dropped. Their work indicated fairly large tonnage, of low grade value, with occasional higher values. In 1933, the Minto Gold Mines Ltd. was incorporated, and development work was carried rapidly ahead. In 1934 a small mill was assembled, and a process worked out for treating the arsenic and antimony ore. Concentrates were shipped to Tacoma. At present the mine and mill is closed down, and its future is rather indefinite.

General Geology.

The country rock is largely altered sediments with some beds of serpentine and greenstone, all of the Bridge River series. The sedimentary series consists of beds of blue-grey chert, separated by thin beds of argillites.

The greenstones are the most interesting and important member of the series since they contain the veins in the

Pioneer mine. Apparently they are of volcanic origin since they contain flow structure, flow breccia and amydules dispersed in the black altered basalts. Alteration products of the volcanicsare chlorite schists and serpentines.

The main metallic minerals are gold, arsenopyrite, pyrite, chalcopyrite, galena, sphalerite, and an unknown mineral named 'x'. The gangue is mainly quartz and calcite.

DISCUSSION

Although a number of polished sections from various levels of the mine were examined, no stibnite was seen. This is contrary to the reports of other investigators. There is a possibility that the telluride mineral identified in this investigation was mistaken for stibnite, since there is a striking resemblance between the two in color and hardness, and both contain antimony.

If the evidence for the presence of a gold telluride can be accepted, many problems related to the ore can be explained, This mineral occurred quite regularly in all the sections examined, in sufficient quantities, even with its low gold content, to account for the low values obtained in the average run of ore, without any free gold being present. This would explain why, in all the sections previously examined, so little, if any, free gold was seen. Where the high values occur, there is some coarse free gold associated with the telluride, as in Sec. 6. In these cases the values are very high, and a little of such high grade ore would increase the value of a large amount of the average low grade ore.

There is various evidence to show that the free gold occurs with the telluride mineral. The two were intimately associated in all cases where gree gold was seen, as shown by the irregular and indistinct contacts between the two.

Ore Dressing tests carried out by the writer in 1937 showed the close relationship between the gold and antimony. Whenever there was a high recovery of antimony in a concentrate, the gold recovery was high, and vice versa. This would indicate either the presence of a gold-antimony mineral, or intimate association between native gold and an antimony mineral.

CONCLUSIONS

A number of polished sections from different levels of the Minto Gold Mine have been examined and the following conclusions have been drawn.

1. Metallic minerals present in the ore are arsenopyrite, pyrite, sphalerite, chalcopyrite, galena, and a telluride mineral. Gangue minerals are quartz and calcite.
2. No trace of stibnite was found in any of the sections.
3. The presence of a gold, bismuth, antimony, telluride was indicated by etch and michrochemical tests.
4. This mineral was present in varying amounts in all the sections examined, indicating very general distribution throughout the ore.
5. The low values obtained in the average run of ore is apparently due to the gold content of the telluride mineral.
6. Free gold was seen, associated intimately with the telluride mineral.

7. Whenever free gold occurs, it is relatively coarse.

DESCRIPTION OF SECTIONS

Polished Section No. 4 - No. 5 face.

Megascopically, this section is approximately 70% fractured arsenopyrite and 24% calcite and quartz. A few particles of pyrite were noted.

With the microscope a few particles of the mineral (x) were seen along a boundary between quartz and arsenopyrite. Also a piece of galena was noted, along the same quartz-arsenopyrite contact. Apparently the galena was later than the other two.

Polished Section No. 6. #4 level, high grade.

This section is approximately 90% arsenopyrite, and the remainder quartz. The arsenopyrite is very badly shattered, but even the finest fractures are healed with quartz.

A number of pieces of gold were seen in this section, some of them large enough to be visible megascopically. All of them were contained in, or very closely associated with the unknown (x). The gold and (x) occurred near but not always in contact with a tongue of quartz which ran across the slide. In a case where the gold was in the arsenopyrite, it was contained in a fracture leading off from the mineral (x).

The contacts between the gold and arsenopyrite and between the gold and mineral (x) indicated that the gold was much more closely related to (x) than to the arsenopyrite. The former boundaries were sharp and regular, while the latter were very irregular and in some cases almost indiscernable. Fig. 6 shows the relation between the three minerals.

Polished Section No. 9. #4 level - High Grade.

This section was mainly arsenopyrite, very much fractured and broken up. The pyrite present, in angular blocks, in fractures in the arsenopyrite, and as a copping on the arsenopyrite (Fig.1) is apparently later than the arsenopyrite. Quartz flows into the fractures of the arsenopyrite and pyrite.

The mineral (x) occurs all through the section, in fractures in arsenopyrite and pyrite, replacing the pyrite (fig. 4) and in the gangue of quartz and calcite (fig.3). Its mode of occurence in the latter case, with innumerable small blebs throughout the gangue would indicate contemporaneous deposition of the two. A small piece of gold was seen in a piece of (x), the two being in a fracture in the arsenopyrite.

Several pieces of sphalerite were seen in the section, occurring in fractures in the pyrite, or at pyrite-arsenopyrite contacts. All the sphalerite contained minute particles of chalcopyrite scattered quite regularly throughout it. This would indicate contemporaneous deposition of the two. Fig. 2 shows one occurrence.

Polished Section No. 10. #5 level - 40 feet in.

This section is mainly arsenopyrite, with a little pyrite, and gangue of quartz and calcite.

An interesting case of zoning was seen in this slide. The pyrite occurred as a layer between the quartz and the arsenopyrite. Microscopically, the boundary between the pyrite and arsenopyrite is often practically indistinguishable, as in fig.1. This would indicate either replacement by pyrite, or the cooling down of an iron-arsenic-sulphur solution which had an excess of iron over arsenic. Arsenopyrite would crystallize out first, and after the arsenic had all been removed from the solution, the remainder would crystallize as pyrite. The latter is probably the better explanation. This same zoning effect was noticed in several other sections.

Polished Section No. 17.

This section is mainly gangue and pyrite, with several large pieces of sphalerite, and one large piece of the unknown (x). Microscopically the sphalerite, containing minute inclusions of chalcopyrite is interlaced with (x), as also was the quartz.

Polished Section No. 18.

This section is mainly pyrite, very badly fractured with the fractures healed with quartz. The unknown (x) is scattered throughout the quartz, and in the fractures of the pyrite.

An interesting case of replacement was seen in this section. Fig. 5 shows where calcite has entered a fracture in the quartz, and replaced the quartz and the mineral (x).

IDENTIFICATION OF THE UNKNOWN MINERAL

A great deal of time was spent in attempting to identify this mineral. Etch tests were performed, and microchemical tests carried out for the common metallic minerals. Following is a description of the mineral, the tests performed, and the conclusions arrived at.

The mineral is a silver grey color, much like galena. It is definitely a soft mineral, easily scratched with a needle, with a hardness of 2 - 3. It does not polish very readily, and is usually pitted and streaked. When a piece is being gouged out with a needle, under the microscope, it appears to break up in angular fragments, and there is a certain amount of internal reflection, giving a bluish tinge to the edges of the particle.

The mineral is anisotropic, and the change of color is from a blue to a brown. In a large piece the color does not change as a whole but rather in small sections. This would indicate crystallization.

The etch reactions are:

HNO_3 - + ve. irridescent - turning to a brown. The reaction takes some time to set in.

HCl - - ve.

KOH - - ve.

KCN - - ve.

$FeCl_3$ - - ve.

$HgCl_2$ - -ve

Microchemical tests [1] were carried for tellurium, gold, silver, bismuth, antimony, lead, copper, and sulphur.

Tellurium was indicated by the caesium chloride test. The particle was broken down with $1:1HNO_3$, the residue leached with 1:5Hcl, and a piece of $Cscl_2$ added. Lemon-yellow plates and triangles were formed. As confirmation, these plates turned brown when a fragment of Kl was added to the centre of the drop. As further confirmation, some of the super-panner tip, +150 mesh, which contained a large amount of free gold, was tested with concentrated H_2SO_4. When the particles and acid were heated in a porcelain dish, the solution turned a faint pink color, indicating tellurium, but probably in quite small concentrations.

Bismuth and antimony were indicated by the double iodide test. The particle was reduced with $1:1HNO_3$, the residue leached with 1:5 Hcl, and a crystal of Kl introduced into the drop. The solution turned yellow, indicating bismuth and/or antimony. Then a particle of $CScl_2$ was added, and hexagons and stars of orange, and hexagons of deep rose red were formed. The former indicated antimony and the latter bismuth. As confirmation, the double chloride test was carried out. The particle was reduced with $1:1HNO_3$, the residue leached with 1:5Hcl and a particle of $CScl_2$ introduced into the drop. Thin, transparent hexagons indicated antimony and rather thicker, transparent rhombs and blade-structures, indicated bismuth.

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[1] Tests are from U.S. Geological Survey Bulletin, No.825.

A particle of the mineral was tested for gold with stannous chloride, with negative results. However, the lower limit for this test is .1% gold chloride, so it was not proof that gold did not exist in very small concentrations. Subsequent tests on a pyrex slide indicated the presence of a small amount of gold. A particle was fused on the slide, and the slide then examined under the ultrapah. In the centre of several of the pools small particles, believed to be gold, were seen. Bismuth was also indicated by the color of the pools. The presence of sulphur was shown by a residue of yellow sulphur appearing on the glass slide when the particles were reduced with 1:1 HNO_3.

Tests for silver, copper, and lead gave negative results.

Thus the metals indicated as being present in the mineral are: Fe, Bi, Sb, Au, S. Taken in conjunction with the etch tests, these would indicate that the mineral is probably nagyagite. This mineral is described by F. L. Stillwell in "The Occurrence of Telluride Minerals at Kalgoorlie", Aus.1 M.M. No. 84, and the formula suggested is $(Pb.Au)(S.Te.Sb)_{1-2}$.

Superpanner Analysis of High Grade Ore.

A piece of the high grade ore, from which sections no. 6 and 9 were taken, was crushed and screened, and then 50 gms. of each of the three products, - 100, and + 150,
- 150 and + 200,
and - 200,

were treated on the super-panner, a tip, middling, and a tailing being obtained for each product. The tip, in each case, contained visible free gold, the middling product was mainly arsenopyrite, and the tailings contained the gangue, most of the pyrite, and any very fine particles which floated off.

The weights and assays of each product are recorded below.

Size Mesh	Head Assay oz/ton	Product	Weight of Product	Assay of Product	Calculated Head Assay
-100+150	44.78	Tip	.14 gms.	7190 oz/ton	45.92 oz/ton
		Middling	33.1 "	30.64 "	
		Tails	15.9 "	14.82 "	
-150+200	19.68	Tip	.06 "	612 "	21.00 "
		Middling	24.0 "	24.62 "	
		Tails	25.0 "	16.00 "	
-200	12.4	Tip	.065 "	431. "	14.40 "
		Middling	17.7 "	20.20 "	
		Tails	31.7 "	10.30 "	

The main feature of this table is the high assays that were obtained in the tip samples, especially on the +150 size. This indicates that a considerable amount of the gold was present in the free state and in relatively coarse size.

PAROGENESIS

A study of the sections indicated that the first minerals were arsenopyrite, pyrite, and quartz in that order. Secondary mineralization, consisting of telluride, galena, sphalerite, chalcopyrite, and quartz, must have almost at one time. The sphalerite and chalcopyrite are doubtlessly contemporaneous. In some places the quartz appears to be replaced by the telluride, as in fig. 5, where the telluride followed in along the quartz fracture, and was itself later replaced by calcite, but in others the very fine mixture of quartz and telluride would suggest contemporaneous deposition of the two. In some sections where it occurs both as large masses, and as stringers among the arsenopyrite and pyrite particles, the quartz is very clean. All this would point to either two generations of quartz,or one generation recrystallized. Calcite is apparently the last mineral to crystallize.