ORES OF THE WINDPASS MINE
BRITISH COLUMBIA

A report submitted in partial fulfillment of the course in Geology 9.

by

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March 20 1946

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ACKNOWLEDGEMENTS

The writer is indebted to Dr. H. V. Warren for helpful suggestions in the study of the ores and for the loan of previously determined sections of tetradymite and tellurbismuth. The writer's thanks are also due to Mr. John Deleen for the spectrographic analysis of a sample of joseite.

Previous Geology 9 and Geology 24 reports on the ores by A. F. Killin (1939) and A. R. Smith (1941) were of assistance in studying the ores.

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ORES OF THE WINDPASS MINE

The Windpass Mine was a small, high-grade gold mine in the North Thompson Valley about eighty miles North of Kamloops, British Columbia. The mine workings are at an elevation of 5,340 feet on Baldie Mountain, $3\frac{1}{2}$ miles East of Boulder Station on the Canadian National Railway.

History

The claims comprising the Windpass Mine were originally staked in 1916. They were examined in 1920 by Dr. W.L. Uglow when enough development work had been done to reveal 100 feet of a steeply dipping vein, 2 to 6 feet wide, striking East. During the ensuing ten years further development was done and unsuccessful attempts were made to mine the ore. In 1933 a 50-ton mill was constructed on Dunn Lake, $2\frac{1}{2}$ miles from the mine at an elevation of 1828 feet and an aerial tramway from the mine to the mill was set up. Production of about fifty tons per day was started and continued until 1939 when the mine was abandoned because of lack of ore.

According to the Minister of Mines' Report for 1937, production for that year was 13,180 tons yielding 4,742 oz. of gold. This represents an average grade of 2.76 oz. of gold per ton. In addition, to gold, the ore contains about 1 oz. of silver per ton and variable amounts of copper.

Geology

The ore-body of the Windpass Mine is a mineralized shear and quartz vein in quartz-diorite. The quartz-diorite is the western or upper facies of a composite or differentiated pyroxenite - quartz-diorite sill 1½ miles wide which strikes north, parallel to the North Thompson River, and dips steeply west. The sill is interbedded with sediments and volcanic rocks of the Fennell and Badger Creek Formations and is intruded on the east by a granite stock (Baldie Granite).

The vein itself strikes East, dips 35 degrees to 80 degrees North, and varies in width from 15 inches to 78 inches. At its eastern end, the vein terminates in a shear zone. In the West, it passes into chert of the Fennell formation, but the mineralization of the vein does not extend beyond the contact of the quartz-diorite with the chert. The western part of the deposit is a fractured quartz filling containing gold and bismuth minerals and scattered concentrations of chalcopyrite and pyrrhotite. To the east, this grades into less regular lenses of magnetite which locally carry high gold values.

References

Minister of Mines, British Columbia: Ann. Repts; 1917, 1921, 1927, 1934, 1937, 1938, 1939.

Uglow, W.L.: Geology of the North Thompson Valley Map-Area, B.C.; Geol. Surv., Can., Sum. Rept., 1921 A.

Uglow, W.L.: and Osborne, F.F.: A Gold-Cobaltite-Lodestone Deposit, British Columbia, with notes on the Occurrence of Cobaltite;

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Ec. Geol.; Vol. 21, p. 285, 1926.

MINERALOGY AND STUDY OF POLISHED SECTIONS

The ore from which polished sections were made, was obtained from the mine workings about the time the mine was closed. Twelve sections were studied and can be grouped as follows:

Windpass No. 1, 2, 3, and 4 --- quartz ore.

Windpass No. 5, 6, 7, and 8 --- sulfide ore.

Windpass No. 11 --- barren magnetite.

Windpass No. 9, 10, and 12 --- high grade magnetite.

Minerals identified in these sections are magnetite, chalcopyrite, pyrrhotite, sphalerite, pyrite, native bismuth, bismuthinite, joseite, tetradymite (?), native gold, quartz, calcite, and limonite.

Quartz Ore; Sections Windpass 1, 2, 3, 4

The west end of the ore-body is a mineralized vein consisting mainly of massive white quartz. It is replaced, in a few places, by a little pyrite and, in others, by a little chalcopyrite. Veining and replacing the quartz are a group of closely related bismuth minerals and native gold. These include native bismuth, bismuthinite, joseite, and tetradymite. Veining the quartz and bismuth minerals are tiny stringers of late calcite.

Bismuthinite

Bismuthinite is the most abundant bismuth mineral in the quartz ore and ranges from tiny blebs to grains 8 mm across. It has hardness about B and does not take a polish readily. It is highly pleochroic, ranging from blue-grey to very pale grey in color. In several places its one perfect cleavage was seen outlined by tiny calcite stringers. Under crossed nicols, the bismuthinite can be seen to have abundant spindle-shaped twinning. On Section Windpass No. 4 a twin lamination was seen to follow an abrupt change in orientation of the cleavage layers as if this twinning is the result of deformation. (See Photo. No. 5.) Microchemical tests and the etch reactions outlined in the table at the end of this section were used to identify the bismuthinite. It could usually be distinguished from the other bismuth minerals by its pleochroism and spindle shaped twinning.

Joseite

Joseite is almost as abundant as bismuthinite in the quartz ore and is found as grains up to 5 mm across. It is paler than bismuthinite, being silver white, and shows only faint pleochroism. In the sections studied no prominent twinning of joseite was seen. Joseite, like bismuthinite has hardness B but polishes more readily, probably because the cleavage plates are quite flexible. As in the bismuthinite, the cleavage of the joseite was brought out sharply in places by veinlets of late calcite.

While studying telluride minerals, Dr. Warren had a sample of a bismuth telluride from the Windpass Mine X-Rayed at the University of Toronto. The X-ray indicated conclusively that the mineral was joseite. In the present investigation, a spectrographic analysis of material dug from one of the polished sections indicated the presence of bismuth and tellurium.

Etch reactions worked out for the mineral are outlined in the table at the end of this section. The etch reactions, coupled with the silvery-white color and lack of pleochroism made separation of joseite from bismuthinite relatively easy.

The joseite occurs veining the quartz and as irregular impregnations or replacements of the quartz but is, almost everywhere, closely associated with bismuthinite. In many places (see Photo. No. 4, Section Windpass No. 1) the two minerals form a graphic intergrown structure, possibly the result of eutectic precipitation or of exsolution. These intergrowths are particularly common where bismuthinite or joseite borders other minerals, while the main contacts between grains of the two minerals are generally regular. The intergrowths probably indicate contemporaneous deposition of the two minerals.

Tetradymite

Associated with some of the bismuthinite and joseite are small amounts of a mineral tentatively identified as tetradymite. It occurs as irregular areas up to .5 mm across. It is very difficult to differentiate from the joseite except by means of etching. Under a microscope which shows color differences well, the tetradymite can be seen to be slightly whiter than the joseite and has a clearer, more highly reflective surface. The tetradymite seems to have almost exactly the same hardness as joseite. Under crossed nicols it showed some twinning.

As the amount of tetradymite present in the sections is small, microchemical tests were not attempted. However, a series of etch reactions were worked out and were compared with etches of samples of tetradymite from the White Elephant property and tellurbismuth from the

Hunter and Ashloo Mines and ~~Hudson Bay Mountain.~~ The samples from these mines have been identified by X-ray methods. The two minerals have almost identical physical properties and etch reactions, and both correspond very closely to the mineral in the Windpass Ore. However, as shown in the table of etch reactions, tellurbismuth tarnishes to an irridescent blue when etched with ferric chloride, while tetradymite and the mineral in the Windpass sections tarnish pale-grey. On the basis of this difference, the mineral in the Windpass ore was classified tentatively as tetradymite. The evidence for this decision is, nevertheless, very slight, as slight oxidation of the mineral surfaces before etching seemed to make the etches less distinctive.

The tetradymite occurs as irregular areas in joseite or in bismuthinite near its contact with joseite. It also forms a tiny intergrown strip along many of the bismuthinite - joseite contacts (Photo. No. 1.) Thus, the tetradymite seems contemporaneous with both bismuthinite and joseite.

Native Bismuth

In the quartz ore, native bismuth is less abundant than either joseite or bismuthinite and occurs as grains up to 2 mm across. The bismuth is yellowish-cream, and because of its extreme softness, has a pock-marked surface in ordinary polished sections which gives it a tarnished appearance. The mineral was identified by hardness, color and etch reactions.

The bismuth forms grains replacing quartz, either independently or associated with bismuthinite or joseite. Most of these grains range from 20 to 100 microns in diameter and occur in swarms or groups. A few, however, are up to 2 mm. across. In a few of the larger grains, minutely serrated contacts were seen between bismuth and bismuthinite, (Section Windpass No. 2) probably indicating simultaneous deposition of the two minerals.

Gold

Abundant coarse native gold is visible in all sections of the quartz ore and is found as independent grains, as grains in bismuthinite or joseite, but most commonly in association with native bismuth.

Most of the gold is associated with the swarms of small grains of bismuth, bismuthinite, and joseite which seem to form disseminated replacements of the quartz. Some of the grains are entirely gold. Others consist of gold and one or more bismuth minerals. Some of the larger ones consist of native bismuth containing irregular areas of a gold-bismuth graphic intergrowth appearing very much like a eutectic. (See Photo. No. 2.)

A few particles of gold occur in the larger areas of bismuthinite, joseite and bismuth. Some of these are euhedral in outline and one was seen in Section Windpass No. 3 which is octagonal in outline. In one place a tiny fissure in quartz is filled with gold. The size of gold particles in the quartz ore ranges from 15 microns to 70 microns.

The gold seems more closely associated with native bismuth than with other minerals although some gold occurs in bismuthinite or joseite where bismuth appears to be absent.

Calcite

Calcite occurs as fissure fillings in the quartz, around the boundaries of bismuth minerals, and in the cleavages of bismuthinite, joseite, and possibly tetradymite.

TABLE OF ETCH REACTIONS

Mineral	Hardness	Color	HNO_3	HCl	$FeCl_3$	KCN	KOH	$HgCl_2$
Standard Properties								
Native Bismuth (Short)	A	Light coppery pink	Effervesces & tarnish black	slowly turns differentially black	irridescent to black			brown spots doubtful
Bismuthinite (Short)	B+	galena white	slow eff. & stains black	some tarnish; some negative				light brown ?
Tetradymite (short)	B	silver white	eff. & stains brown-black	light brown to irridescent	irridescent			Some samples tarnish
Joseite (Peacock)	B	silver white	eff. & stains black	pale grey tarnish	Bluish-grey			
Windpass Ore								
Native Bismuth	A	Tarnished yellowish cream	Eff. & turns black	black tarnish	black			?
Bismuthinite	B+	Pale grey to galena white (pleochroic)	Faint tarnish					
Tetradymite (?)	B	silver white	eff. and stains black: slower than joseite		pale grey (becomes faint with buffing)			
Joseite	B	silver white	rapid eff. black stain	pale grey tarnish.	grey			
Comparative Etches on Known Slides								
Tetradymite from: "White Elephant Mine"	B	silver white	eff. & stains black.		pale grey			
Tellurbismuth from: "Hunter Mine" "Ashloo Mine" ~~"Hudson Bay Mountain"~~	B	silver white	eff. & stains black.		irridescent blue tarnish			

In one corner of section Windpass No. 1, is an area of complexly inter-replaced quartz, joseite, gold, calcite, and pyrite. The relations here are complex but joseite appears to replace calcite. Thus, calcite may have been deposited before, or at the same time as the bismuth minerals, as well as after them.

Sulfide Ore; Sections Windpass No. 5, 6, 7, 8.

The sulfide ore is found in the western part of the windpass vein and megascopically appears to consist of pyrrhotite and chalcopyrite, cut by small pyrite stringers. The polished sections studied contain pyrrhotite, chalcopyrite, sphalerite, quartz, pyrite, bismuth, bismuthinite, joseite, gold, and limonite. Although this material is reported to carry high gold values, those samples studied contained much less gold than either the quartz ore or the magnetite ore.

Pyrrhotite and Chalcopyrite

Massive, pinkish pyrrhotite makes up over half of this ore and chalcopyrite makes up most of the remainder. Contacts between the two minerals are very irregular but do not indicate which is the older. Blebs of pyrrhotite replace chalcopyrite along tiny limonite veinlets in sections Windpass No. 6 and 7. Also veinlets of quartz, pyrite and limonite cutting pyrrhotite contain irregular particles of chalcopyrite. From the above relations, it is inferred that the pyrrhotite and chalcopyrite were deposited at about the same time. As chalcopyrite is found in the quartz-pyrite veinlets and pyrrhotite is not, deposition of chalcopyrite continued later than deposition of pyrrhotite. There may have been a break between the main deposition of chalcopyrite and deposition of the chalcopyrite associated with the quartz, during which pyrrhotite was able to replace earlier chalcopyrite.

The chalcopyrite has its characertistic pale yellow color. The gold in the sulfide ore sections is paler than that in the other types of ore studied and could only be differentiated from the chalcopyrite by its higher reflectivity and poorer polish.

Sphalerite

Up to 10% of the sulfide ore is sphalerite. It is paler grey than most sphalerite and shows no internal reflection under inclined light. Even when powdered, it shows almost no color under inclined light. It was determined positively by a microchemical test.

The sphalerite occurs as small particles in the chalcopyrite and in the pyrrhotite near chalcopyrite. It also forms larger areas along and near chalcopyrite -- pyrrhotite contacts. In section Windpass No. 7 sphalerite was seen filling a fissure in chalcopyrite. In Section Windpass No. 6 a piece of sphalerite was seen to contain chalcopyrite as a rectangular grain, possibly pseudomorphous after the sphalerite. Thus, the sphalerite belongs to the same period of deposition as the chalcopyrite and pyrrhotite. Probably deposition of sphalerite started after some chalcopyrite had formed but ended before chalcopyrite deposition was complete.

Quartz and Pyrite

In the sulfide ore, veinlets of quartz and pyrite up to 2 mm across cut the chalcopyrite, pyrrhotite, and sphalerite. Some of the veinlets consist entirely of quartz, but in most, pyrite replaces the quartz along the centre of the veinlet. In some of the veinlets pyrite has replaced nearly all of the quartz and some of the surrounding pyrrhotite. However, the pyrite does not replace chalcopyrite.

Where the quartz veinlets cut pyrrhotite their walls are extremely irregular and do not match. Apophyses of quartz extend into the pyrrhotite. Hence, the quartz replaces pyrrhotite (See Photo. No. 6.)

The veinlets are strong and irregular where they cut pyrrhotite but narrow to tiny, regular fissure-fillings where they cut chalcopyrite (Photo. No. 7). The veinlets may be wider in pyrrhotite because pyrrhotite is replaced by pyrite and quartz whereas the chalcopyrite is not, or because pyrrhotite fractured more readily than chalcopyrite.

Bismuth Minerals and Gold

The sulfide ore sections contained much smaller amounts of gold and bismuth minerals than the quartz ore. As in the quartz ore, the bismuth minerals are bismuthinite, joseite and native bismuth. Tetradymite may also be present but was not recognized. Bismuth is much more abundant than either bismuthinite or joseite and tends to form euhedral grains, many of which are roughly hexagonal. These minerals occur as grains 20 to 200 microns in diameter.

All the gold occurs within grains of the bismuth minerals or very near to them. It forms subhedral grains averaging 30 mincrons in diameter. No intergrowths of gold with bismuth were seen. The gold in the sulfide ore is much paler than that in the quartz ore and probably contains a higher percentage of silver.

The bismuth minerals and associated gold occur as small grains replacing pyrrhotite or chalcopyrite. They seem concentrated near pyrrhotite-chalcopyrite contacts or near quartz-pyrite veinlets. None of them were seen in contact with quartz or pyrite.

Limonite

Massive limonite forms about 5% of the sulfide ore. In polished sections it has a rough mottled surface and a dark grey color. Under inclined light it is orange or brownish.

Most of the limonite occurs as irregular patches but some forms veinlets in chalcopyrite or pyrrhotite. The limonite veilnets are probably an alteration of quartz-pyrite veinlets. However, as some of the irregular patches of limonite are larger than any areas of fresh pyrite and are crossed or bordered by stringers of fresh pyrite, this limonite may be an alteration of chalcopyrite rather than pyrite.

Magentite Ore, Sections Windpass 9, 10, 11, 12.

The eastern end of the Windpass ore-body consists of a succession of magnetite lenses. Some of these are barren but some carry very high gold values. Sections Windpass No. 9, 10, and 12 are rich magnetite ore taken from the No. 6 stope of the mine while Section Windpass No. 11 is barren magnetite.

Microscopic study revealed only a little quartz, calcite, and pyrite veining and replacing the barren magnetite. The rich ore contains magnetite, quartz, pyrite, calcite, limonite, bismuthinite, joseite, possibly tetradymite, native bismuth, and gold. The descriptions below apply to this material.

No chalcopyrite or pyrrhotite were seen in the polished sections but lenticular areas of chalcopyrite occur in hand specimens of magnetite from other parts of the mine.

Magnetite

The magnetite has a wide range of textures. Some is very fine grained bluish-grey material but most is very coarsely crystalline and grey to black. Some of the coarser material is the strongly-magnetic lodestone variety of magnetite.

In the polished sections the magnetite is coarsely crystalline, pale grey material, cut by a network of fractures and irregularly veined and replaced by later minerals.

Quartz

Quartz occurs as fissure fillings in the magnetite and as irregular areas replacing the magnetite. The irregularity of the areas occupied by quartz and the apophyses of quartz extending into magnetite were taken to indicate replacement.

As in the quartz ore, the quartz seems to be veined and replaced by younger pyrite and bismuth minerals. However, in the sections of magnetite ore which were studied, irregular areas of limonite partly obscured these relations.

Pyrite

Replacing the quartz in many places in the polished sections are irregular bodies of pale yellow pyrite. Their contacts against quartz and magnetite are very irregular. Pyrite also forms narrow rims along parts of the boundaries of the bismuth minerals. Contacts of the bismuth minerals with the pyrite are smooth and gave little indication of their relative ages. If, as seems probable, the pyrite is older than the bismuth minerals, the areas of bismuth minerals, within the magnetite, may correspond to areas of earlier pyrite which have been almost entirely replaced.

Lenticular bodies of limonite, associated with quartz and bismuth minerals, may be alterations of pyrite.

Bismuth Minerals

Associated with quartz and pyrite or veining the magnetite are areas of bismuthinite, joseite, and native bismuth. The bismuth minerals form a few regular areas about 3 mm across and adjacent swarms of highly irregular areas about .25 m m across. In general, the native bismuth is more abundant in the small irregular bodies than in the larger bodies. Although the relations of the bismuth minerals to the surrounding material is partly obscured by limonite, they seem to replace quartz and pyrite. They were not seen to replace magentite. The bismuth minerals, particularly native bismuth, and associated gold form fissure fillings in the magnetite but were not seen to extend more than 2 mm into the barren magnetite from the replacement areas.

In the magnetite ore, as in the quartz ore, the bismuthinite, joseite and native bismuth are closely associated and were probably all deposited at about the same time. The bismuthinite and joseite almost invariably occur together and in a few places have intergrown contacts. Although bismuth forms grains independent of bismuthinite and joseite in many places, it is intergrown with bismuthinite in others.

Gold

In the sections Windpass 9, 10 and 12, the areas of mixed replacements and the fissure fillings contain abundant native gold. Some gold forms subhedral grains 25 to 100 microns in diameter in joseite or bismuthinite. Most of the gold, however, forms irregular grains in bismuth or intergrowths with bismuth (See Photo. No. 2). These are 50 to 200 microns across on the average. The intergrowths are very abundant and probably indicate simultaneous deposition of gold and bismuth. Gold was also seen as veins in the magnetite surrounding the replacements. Here the gold occurs by itself or associated with native bismuth (see Photo. No. 3).

Calcite

Tiny stringers of late calcite vein the bismuth minerals and, to a smaller extent, the magentite and quartz. In addition, calcite replaces quartz and is replaced by the bismuth minerals and gold. Thus, calcite appears to have been deposited both before and after deposition of the bismuth minerals.

Limonite

Irregular bodies of limonite are common in the mixed replacements of the magnetite ore. The limonite is a mottled dark grey color under reflected light and brownish under inclined light.

The limonite forms irregular areas in quartz and calcite and, in many places, partly encloses bismuth minerals. Contacts of limonite against other minerals, particularly bismuthinite and joseite, are crenulated as if the limonite is replacing them. (See Photo. No. 8.) However, replacement of sulfide minerals by limonite is unlikely. It is possible that the irregular contacts were caused by replacement of pyrite by bismuthinite or joseite followed by alteration of the pyrite to limonite. However, contacts of the bismuth minerals with fresh pyrite are smooth. Also, in a few places, the limonite has a radiate structure which extends into the bismuth minerals. More probably, as the pyrite or magnetite from which the limonite was derived became altered, parts of the surrounding minerals were dissolved and the limonite was deposited on the irregular surface formed by solution.

Other Minerals

In their report on the Windpass Mine in "Economic Geology" Uglow and Osborne mention the presence of cobaltite. It is described as occurring as masses of the pure mineral mixed with chalcopyrite and magnetite. It was found concentrated in a few places in the workings which then existed. In the present investigation, although the sections were studied in detail and although all available hand specimens were examined, no cobaltite was recognized. However, all these samples were collected late in the life of the mine, whereas Uglow's studies were based on near surface material. Thus, it may be that cobaltite was confined to the upper levels of the mine.

The same report also mentions the presence of native copper in the ore but none was seen in the present investigation. The copper is probably secondary and was found only in near-surface material.

SUGGESTED PARAGENESIS

The microscopic studies outlined above indicate enough overlap in minerals present and agreement in the sequence of dèposition in the three types of ore that a single scheme of paragenesis fits all types.

Apparently three independent periods of mineralization occurred. First, magnetite was deposited as lenses in the east end of the vein. Then pyrrhotite, chalcopyrite, and sphalerite formed farther west and were veined by quartz and pyrite. At this or earlier time the west end of the ore-body was filled with vein quartz. Then quartz and earlier minerals were impregnated and replaced by the bismuth minerals and associated gold. This sequence of deposition is outlined graphically in the following chart.

If the sequence of deposition of elements, rather than minerals, is considered, the same three periods of mineralization are apparent. During the first, only iron was deposited. Then iron, copper, zinc, silica, and sulfur were deposited.as a fairly closely related group. Finally, gold, bismuth, and tellurium, with associated sulfur, were introduced and precipitated to form a group of closely related minerals.

PARAGENESIS

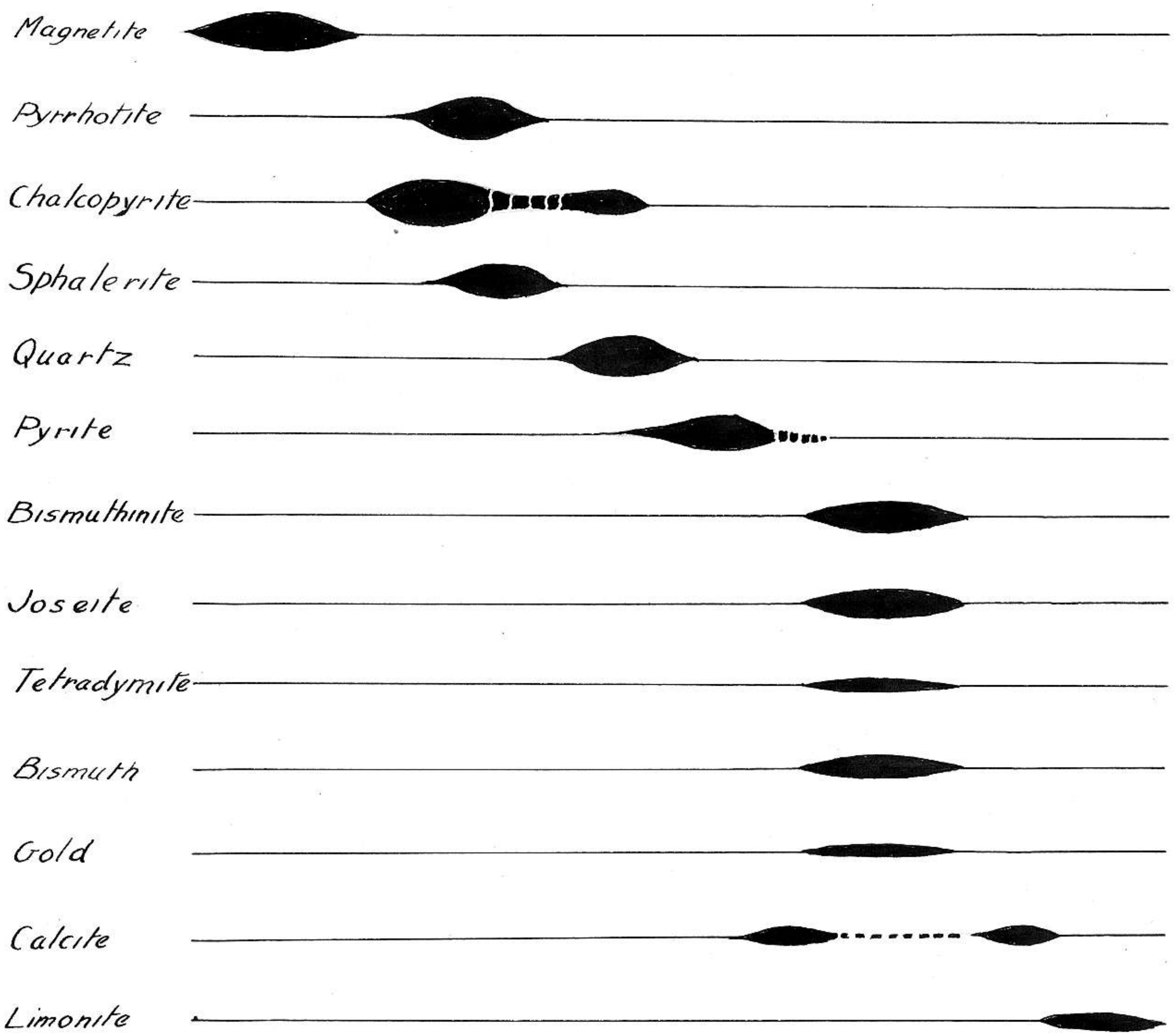
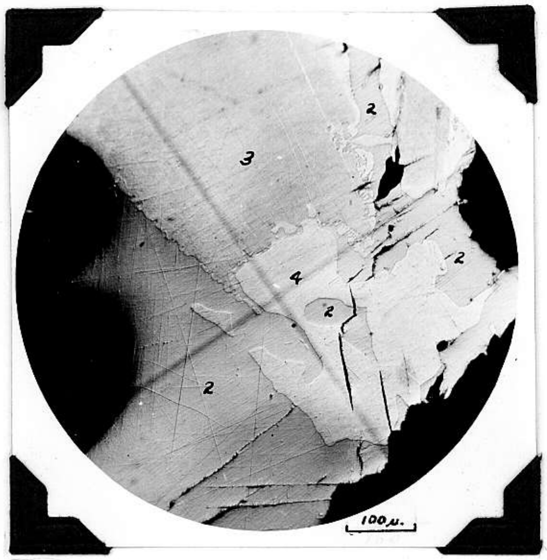


Photo No. 1
Section Windpass No. 3



Magnification
95x

1. quartz   2. bismuthinite

3. joseite   4. tetradymite

Showing relations and appearance of bismuthinite, joseite, and tetradymite. Joseite has been etched with HCl to make it distinguishable from tetradymite. In the upper right tetradymite follows bismuthinite-joseite contact and is intergrown with bismuthinite.

Microscope: Dr. Gunning's Leitz

Objective: 3b

Ocular: 8x

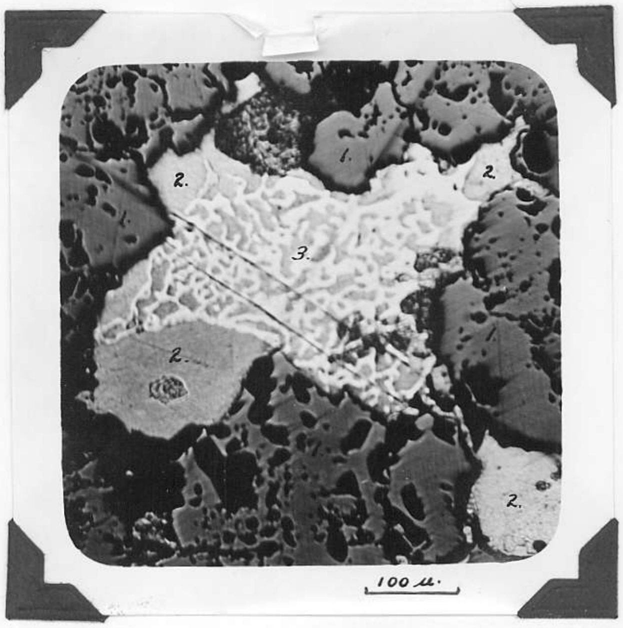
Illumination: Leitz 6v 6a., daylight filter

Plate: Wratten M

Exposure: 2 minutes

Coordinates; 15.2 56.8

Photo No. 2.
Section Windpass No. 12



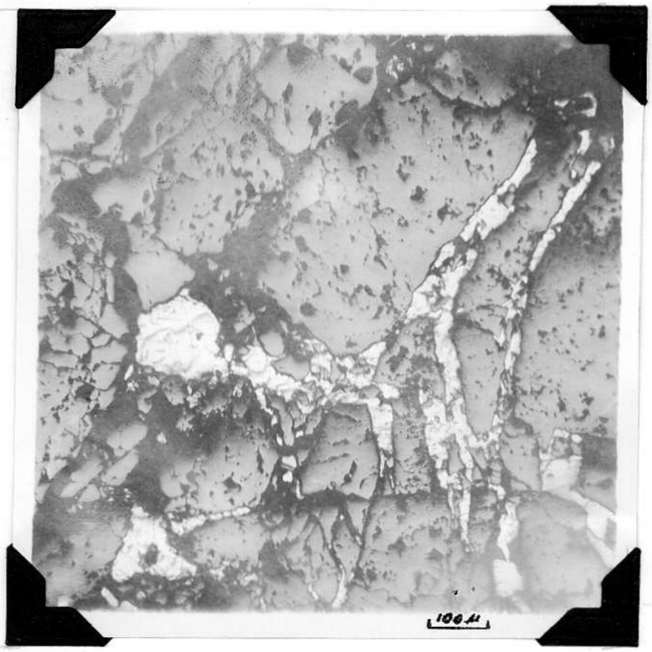
Magnification
120x

1. magnetite 2. bismuth

3. bismuth-gold intergrowth

Microscope;	Dr. Gunning's Leitz
Objective:	3b
Ocular;	8x
Illumination:	Leitz, 6v 6a, daylight filter
Plate:	Wratten M
Exposure:	2 minutes
Coordinates:	7.3 49.2

Photo No. 3.
Section Windpass No. 9.



Magnification 100x

A gold-bismuth intergrowth (bright) as a fissure-filling in magnetite (grey). The black material is limonite.

Microscope:	Dr. Gunning's Leitz
Objective:	3b
Ocular:	8x
Illumination:	Leitz 6v 6a, daylight filter
Plate:	Wratten M
Exposure:	20 seconds
Coordinates:	15.8 51.2

Photo No. 4.
Section Windpass No. 1.

Magnification 325x

An intergrowth of bismuthinite (grey) and joseite (white and pale grey). The black mineral is calcite.

Microscope: 52 Leitz

Objective: 1.215 mm

Ocular: 6b

Illumination: daylight lamp (G. 9.)

Plate: Wratten M

Exposure: 5 minutes

Coordinates: 11.3 51.8

Photo No. 5
Section Windpass No. 4.

Magnification 66x

Twinning of bismuthinite, under crossed nicols. Cleavage lamellae of the bismuthinite are outlined by calcite stringers (black). The prominent spindle-shaped twin across the centre of the picture follows a line of deformation of the cleavage lamellae.

Microscope:	Dr. Gunning's Leitz
Objective:	1b
Ocular:	6x
Illumination:	Leitz 6v 6a, no filter crossed nicols
Plate:	Wratten M
Exposure:	25 minutes
Coordinates:	13.5 57.0

Photo No. 6.
Section Windpass No. 6.

Magnification 60x

Quartz-pyrite vein on pyrrhotite. Pyrrhotite (smooth, greyish-white) is replaced by quartz (dark grey). Pyrite (pitted, white) replaces quartz and some pyrrhotite.

Microscope: Dr. Gunning's Leitz

Objective: 3b

Ocular: 5x

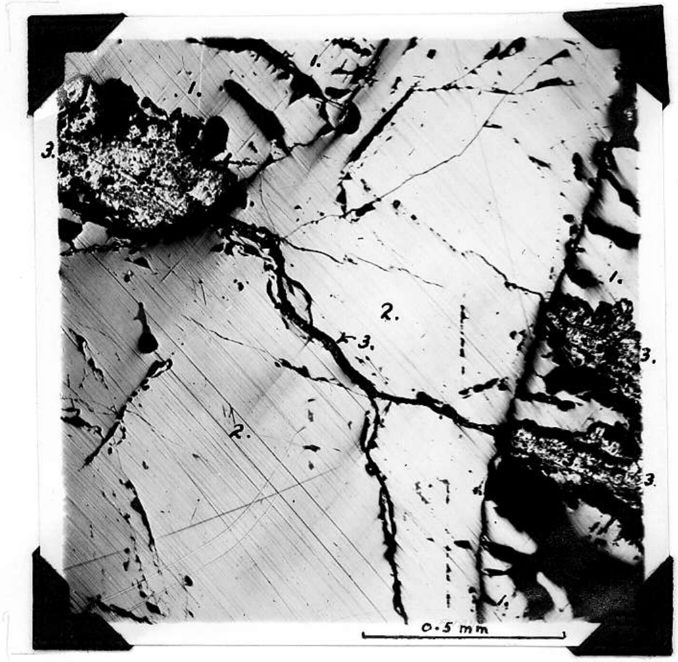
Illumination: Leitz, 6v 6a, daylight filter

Plate: Wratten M

Exposure: 25 seconds

Coordinates: 9.0 58.5

Photo No. 7.
Section Windpass No. 5.



Magnification 54x

1. pyrrhotite. 2. chalcopyrite

3. quartz-pyrite vein, black material is quartz

Shows abrupt narrowing of quartz- pyrite veins in passing from pyrrhotite to chalcopyrite.

Microscope: 52 Leitz

Objective: 3

Ocular: 6xB

Illumination: Daylight lamp

Plate: Wratten M

Exposure: 25 seconds

Photo No. 8.
Section Windpass No. 12.

Magnification 134x

1. bismuth 2. bismuthinite

3. gold 4. limonite

Shows relation of limonite to bismuth minerals. The limonite occurs in quartz and cannot be distinguished from it in this picture.

Microscope:	Dr. Gunning's Leitz
Objective:	3b
Ocular:	8x
Illumination:	Leitz 6v 6a, daylight filter
Plate:	Wratten M
Exposure:	30 seconds (under exposed)
Coordinates:	7.3 45.3

NOTE

An X-ray at the University of Toronto of the three minerals shown in Photo No. 1, Section Windpass No 3 checked that they are Bismuthinite, Joseite, and Tetradymite.