A MINERALOGRAPHIC STUDY OF ORE FROM THE VIOLAMAC MINE, NEW DENVER, BRITISH COLUMBIA.

by

J. F. Bristow.

April, 1957.

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April 18, 1957.

Dr. R. M. Thompson, Associate Professor,
Department of Geology and Geography,
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Vancouver 8, B. C.

Dear Sir:

I have the pleasure of submitting this report, A MINERALOGRAPHIC STUDY OF ORE FROM THE VIOLAMAC MINE, NEW DENVER, BRITISH COLUMBIA, in partial fulfilment of the course in Geology 409 in the Winter Session 1956 - 1957.

Yours truly,

James F. Bristow

James F. Bristow.

Few wild statements
English not so hot.

ACKNOWLEDGEMENTS.

The writer would like to take this opportunity to thank Dr. R.M. Thompson, Associate Professor of Geology, under who's supervision this study was made, for the advice and assistance in identifying the minerals. Mr. S. J. Pedley, of Violamac Mines Ltd., for supplying the specimens and without who's aid this work could not have been written. Mr. J. A. Donnan who kindly assisted in the cutting and polishing of the specimens for microscopic examination. To the above and to Mr. Papezik, laboratory assistant, the writer extends his thanks.

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ILLUSTRATIONS.

A MINERALOGRAPHIC STUDY OF ORE FROM THE VIOLAMAC MINE NEW DENVER, BRITISH COLUMBIA.

Introduction.

Location.

The Violamac Mine is located in the Slocan Mining Division of southeastern British Columbia. It is situated on a steep north facing mountain slope several hundred feet above Carpenter Creek in the close proximity of Three Forks.

The maximum relief in this area is approximately 5,000 feet. Mountain slopes of 35° are not uncommon. In general, the slopes are covered by dense second growth timber, thus outcrops are not plentiful. The dense forest cover, steep slopes and poor rock exposures make surface geological mapping a tedious and costly procedure.

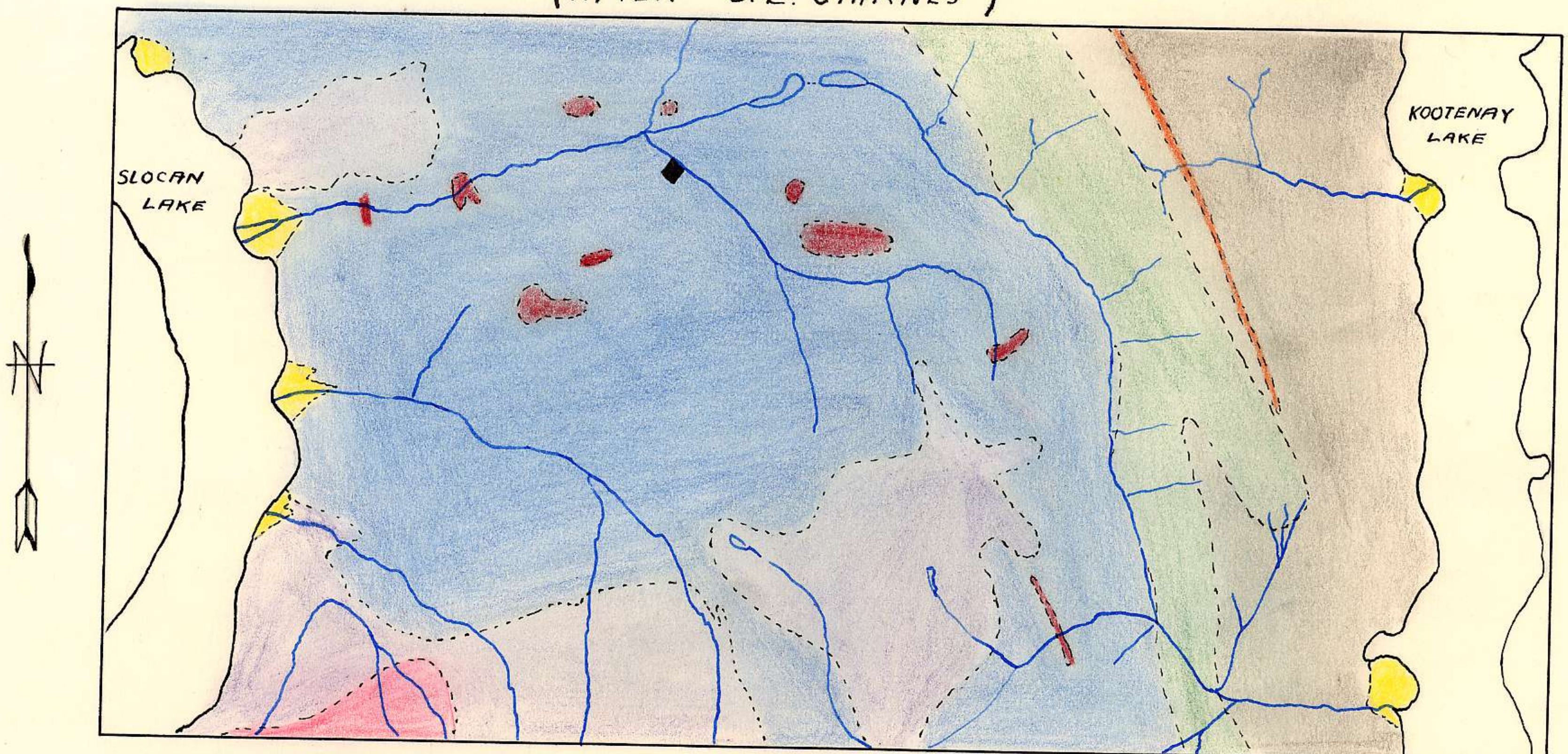
The Violamac Mine is served by an all weather gravel road which gives access to either Kaslo or New Denver. Concentrates from the mill are trucked approximately one (1) mile to a branch line of the C. P. R. at Three Forks. Here it is loaded into gondolas and transhipped to the smelter at Trail 60 miles to the west.

History of the Property.[5]

The present mine (Violamac Mines (B. C.) Ltd.) is composed of the former Victor group and the Lone Batchelor and Cinderella claims. In 1948, this group was composed of seven crown granted claims.

A GEOLOGICAL MAP OF SANDON AREA B.C.

(AFTER C. E. CAIRNES)



LEGEND

- SHISTS, PARAGNEISSES
- ARGILLITE, LIMESTONE AND TUFFACEOUS SEDIMENTS
- EXTRUSIVES ANDESITES
- GRANITE SYENITES GRANODIORITES
- VIOLAMAC MINE ■
- 1" ≈ 3 1/3 Mi
- PORPHYRITIC GRANITE
- ALTERED VOLCANICS
- CHERT
- STREAM DEPOSITS

The original discovery, in 1921, was made on the Victor by G.A. Petty as a result of trenching and ground-sluicing since the hillside is almost completely covered with overburden. Several adits were driven and between 1923 and 1929, 402 tons of ore were shipped. The property was leased in 1931 by E. Doney. The total production up to the end of 1947 was 1,424 tons.

In 1948, Violamac Mines Limited of Toronto formed the present company and purchased the property plus Mr. Doney's lease,

In 1950, a small mill was constructed to mill low grade ore and to separate the zinc blende from the galena, thus making the zinc of some value.

From 1948 to 1950, the production of the crude ore was 4,355 tons containing 194 ounces of gold, 368,042 ounces of silver and 3,948,726 pounds of lead and 1,496,336 pounds of zinc. In 1955, a total of 22,253 tons of ore were treated with a gross smelter value of $1,420,835.

General Geology.

The Violamac Mine is located in triassic rocks of the Slocan series ? in the near vicinty of post - triassic intrusion. The Slocan series is composed of interbedded argillites and quartzites that are commonly rather thin bedded. These sediments are cut by numerous porphyry sills. In the vicinty of the mine the rocks at the surface dip into the hill approximately 40°.

The mine cross section, accompanying this report, will give the reader an idealized sketch of the complex crumpling and folding that has been mapped in the mine. In general, in the Slocan area the ore minerals seem to have been deposited in greatest abundance in areas of siliceous rocks near or at the crest of the drag folds.

Mine Geology.

In the process of mining, the ore body has been traced down rake for approximately 2,000 feet. The width of the ore body is erratic and and at one point the mineralization extends for more than 400 feet. As shown in the cross section, accompanying this report, the ore body is traversed or boardered by two main faults namely the 41P and the 3,880 fault.

East of the No. 3 winze and below the 3,880 fault the lode loses its identity in a ~~board~~ broad zone of weak jointing. Below the 3,880 sub level, zinc mineralization is more strongly developed than the load mineralization. In general, the opposite is true for the rest of the shoot.

Siderite veins are found to be the most abundant at the bottom of the ore body.

Purpose and Scope of this Study.

Thirty-three specimens of Violamac ore were examined in hopes that some additional information might be obtained concerning the silver bearing minerals; also to establish, if possible, that there were two periods of mineralization, for example, one along the No. 2 drag fold and the other, with more widespread deposition, along the No. 1 drag fold. (see appendix - mine cross section.)

The following laboratory procedures were used to identify the minerals - microscopic examination under plane and polarized light, determination of physical properties of the specimens, microchemical and etch tests. Standard etch reagents were used. Dr. R. M. Thompson x - rayed and spectrographed several samples of galena to aid the author in identifying unknown minerals.

Megascopic Description.

The hand specimens are typically massive sulphides consisting mainly of coarse grained galena with aggregates of medium grained sphalerite. The galena is frequently seen to vein the sphalerite.

In many of the high grade stringers, the galena is gneissic and shows evidence of flowing. The gneissic galena is most common in the region where the 41P fault transverses the ore body.

Siderite is the most common gangue mineral near the bottom terminations of the ore body. Often it has a decided pink cast which is possibly due to a high percentage of manganese.

Cerussite alteration is plentiful, especially in those sections of the lode where quartz is the common gangue.

Microscopic Description.

The following minerals were identified in polished sections. They are listed in approximate order of abundance.

1. Galena.
2. Sphalerite.
3. Chalcopyrite.
4. Tetrahedrite.
5. Pyrite.
6. Pyrargyrite.
7. Pyrrhotite.
8. Arsenopyrite.
9. Cerussite.
10. Covellite.

The main gangue minerals were;

1. Siderite.
2. Quartz.
3. Calcite.

Galena - PbS.

Galena is the most abundant mineral. It is commonly quite coarse grained, with the crystals averaging 10 cm. across. Gneissic galena is also found especially in the region where the 41P fault traverses the ore body. Much of the gneissic galena occurs as a banded ore (alternate bands of sphalerite, pyrite and carbonate.) Where the galena is gneissic it has been deformed and shows evidences of flowing such as curved cleavage and flow planes. (Fig. 2.)

Fewer silver minerals are seen in the gneissic galena. This checks with the assay results as the oz.Ag/ % Pb ratio is lower for these specimens.

? Galena is preserved later than the sphalerite as it embays and forms veinlets in it. (Fig. 3.)

Sphalerite - ZnS.

Sphalerite is the second most abundant mineral. at the Violamac Mine. It is finer grained than the galena and is generally dark brown in colour. The colour indicates that it is high in iron. (Marmatite.) What is the definition of marmatite.

The sphalerite is intimately associated with chalcopyrite which occurs as veins or exsolution blebs in it.

On careful examination of the galena, it was found that on occasion small blebs of sphalerite formed the nuclei of larger exsolution blebs of tetrahedrite. (Fig.4.) Sphalerite is seen to embay carbonate (siderite), however, it occurs with galena and chalcopyrite as a breccia in veinlets of calcite. This would indicate that it is later than the siderite, but younger than the calcite.

Chalcopyrite - $CuFeS_2$

Chalcopyrite commonly occurs as exsolution blebs and veinlets in the sphalerite.

These veinlets were seen to enter into the galena in specimens from two localities in the mine.

1). in several specimens taken from the lower crest of

No. 2 drag fold in between No. 4 and No. 5 level. (Fig. 5)

2) in the vicinty of the 4,150 sub level.

Chalcopyrite is also occasionally associated with the quartz and calcite gangue in fractures.

Tetrahedrite- 5 $Cu_2S \cdot 2(Cu,Fe)S \cdot 2Sb_2S_3$.

Tetrahedrite has been considered to be the most important silver bearing mineral in the mine. It is found in varying amounts in all the galena, however, galena which contains very little tetrahedrite, on assaying, was found to run 150 oz./ ton in silver.

The tetrahedrite occurs in scattered patches which can be seen megascopically down to minute elongated blebs 2 - 3 u. in cross section.!

The larger areas of tetrahedrite are seen to embay the galena. (Only mutual boundaries were noted between tetrahedrite and sphalerite.) Much of the tetrahedrite occurs as minute exsolution blebs along the crystallographic axis of the galena. (Fig. 6.)

Pyrite - FeS_2

Pyrite is found intimately associated with the ore minerals. It is commonly associated with quartz and scattered throughout the carbonate and wall rock.

It has been cut by galena, sphalerite and quartz and is believed to be one of the oldest minerals present.

In general, its cubic outline has been modified by replacement until at times only remnants remain. (Fig. 7) It was noted that pyrite forms in the sphalerite as discontineous "reaction rims" and adjacent to the galena.boundaries and as disseminated rims in (on?) much of the argillite. Thus, pyrite has been formed by the action of hydrogen sulphide (H_2S) gas on iron in the argillites and sphalerite. !

Hence, pyrite of two ages occurs in this ore. The older pyrite which can be identified by its modified form and the younger pyrite "reaction rims" formed because of the action of the H_2S on wall rock and sphalerite.

Pyrargyrite- $3Ag_2S.Sb_2S_3$

Pyrargyrite was seen only in the galena as smooth blebs. Without exception, when considerable pyrargyrite was seen under the microscope the oz.Ag/%Pb ratio was high. Its distribution is wide and no marked increase in the occurance was noted at depth.

Because of its smooth outline and disseminated nature, it is believed to have been deposited contemporaneously with the galena and thus to occur as exsolution blebs.

Pyrrhotite - $Fe_{1-x}S$.

Pyrrhotite was found in seven of the thirty-three specimens studied. The specimens that it was found in came from widely separated localities and thus its occurance could not be associated with any structural feature such as a fault or a drag fold. It was found occuring as small veinlets approximately 4 mm. wide and was seen to cut carbonate, sphalerite, and galena.

Arsenopyrite- FeAsS

Arsenopyrite is not a common mineral constituent of the Violamac ore. It was identified in fractures in sphalerite and was associated with quartz and pyrite.

Cerussite- $PbCO_3$

Massive cerussite was identified in many of the specimens from the deeper workings of the mine, namely those below the 4,150 sub level. This ore was found to be vuggy and exemplifies open space filling.

Covellite - CuS.

Minute blue specks, 2 - 3 microns in diameter, were seen in some of the weathered sphalerite examined. These blebs were too small to positively identify. However, since the sphalerite in this camp invariably contains chalcopyrite it is the author's belief that this blue mineral was covellite formed as a secondary mineral from the weathering of chalcopyrite.

Unknown 1.

When the galena was etched with HNO_3, it was found to contain numerous elongate exsolution blebs that roughly paralleled the crystallographic axis. Of them, the greater proportion of these blebs were weakly anisotropic. They showed no relief with galena and were not seen until the galena was etched. Because of their size, (width 2 - 3 microns) it was impossible to make tests of their physical properties.

Microchemical tests verified the presence of lead, sulphur and silver.

An area containing a large number of these blebs was circled with a needle under the microscope and excavated. This material was X-rayed by Dr. Thompson. However, the results were inconclusive and verified only the presence of galena.

The writer suspected the unknown to be Matildite $(Ag_2Pb)SBi_2S_3$. Dr. Thompson kindly offered to spectrograph some of the galena containing the unknown. It was hoped that by the aid of the spectrograph to positively identify the bismuth. The presence of bismuth would have excluded tetrahedrite ($5Cu_2S.\ 2(CuFe)S.2Sb_2S_3$) as the possible unknown and support the Matildite theory.

However, the spectrograph positively proved that there was no Bismuth present. Hence, it can only be concluded that the unknown is possibly tetrahedrite which appears to be slightly anisotropic because of the width of the lamellae.

Gangue Minerals.

Much of the following material on gangue minerals is summerized from Mason (1950). In general, the writer agreed with this author and the text has been altered only sightly where such variation occured.

Quartz.

Minor amounts of quartz are distributed throughout the ore in stringers that rarely exceed 10 mm. in width. Arsenopyrite and pyrite are commonly associated with it. At least two - probably more - ages of quartz are indicated . Some quartz cuts carbonate and occasionaly some fractures are lined with quartz and then filled with carbonate.

In some places quartz, with associated arsenopyrite, appears to have replaced sphalerite. (Arsenopyrite is normally earlier in the paragenetic sequence than sphalerite.) Fractured crystals of pyrite are commonly enclosed in quartz. On the other hand, euhedral crystals of quartz enclosed in tetrahedrite show that some quartz is earlier than tetrahedrite and is not displaced.

Carbonate.

Calcite is abundant in the ore, especially in the banded specimens, occuring as disseminated grains, islands or veinlets. It is cut by, enclosed in and embayed by galena. Small carbonate stringers are seen to traverse the sphalerite and in places forms the matrix of a breccia containing galena, sphalerite and chalcopyrite.

Siderite is the common carbonate in the lower terminations of the ore. It is seen to be vuggy and believed by the author to be earlier than the galena.

Conclusions.

One may conclude from tha assay results that there is an erratic yet higher silver content in the ore along the crest of No. 1 drag fold. (A ratio of over 1.3 oz. Ag/ %Pb compared to a more constant ratio of approximately 1 oz. Ag./%Pb in the other areas.)

The author does not feel that this is sufficient evidence to assume that there were two periods of galena mineralization. Perhaps if a more detailed study was carried out in the areas of major drag folding one would be able to arrive at some concrete conclusion.

Examination of the polished section showed that the high silver assys were, in general, directly proportional to the abundance of pyrargyrite and tetrahedrite.

Chalcopyrite was noted to intrude galena along the No. 2 drag fold between No. 4 and No. 5 levels and in the vicinity of the 4,150 sub level. This indicates that at least in these sections of the mine there were two stages of copper mineralization. The author does not feel that this evidence has necessarily any bearing on the distribution of silver minerals. In the areas where the silver minerals were high and no silver minerals could be seen on polished sections before etching with HNO_3 it is believed that the silver is contained in minute exsolution blebs of tetrahedrite.

The vuggy nature of much of the ore suggests open space filling. The galena and sphalerite crystal aggregates are of approximately the same size which suggests nearly contemperaneous deposition.

Movement and fracturing has taken place after deposition of the ore minerals as is shown by the curved cleavages and flow planes in the galena.

Secondary minerals occur in only very minor amounts. Therefore, the deposit is believed to be hypogene in origin.

Two ages of pyrite were identified. The oldest is characterized by its modified form. The youngest pyrite occurs as " reaction rims " due to the action of H_2S gas on the high iron content and iron rich argillites.

The mineral assembledge indicates that the deposit was formed in a mesothermal environment between 175'C. and 300'C.

KEY TO POLISHED SECTION DRAWINGS

g	Galena
sp	Sphalerite
t	Tetrahedrite
ch	Chalcopyrite
pi	Pyrite
py	Pyrargyrite
ca	Carbonate
q	Quartz

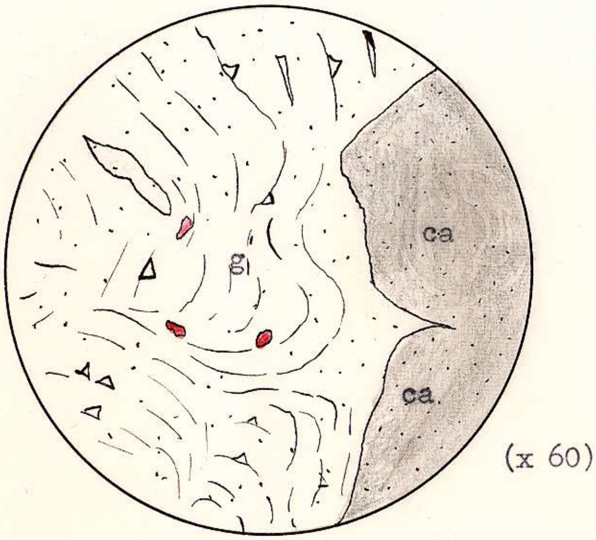


Figure 2. Polished section drawing. Curved cleavage and flows as seen in gneissic galena.

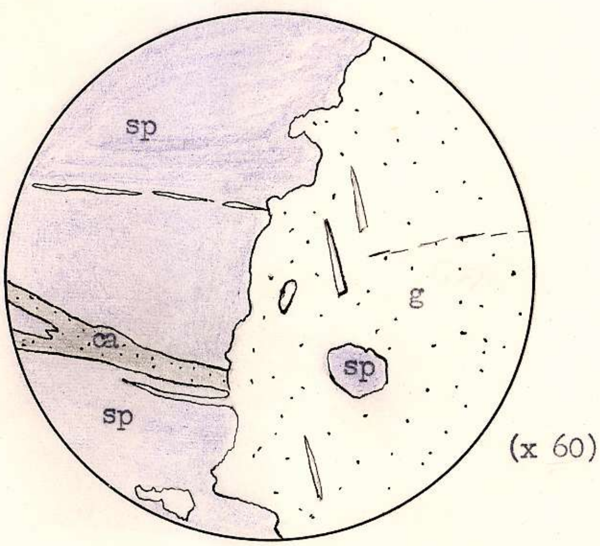


Figure 3. Polished section drawing. Cutting relationship between galena and sphalerite.

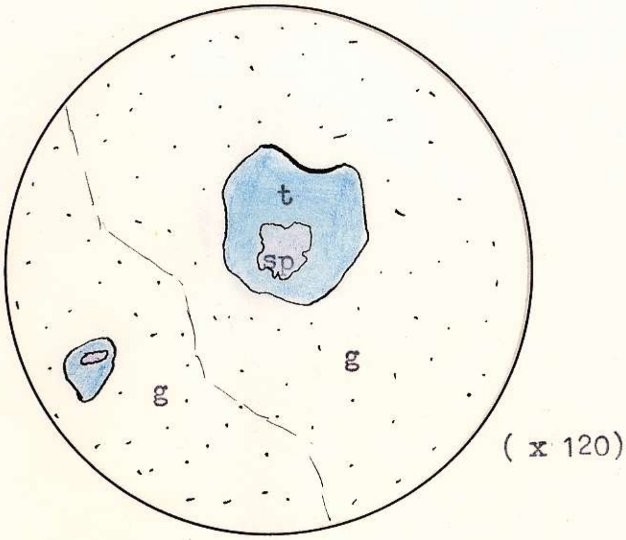


Figure 4. Polished section drawing. Section showing tetrahedrite exsolution blebs that have formed around the nuclei of the sphalerite.

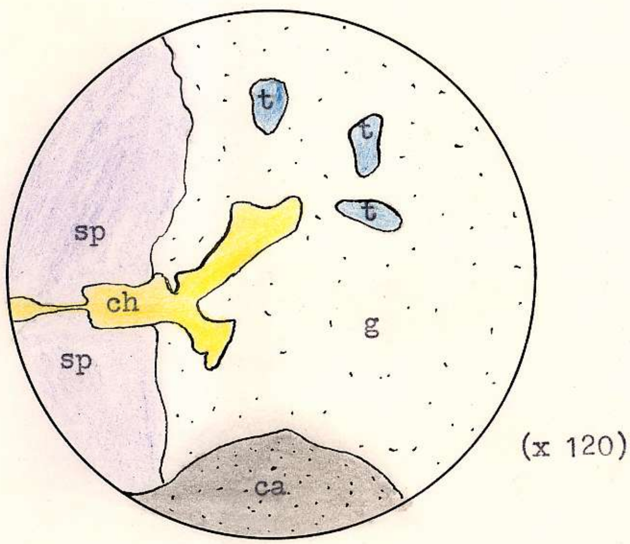


Figure 5. Polished section drawing. Chalcopyrite crossing Galena sphalerite boundry.

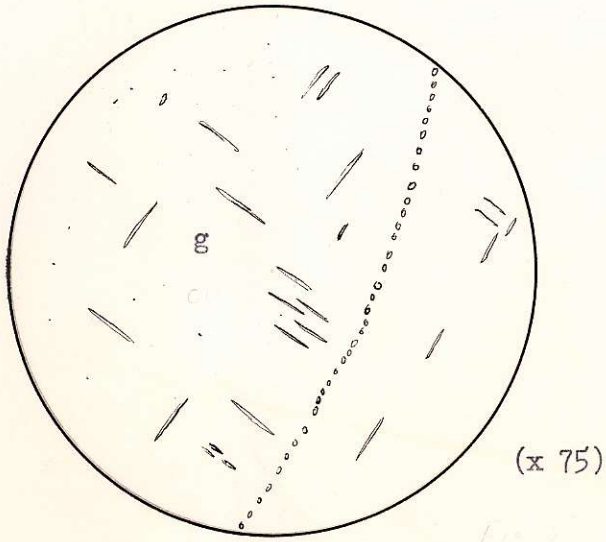


Figure 6. Polished section drawing. Exsolution lamellae of tetrahedrite along crystalographic axis of galena as seen after galena was etched with 1:1 HNO_3.

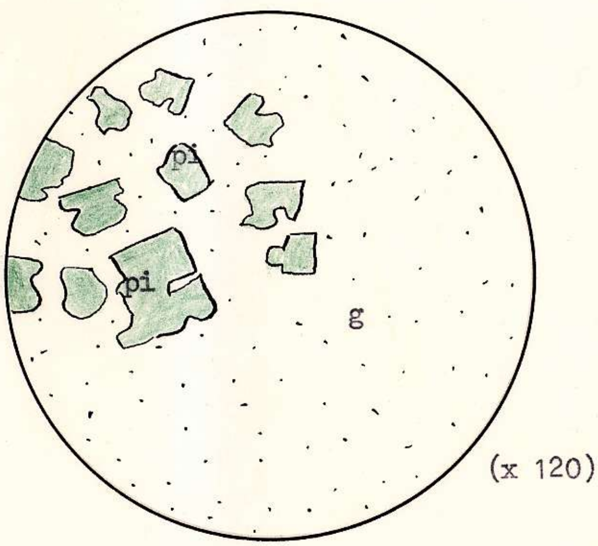
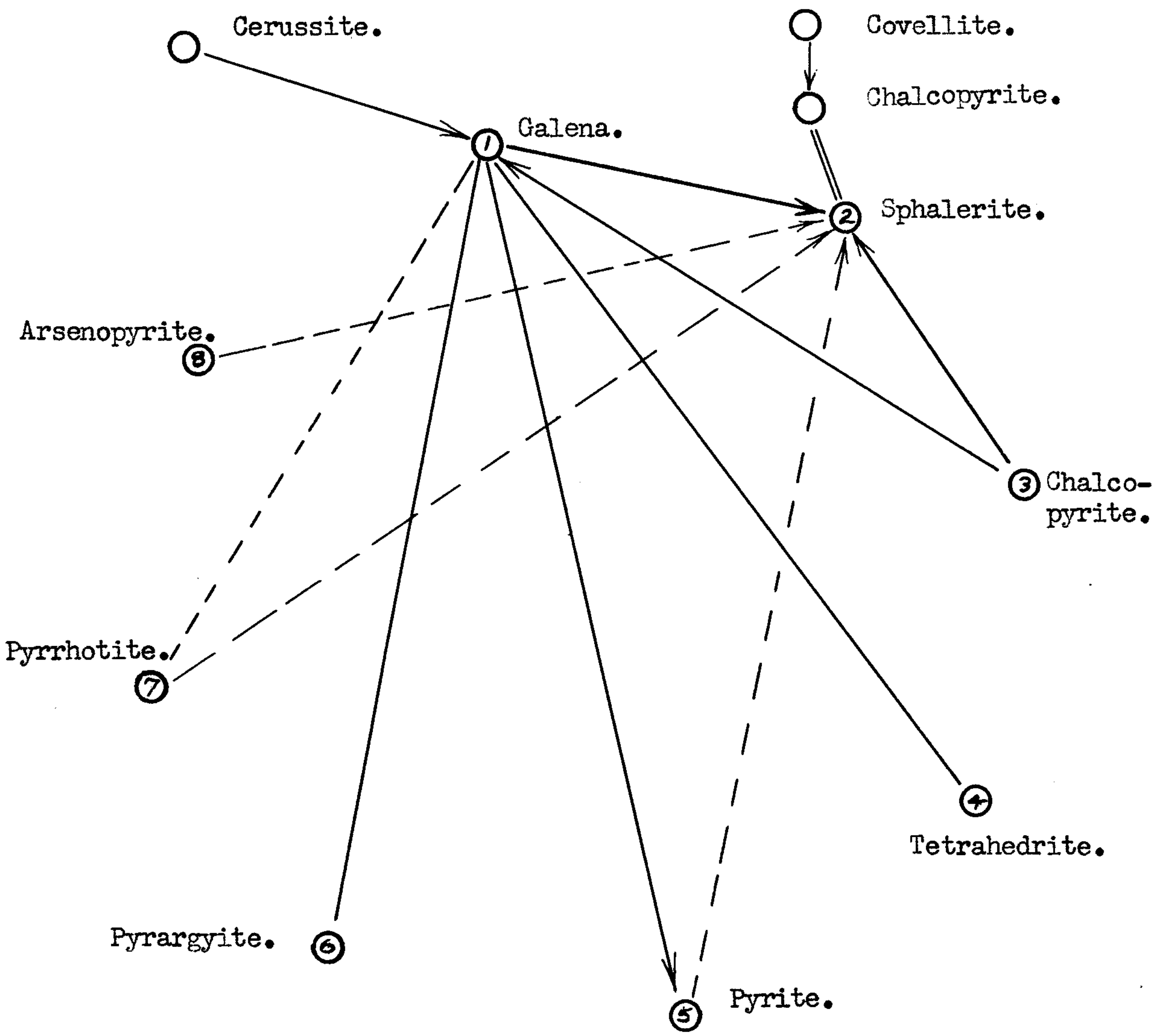


Figure 7. Polished section drawing. Modified pyrite crystals.

PARAGENETIC SEQUENCE.



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APPENDIX.

ASSAY RESULTS AND ENVIRONMENTAL LOCATION.

SPECIMEN NUMBER.	SILVER. OZ/TON.	LEAD %.	OZ. Ag. / % Pb.	LOCATION.
S - 1.	212.6.	2.2	96.3	joint largely sphalerite
S - 3.	45.2	10.9	4.1	galena border on 8 inch sphalerite.
S - 4.	127.2	0.2	636.0	sphalerite,no visible galena.
S - 5.	97.5	3.8	25.0	quartz & carbonate, plus minor Pb & Zn.
S- 7.	54.6	68.7	0.8	4 inch galena tail off main vein.
S - 8.	92.8	58.5	1.6	galena in sphalerite.
S - 9.	65.0	39.3	1.7	15 foot vein,(est. 15% PbS 30% ZnS.)
S - 10.	30.2	31.6	1.0	½ foot swell, quartz, siderite, PbS, ZnS.
S - 12.	90.4	71.6	1.3	high galena.
S- 13.	191.6	72.3	2.6	high galena.
S - 14.	173.7	59.3	2.9	high galena.
S - 15.	76.2	53.7	1.4	1½ foot vein, high in % Pb.
S - 16.	48.3	46.8	1.0	2-3 inch galena swell, in tight filled joint.
S - 17.	80.5	68.7	1.2	1.2 foot galena,quartz predominate gangue.
S - 18.	115.6	84.2	1.4	3 foot galena vein, near major (3880) fault.
S - 19.	60.1	49.8	1.2	6 inch PbS in centre of 1½ foot siderite,ZnS.vein
S - 20.	52.5	49.9	1.1	3 inch PbS in sphalerite sheath.
S - 21.	36.9	41.7	0.9	wall as above.
S - 23	55..0	48.0	1.1	galena and sphalerite, quartz predominate gangue
S - 24.	55.3	61.8	0.9	galena lense in ZnS sheath.
S - 25.	1.9	0.9	2.0	3 foot drusy ZnS , no visible galena.
S - 26.	0.9	trace.	----	3 foot ZnS, no visible galena.
S - 27.	82.9	71.1	1.2	2 inch galena stringer cutting 1 foot ZnS vein.

ASSAY RESULTS AND ENVIRONMENTAL LOCATION.

SPECIMEN NUMBER.	SILVER OZ./ TON.	LEAD %	OZ. Ag. / % Pb.	LOCATION.
S - 28.	60.2	64.8	0.9	2 inch galena stringer, cutting 1 foot ZnS.
S - 29.	72.8	68.3	1.1	galena and ZnS stringers cutting siderite vein.
S - 30.	34.0	46.6	0.7	vein composed of 4 foot siderite with minor PbS, and ZnS.
S - 31.	142.7	79.1	1.8	banded ore 30% galena, 40% ZnS.
S - 32.	75.2	17.6	4.2	narrow sphalerite galena vein.
S - 33.	6.1	1.6	3.8	low grade pillar.
S - 34.	70.8	58.5	1.2	small joint
S - 35.	66.3	19.3	3.4	small galena swell in sphalerite joint.
S - 36.	119.7	15.5	7.7	4 inch vein galena and sphalerite.
S - 37.	114.0	74.9	1.5	small galena vein (quartz siderite gangue)

Note - Figures in red are irrelevant.

LEGEND

(1.)	APPROXIMATE LOCATION OF SPECIMENS		STOPED AREA
	BEDDING TRACE		AREA WHERE SIDERITE VEINS PREDOMINATE
	MAJOR FAULTS		SILLS

LONGITUDINAL VERTICAL SECTION

VICTOR MINE, NEW DENVER, B.C.

Scale: 1" = 100' December, 1956

S.J.P.