

600341

A LABORATORY INVESTIGATION  
OF THE  
ST. PAUL GROUP ORES

Report submitted

In fulfillment of the requirements of Geology 9, the  
Mineralography portion of the course in Geological  
Engineering at the University of British Columbia.

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### ACKNOWLEDGMENTS

The writer wishes to thank Dr. H. V. Warren, under whose supervision the investigation was carried on, for his advice and assistance during the semester.

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### PURPOSE OF INVESTIGATION

The St. Paul Group ore samples were investigated in order to obtain as much of the following information as possible;

- (1) The minerals present in the ore.
- (2) The paragenesis of these minerals and their relationships to one another.
- (3) Any evidence as to the type and depth of the St. Paul deposit.
- (4) The precious metal content of the samples.
- (5) The size of the mineral particles.
- (6) The type of treatment most suitable for this ore.

INTRODUCTION

The samples made available to the writer for this investigation were collected from the old workings on the St. Paul Group of claims.

The property was owned in 1930 by the St. Paul Mines, Limited, a three-man syndicate consisting of, Dr. O. Van Etter and Messrs. O. M. Sheppard and R. Brown. Information on the property since 1930 was lacking but Dr. Warren informed the writer that some work was again being done on the property workings.

The claims are situated on Monashee mountain, Vernon mining division, Osoyoos district, British Columbia. They are accessible from the Vernon-Edgewood highway 42 miles east of Vernon. A branch road follows Yeoward creek for a mile and is continued by a  $2\frac{1}{2}$  mile trail to Monashee mountain. The old workings are 1220 feet above Yeoward creek on the northern slope of the mountain.

These claims were investigated by C. E. Cairnes in 1930 and described by him in the report listed at the bottom of this page. The writer made use of this report for information on the geology and occurrence of

the deposit. Other than what was obtained from the report nothing is known to the writer at the present time of the size of the showing nor from what part of the property the samples were originally taken. Therefore, all study and conclusions recorded in this paper are based on random samples.

---

C. E. Cairnes, St. Paul Group of Mineral Claims, G.S.C.  
Summary Report, 1930, Part A ., P 116A.

PROPERTY

The location and accessibility of the property have already been mentioned on the previous page in the introduction to this paper.

History:

The property has been worked off and on since 1900 by various owners with some success apparently. All in all, a few hundreds of tons of ore have been shipped or given mill tests and are reported to have run high in gold and silver values. In 1927 eleven tons of St. Paul ore were shipped to the Trail smelter and ran<sup>2</sup> ;

Gold	0.50 oz/T
Silver	147.9 oz/T
Pb	12.4 %
Sb	2 %
S	17 %
SiO	25.4 %
Fe	13.2 %
CaO	0.7 %

In 1930 Dr. Cairnes mentioned that about 8 tons of high-grade silver ore were stacked at the mine.

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(2) Annual Report, Minister of Mines, B.C. 1927, p 213



No information was available about any work done since Dr. Cairnes' report.

General Geology:

The St. Paul Group is in an area mapped by G. M. Dawson in 1898. Dawson's map includes this district in his Shuswap Series but there was no detailed geology shown particular to the St. Paul property. The geology of the property is adequately dealt with however by Dr. Cairnes in his report mentioned previously. The writer will give a brief outline of the geology from this report.

Monashee mountain and the environs are underlain by greenish volcanics and intercalated sediments. Andesitic volcanics lie on the upper part of Monashee mountain. Below them lies a belt of Argillites and Limestone which is intruded by a Diorite body. This intrusive is apparently related to the main Mesozoic batholithic intrusion.

Economic Geology:

Mineralization at the mine workings is in the form of veins occurring in a strong shear zone in or near the contact of the Diorite intrusive.

These veins fall into two groups: (a) The gold-bearing quartz veins, usually about one foot thick, and (b) Veins, 3-4 ft. wide, of heavily mineralized diorite with varying thickness, up to 2 ft., of solid sulfides---these veins apparently were rich in silver.

The sulfides occurring in the latter type of veins are arsenical iron with kidneys of other sulfides, particularly Jamesonite. Dr. Cairnes lists the main sulfides present as follows:

In order of abundance,

Arsenopyrite  
 Antimonial sulfides  
 Pyrite  
 Pyrrhotite

The antimonial sulfides include:

Jamesonite  
 Stibnite  
 Tetrahedrite

These antimonial sulfides occur as:

- (a) Streaks or bands, from one inch to several inches thick, in quartz.
- (b) Kidneys in quartz or other sulfides.
- (c) Intimately associated with Arsenopyrite.
- (d) Crystals disseminated in quartz.

Judging from the appearance of the various samples available they would seem to fall into classes (b) or (c) in the above occurrences. However, there are some

that may bear a relation to the other occurrences.

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(2) Annual Report, Minister of Mines, B.C. 1927, p 213

LABORATORY INVESTIGATIONProcedure

Various available samples of St. Paul ore were examined megascopically and nine specimens were selected by the writer as being diagnostic and typical.

A detailed inspection of the specimens was made with the binoculars to aid the subsequent microscopic investigations. Polished sections were made from each specimen and the various minerals in them were determined by etch tests and microchemistry. Where the above methods were not conclusive in determining an unknown mineral the specific gravity was determined from picked crystals as well as the composition from assays.

The paragenesis of the minerals was then determined as closely as possible from the various polished sections. The size of the mineral grains and the type of deposit were also determined.

Investigation of the ore for gold and silver was aided by use of the superpanner and assaying the products. (NB: The results of these assays were not available by the time of the writing of this report. They will be added as a supplement as soon as possible.)

Photographs of diagnostic sections were taken  
to illustrate the report.

MEGASCOPIC EXAMINATION

Specimens A, B, and C : These specimens represent various differences in solid sulphide (Jamesonite) texture and purity.

Specimen A is fairly pure, compacted Jamesonite (As determined under the microscope) which has crystallized in stubby, scale-like flakes about 1mm. in length. Sheaf-structure and cleavage are not as well pronounced as in other specimens. The massive Jamesonite has an uneven fracture in any direction. The section from specimen A is cut through the haphazardly oriented crystals.

Specimens B and C are massive Jamesonite as in the previous specimen but with more pronounced columnar sheafs of crystals. Pyrite and Arsenopyrite crystals are interspersed through the samples with occasional calcite.

There are at least two cleavages parallel to the long axis of the Jamesonite crystals and one cleavage perpendicular to it which breaks the columns off sharply leaving square ends.

Hardness is about 2.5 across crystalline lengths and slightly harder along them. This property of

varying hardness is also evident in polished sections as is mentioned later in this report.

Specimens D, E, F : These specimens contain various types of jamesonite-quartz-arsenopyrite association. In all hand specimens the arsenopyrite occurs as a loose band along the quartz-jamesonite contacts.

Specimens D & E contain varying amounts of pyrite, chalcopyrite and calcite as well as quartz, arsenopyrite and jamesonite. Small amounts of jamesonite occur also as clusters intimately associated with quartz.

Specimen F shows a quartz vein bordered on either side by arsenopyrite and jamesonite.

Sections of the above three specimens were cut across the mineral contacts.

Specimen G : This specimen shows veining of what is presumably country rock by jamesonite, arsenopyrite and quartz. Pyrite cubes up to 1mm. in size are scattered through the rock.

The contact between the jamesonite and country rock is fronted by arsenopyrite and (or) pyrite. Metallics are scattered through the rock and find particular access in fractures.

# TABLE 1

SECTION	MINERALS PRESENT		PARTICLE SIZE	DESCRIPTION
	NAME	%		
A	Jamesonite Arsenopyrite Tetrahedrite Chalcopyrite Quartz	80 20	280 $\mu$	Jamesonite with inclusions of other mins. Few included Qtz. particles with remnants of Arsenop. in them. Chalcopyr. occurs in James. with the arsenop. Considerable amts. of Tetrahedrite in Jamesonite.
B	Jamesonite Arsenopyrite Tetrahedrite Calcite	95 5 —	280 $\mu$	Jameson. with remnants of Arseno & little Qtz. Calcite intrudes as tiny irreg. veinlets. Tetrahedr. as blebs in Jameson.
C	Jamesonite Arsenopyr. Tetrahedr. Pyrrhotite Chalcopyr. Quartz	90 5 5	140-280 $\mu$ 140 $\mu$ 70 $\mu$	Again, inclusions in Jamesonite. Arsenopyr. $\diamond$ 's very common. Tetrahedr. ; very slightly darker than Jamesonite. Chalcopyr. ; pieces isolated in James. sometimes with Pyrrho.
D	Electrum Jameson. + Tetrahedr. Pyrite Arsenopyr. Qtz. Calcite	— 25 20 50 5	100-200 $\mu$ 70-140 $\mu$ "	James. eating into Qtz. and eating into Pyr. & Arsenop. remnants in Qtz. Remnant xtals of " " are isolated deep within Qtz. Electrum as tiny particles in Pyr., Arsen. & Qtz. — all deeply within Qtz. Calcite encroaches into breaks in James.
E	Arsenopyr. Tetrahedr. Chalcopyr. James. Qtz.	25 20 5 50		Tetrahedr. replacing Qtz. & residual Arsenop. in spots. Finger of James. also enters replacing Qtz. & Arsenop. Chalcopyr. with James. & Tetrahedr. Tetrahedr. and James. often intermixed.
F	Arsenopyr. Tetrahedr. Chalcopyr. James. Qtz. Calcite.	50 50		Same as Sect <sup>n</sup> E. Patterns of Jameson. replacing Calcite. Qtz. & Jameson. close in on Arsenop. from opposite sides.
G.	James. Arsenopyr. Pyrite (Galena) Qtz.	Qtz. veins in Country rock.		Qtz. veins with residual Arseno. & Pyr. cut rock in several places. James. advances from one side of sect <sup>n</sup>



MICROSCOPIC EXAMINATION

In examining the polished sections of the ore under the microscope the writer was presented not only with the problem of identifying the minerals present but also of becoming familiar with the deceptive microscopic characteristics of jamesonite. This latter problem will be explained in detail in the discussion on jamesonite which follows the general results of the microscopic examinations.

Minerology :

Rather than make a great many detailed descriptions of the sections the writer compiled a table which gives the desired information in a clearer and more concise manner. Thus in Table 1 are given all the important facts about each polished section corresponds to the one on the particular specimen it was cut from. (Described previously under "Megascopic examination")

As can be seen in Table 1 the principal minerals present, in order of abundance, are as follows :

<u>Metallics</u>		<u>Gangue</u>
Jamesonite	- $4\text{PbS} \cdot 3\text{Sb}_2\text{S}_3 \cdot 3\text{FeS}$	Quartz - $\text{SiO}_2$
Arsenopyrite	- $\text{FeAsS}$	Calcite - $\text{CaCO}_3$
Pyrite	- $\text{FeS}_2$	
Tetrahedrite	- $3\text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$	
Pyrrhotite	- $\text{FeS}_{n+1}$	
Chalcopyrite	- $\text{CuFeS}_2$	
Electrum	- $(\text{AuAg})$	
(?) Galena	- $\text{PbS}$	

The last seven minerals listed above occur as inclusions in either the jamesonite or the quartz. The calcite is present, in minor amounts, not only in residual form but also as a very late veining phase.

The jamesonite and the quartz are very seldom in intimate contact but are usually separated by arsenopyrite and, or, pyrite which form (s) a fringe in and in front of the quartz borders. The arsenopyrite and pyrite are almost entirely in good crystalline form and in polished sections exhibit characteristic squares, triangles etc.

The question mark is put before Galena in the above list because this mineral was not conclusively determined. It was present only in extremely minute amounts in one section and no good tests could be made. Microchemistry was not possible due to the lack of large enough specks of the mineral.

**TABLE 2.** (REACTIONS AS IN SHORT = ✓)

MINERAL	COLOR	HARD-NESS	ETCH REACTIONS						Iso-trop.	Aniso-trop.	REMARKS.
			HNO <sub>3</sub>	HCl	KCN	FeCl <sub>3</sub>	KOH	HgCl <sub>2</sub>			
Jamesonite	Galena white.	B	✓	✓	Neg.	Neg.	✓	Neg.	✓	Agua Regia ✓	
Arsenopyrite	Galena white	F	Eff. - stains brown	-	-	-	-	-	✓	Diamond x sects.	
Pyrite	Pale yellow	F	Slow irred.	-	-	-	-	-	✓	Aq. Reg. fumes tarnish.	
Tetrahedrite	Gray	D	Fumes tarn.	-	Brownish.	-	-	-	✓	Neg. to Aq. Reg.	
Chalcopyrite	Brass yellow	C	Fumes tarn.	-	-	-	-	-	✓	Aq. Reg. = stain.	
Pyrrhotite	Pink cream	D-	Light brn.	-	-	-	Brown	-	✓	Magnetic.	
Galena (?)	Galena white		Blk. - eff. (?)	Grn. yell.	Neg.	✓	-	-	✓		
Electrum.	Pale yell.	B	Fumes tarn.	-	Dark	-	-	Irridescent	✓	Sectile	

**TABLE 3.**

**JAMESONITE TESTS :**

**HNO<sub>3</sub>** - Fumes tarnish brown around periphery.  
Not always effervescence.

Test same for light patches & James. & both.

Very slight eff. then after second or two from a focal point in the drop a cloudy brown-green irridescence spreads over drop. Immediate border of the drop is never covered by "cloud".

If wash drop off = brownish stain.

If let drop dry up = green-red irridesc. area rimmed by bluey border.

**Aq. REG.** - Fumes tarnish strong brown.  
Slight eff.

**HCl** - Fumes always tarnish brownish. Irregularly, not continuous ring.

**KOH** - Sweat band around drop.

KOH stains in pattern of patches which vary in colour and change as the drop remains. The nature of these patches is admirably shown in Plate #1. The three types of patches, & their color changes as the drop remains are shown on the right →

When wash drop off, = very pale shades of various colors. →

\* **NB** Light areas :

No react<sup>n</sup> alone but when drop contacts darker parts the lighter patch will follow the ③ color sequence →. (Other areas that are the usual Jamesonite also follow this identical sequence).

TIME	COLORS OF PATCHES (3 varieties)		
	①	②	③
20 secs.	Brown		Brownish
30	Blue violet		↓
50	↓	Brown	Brown yell.
55		Violet	↓
70	Pale blue	↓	Brown
90	↓	Blue violet	↓
100		↓	Blue violet
140	Yellow blue	↓	↓
170	↓	Pale blue	↓
180		↓	Blue
200	Pinkish brown	↓	↓
4 mins.	Blue violet	White blue	Pale yellows & blues
7 "	Blues	"	Red violet.
12	↓	White yellow	↓
	Merged in differential irredes.		

Overall affect of Blue-brown patch work.  
Eg. At 70 secs. the drop of KOH will be patches colored: { Pale blue  
Violet  
Brown

The results that could be obtained seemed to indicate Galena.

Table 2 shows the particular properties by which the various minerals were determined under the microscope. Any other methods used will be outlined under the following discussions of each mineral.

Jamesonite:  $(4PbS3Sb_2S_3FeS)$  Characteristics & Determination.

In nearly all the sections jamesonite is present as a late phase replacement advancing persistently into all the other minerals both metallic and gangue. When highly polished the jamesonite has a smooth galena-white surface with a very faint mottled appearance. This mottling gives the affect of grains of another mineral being included in the jamesonite. These included patches are somewhat whiter and very slightly harder than the surrounding jamesonite. However etch tests and anisotropism are identical for both the light patches and the jamesonite.

Detailed investigation was done on the etch reactions of jamesonite; first excluding the lighter patches, then including them. The results of these tests are shown in Table 3. Obviously the best of the tests for jamesonite is with KOH. The writer has found the reactions of KOH on jamesonite to be unmistakable and consistent. For this reason the

KOH reactions are given in full detail in Table 3.

From the etch results it could be seen that the entire surface of the jamesonite would mottle under KOH and that the included lighter patches fitted into a general grain pattern brought out as this mottling by the KOH.

Under polarized light the same held true of the lighter patches fitting into a pattern of grains made visible by their varying degrees of anisotropism.

Jamesonite is anisotropic with colors varying from brown to bluish grays in the different grains. The appearance of jamesonite under crossed nicols can be seen in Plate #1 as contrasted to the plain unmottled appearance under unpolarized light, as in Plate #2.

When the sections were given a slightly coarser polish all the jamesonite took on a distinctly mottled granular appearance and the lighter patches merged with the rest of the crystals. Cleavages in the jamesonite became quite evident as seen in Plate #3.

To further substantiate this evidence the writer picked enough mineral, including both the jamesonite and the associated "light patches", to have an analysis made. The composition of the sample ran as follows:

<u>Sample</u>		<u>Jamesonite*</u>
1.10---	<u>Insolubles</u>	.88
38.74	<u>Pb</u>	38.90
33.32	<u>Sb</u>	34.46
.39	<u>As</u>	.38
.47	<u>Cu</u>	.15
.25	<u>Ag</u>	.30
—	<u>Zn</u>	—
3.74	<u>Fe</u>	3.42
21.97	<u>S</u>	21.50

---

\*From sample taken by Dr. H.V. Warren, Prof. of Minerology,  
U.B.C.

Thus the sample can safely be assumed to be fairly pure jamesonite and the light patches are ostensibly not another mineral.

A few crystals picked as clean as possible under the binoculars gave an average specific gravity of 5.59 which is a reasonable correspondence to jamesonites' 5.62.

From the above evidence the writer concludes that jamesonite may be so mottled that it appears as two minerals under the polished section microscope. This mottling appears faintly under the microscope with unpolarized light very distinctly under polarized light, and best when etched with KOH (Showing the same pattern as under polarized light.)

Whereas a light patch in jamesonite may be another mineral, care should be taken to examine it in detail before assuming it not to be a differently oriented grain of jamesonite. To absolutely confirm the identity of these lighter patches in the jamesonite enough of them should be picked from the polished section to have an analysis made. Lack of time and large enough samples prevented the writer from doing this in this investigation.

Electrum : (Au Ag)

Electrum was found in section D, as shown in Table 1, as a few very **small** scattered specks. Confirmation of the tests identifying this mineral should be made by assays. The lack of time prevented the writer from including this assay in the investigation so the mineral is assumed to be electrum on the strength of the tests made and recorded below and in Table 2.

The gold-silver amalgam seemed to be residual in the arsenopyrite, pyrite and quartz. None was found associated with the jamesonite. This could mean that the quartz is the precious metal carrier and the jamesonite hasn't advanced into the quartz far enough to pick up any electrum or if it has, it has dissolved the silver and gold. The association of the amalgam in the quartz with residual crystals of arsenopyrite and pyrite indicate either a genetic relation to the sulphides or merely an

attraction to the sulphides while the quartz was still fluid.

The electrum was distinguished from Chalcopyrite (common in all sections) by its sectility, etch reactions, occurrence, form and, to a certain extent, colour. The etch reactions obtained are in Table 2. Plates #4 and #5 clearly illustrate the size, shape etc. of the electrum as found by the writer.

Arsenopyrite : FeAsS

Arsenopyrite occurs in considerable amounts both as remnant crystals in the jamesonite and quartz and as relatively solid crystalline masses neighbouring the quartz. In all the specimens examined it occurred invariably between the jamesonite and quartz as if it had been accumulated on the advancing edges of the quartz before being met and replaced by the later intruding jamesonite.

The arsenopyrite has been broken and maybe replaced by invading quartz which contains occasional coarse remnant crystals near the contacts. This is in contrast to the arsenopyrite inclusions in jamesonite which are finer, smoother and more numerous.

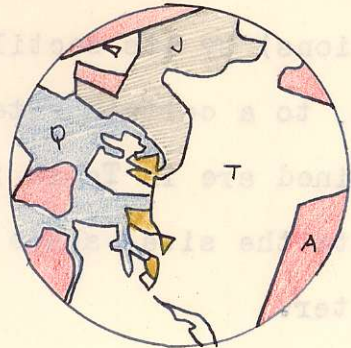
Typical occurrences of arsenopyrite can be seen in nearly all the photographs included in this report.



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- Quartz
- Arsenopyrite
- Tetrahedrite
- Jamesonite
- Chalcopyrite

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to the arsenopyrite inclusions in Jamesonite which are  
finer, smoother and more numerous.  
Typical occurrences of arsenopyrite can be seen in  
nearly all the photographs included in this report.

Tetrahedrite :  $3\text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$ 

Grey-copper occurs fairly commonly as irregular dark blebs in the jamesonite. It is present in large amounts in section E where it evenly intrudes the arsenopyrite. This characteristic of clean-cut replacement is in sharp contrast to the jamesonites' habit of rounding, veining and smoothing the arsenopyrite as it intrudes. Quartz has preceded the tetrahedrite in intrusion as indicated by inclusions of the quartz in the grey-copper. In some respects the tetrahedrite in the jamesonite seems to indicate simultaneous deposition. Illustrations of the occurrences of tetrahedrite can be seen in Plates # 3, 6, 7 and 8 as well as the illustrations on the opposite page. Under high power five chalcopyrite can usually be seen along the edges of the tetrahedrite.

Pyrite :  $\text{FeS}_2$ 

Remnant pyrite crystals are found scattered through the arsenopyrite in varying amounts and sizes. Examples are seen in Plates #4, 5, and 8.

It has been partially replaced in several sections by arsenopyrite.

Pyrrhotite :  $\text{FeS}_{n+r}$ 

Odd isolated crystals of pyrrhotite are found with the arsenopyrite remnants in the jamesonite, as seen in

Plate #7, and also as tiny rod-like remnants in calcite and quartz.

Chalcopyrite :  $\text{CuFeS}_2$

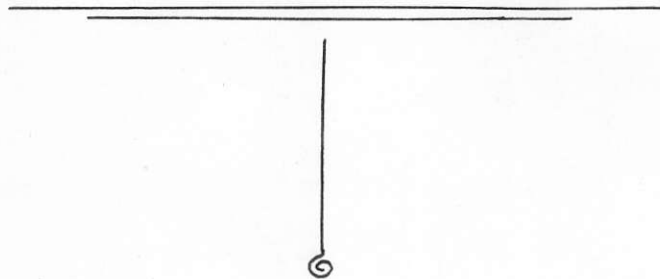
Small areas of chalcopyrite are found isolated in the jamesonite, sometimes associated with pyrrhotite and other times in blebs by itself. Where the quartz and jamesonite are found cutting into the arsenopyrite there are always small irregular patches of chalcopyrite. It is usually found close to tetrahedrite in these cases but very seldom near the tetrahedrite when both are included in jamesonite. Chalcopyrite is in nearly every polished section but always in very tiny irregular blebs. It seems to be simultaneous with the tetrahedrite.

Quartz :  $\text{SiO}_2$

Quartz is extremely abundant in many of the samples and represents a stage of intrusion immediately before the jamesonite. It includes and displaces pyrite, arsenopyrite, and pyrrhotite. Quartz remnants are occasionally found in the jamesonite although there are few places where these two minerals come in actual contact. They are almost invariably separated by a wall of jumbled arsenopyrite. In Plate #8 can be seen a patch of quartz which seemingly has partially replaced arsenopyrite and subsequently has been isolated by invading jamesonite.

Calcite - CaCO<sub>3</sub>

This gangue mineral is present in many of the sections as tiny veinlets along fractures. It represents the last stage of mineralization. In section F the calcite and jamesonite occur together as what at first appeared to be intergrowth but on closer inspection proved to be jamesonite replacing the calcite along cleavage and fracture planes, thus indicating an earlier age of the gangue, probably with quartz. Calcite veinlets can be seen in Plates #3 and #6.



CONCLUSIONSParagenesis

The St. Paul deposit exhibits successive replacement by the main minerals and contemporaneous deposition of some of the sulphides.

Gangues appear first in the form of calcite in very small amounts as can be seen in section F where jamesonite is replacing it. Quartz also appeared, in very large amounts, with or before the above calcite. Veining calcite is the latest intruding mineral.

The earliest metallic minerals are :

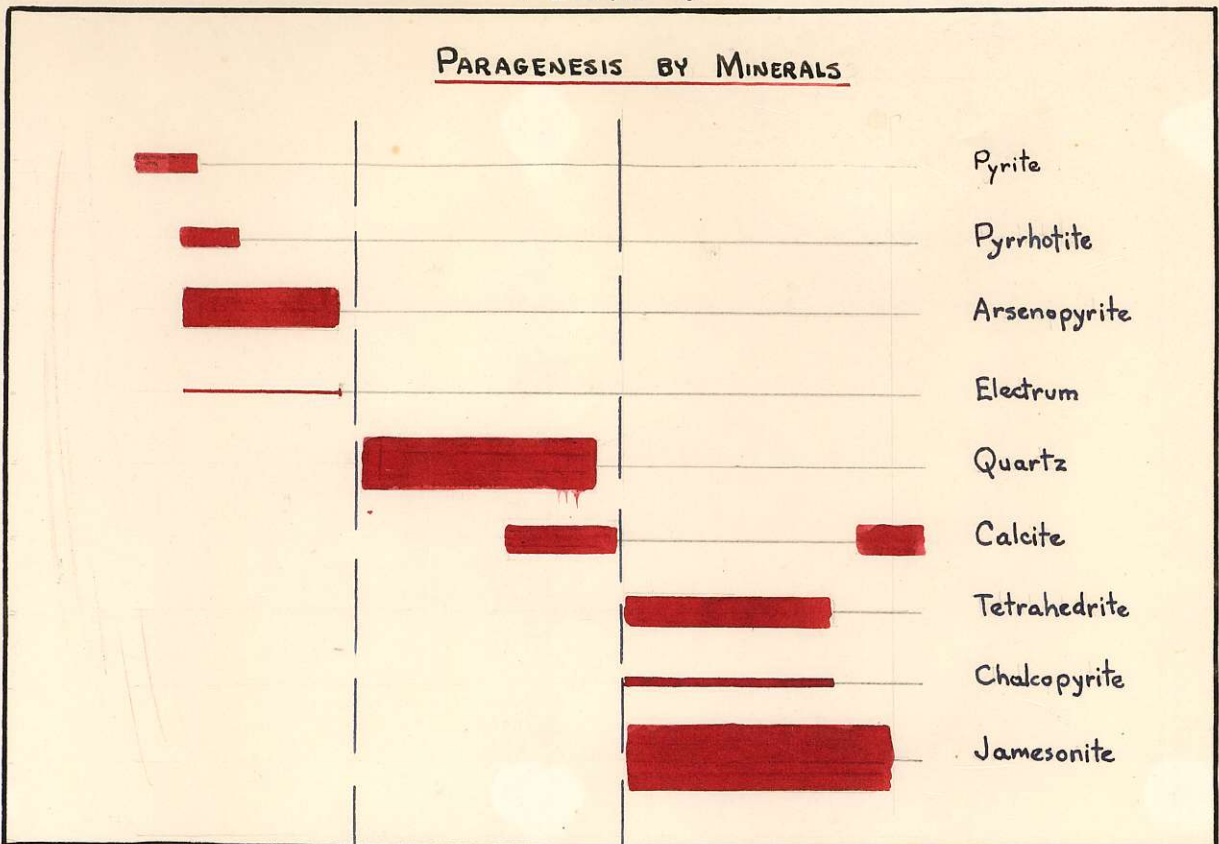
Pyrite  
Pyrrhotite  
Arsenopyrite  
Electrum

The arsenopyrite and pyrrhotite are probably simultaneous and include previous pyrite. The electrum seems to fit in with this stage of mineralization and is associated with the arsenopyrite in the quartz. Evidence of this can be seen in Plates #4,5,7 and 8 as well as in sections C,D,E,F and G.

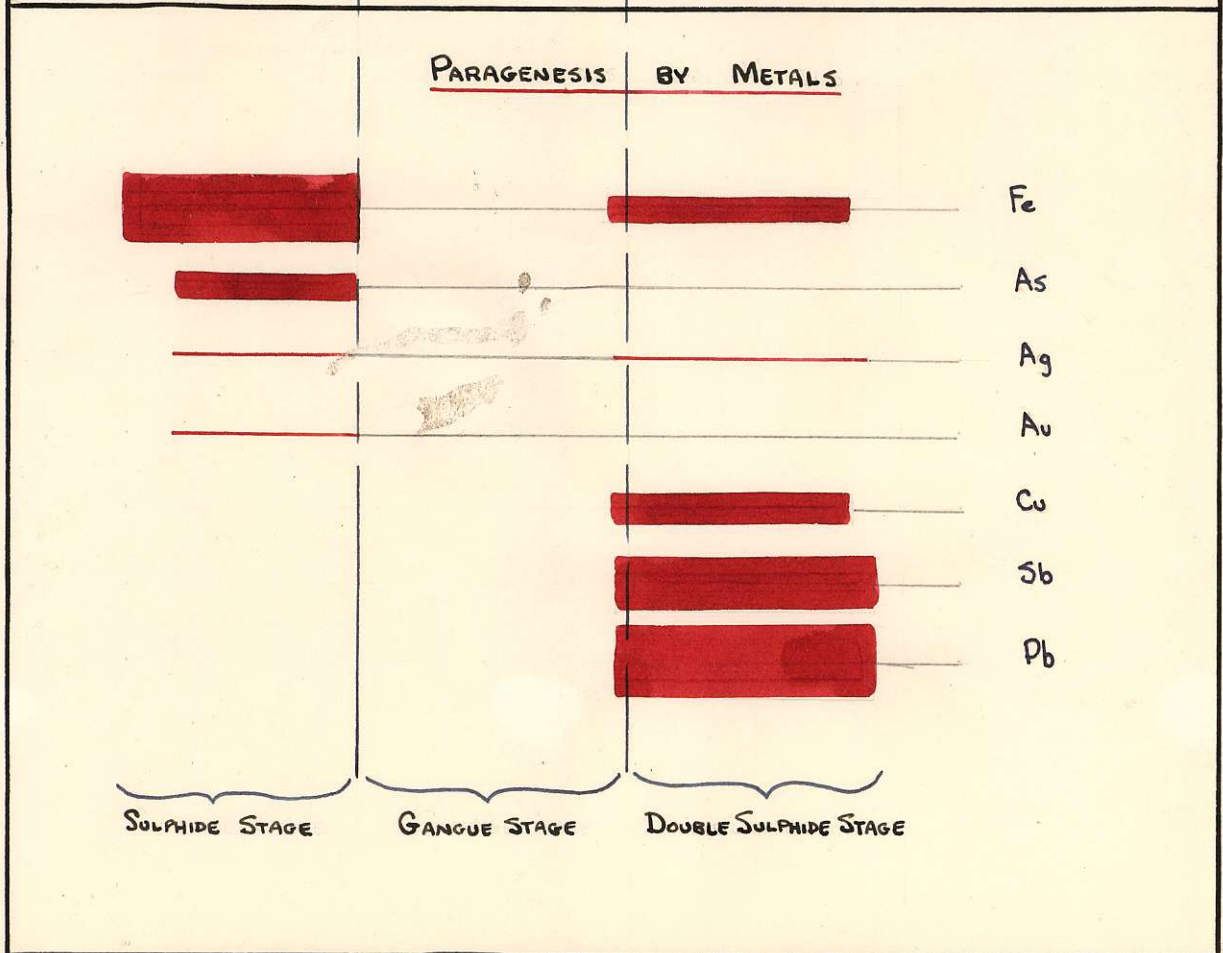
The next mineral to appear was the quartz which veined, fractured and seemingly replaced the previous sulphides. Examples can be seen in Plates #4,5,8 and 9. Calcite either closely followed or was contemporaneous with the quartz as is evidenced by their mutual filling of fractures in the arsenopyrite. The calcite however

# PLATE 4

## PARAGENESIS BY MINERALS



## PARAGENESIS BY METALS



does not appear to replace the sulphides as does the quartz which in some cases is found deep within them in the form of an arsenopyrite crystal. (On the whole the quartz intrusion of the arsenopyrite seems to be stoping and assimilation.

Jamesonite, Tetrahedrite and Chalcopyrite then appear and engulf, vein and replace all the previously deposited minerals. Evidence of this can be seen in every section and most of the plates.

The Calcite appears last as final stringer veinlets filling fractures in the earlier minerals. Good examples of this are seen in Plates 3 and 6 and nearly all the sections.

Thus the writer concluded the order of mineral introduction to be roughly as follows :

Pyrite	$\text{FeS}_2$	}	<u>Sulphide stage</u>
Pyrrhotite	$\text{Fe}_{n+1}\text{S}_n$		
Arsenopyrite	$\text{FeAsS}$		
Electrum	$\text{AuAg}$		
Quartz	$\text{SiO}_2$	}	<u>Early gangue stage</u>
(Calcite	$\text{CaCO}_3$		
Tetrahedrite	$3\text{CuS} \cdot \text{Sb}_2\text{S}_3$	}	<u>Double Sulphide</u>
Chalcopyrite	$\text{CuFeS}_2$		
Jamesonite	$2\text{PbS} \cdot \text{Sb}_2\text{S}_3$	}	<u>Late gangue stage</u>
Calcite	$\text{CaCO}_3$		

The above sequence is represented in Table 4, both as minerals and as metals.

CLASSIFICATION

Type - The St. Paul ores are of hydrothermal origin with various stages of mineralization. The early sulphide stage was probably high temperature as indicated by the pyrrhotite. The following stages, which comprise most of the deposit, were mesothermal.

The deposit is apparently fissure filling with little or no replacement of the wall rock as evidenced in section G.

Precious metals -

The precious metal content of the St. Paul ore arises from two sources known to the writer.

At least one source of gold and silver is the electrum, as determined in this investigation.

The other source, of the silver at least, is the jamesonite as indicated by the analysis given previously on page

Other sources either unfound or too small to find, such as silver with the tetrahedrite, may, and probably do, exist.



METALLURGY

The electrum can be released from the ore by crushing to at least 150 mesh and recovered by standard methods.

The precious metals existing as an intergral part of the sulphides could probably be recovered by smelting a concentrate of the ore. The lead from the jamesonite may aid in the collection of silver and gold during smelting. The feasibility of such a process would depend entirely on the size and grade of the actual deposit which, as mentioned before, are unknown by the writer.

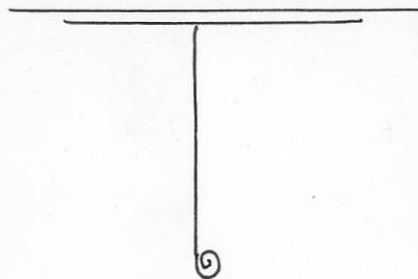
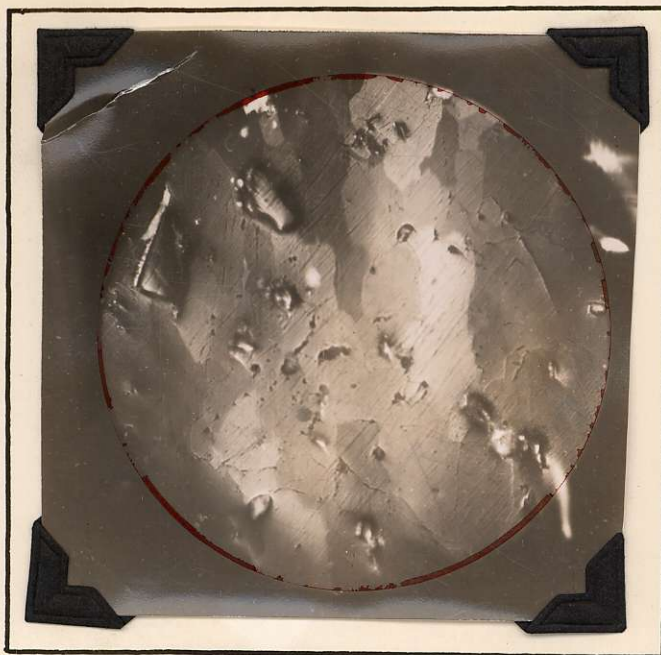
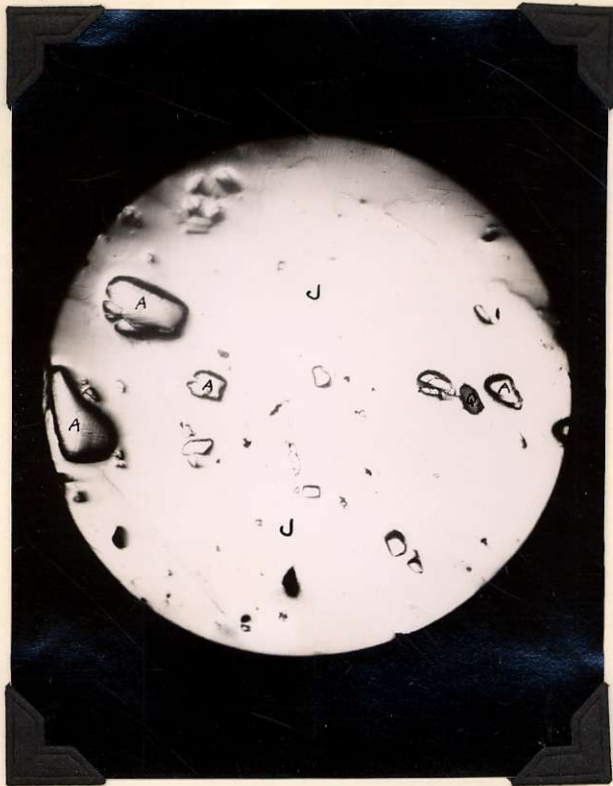


PLATE 1

<u>Magnification</u>	x 36	<u>Exposure</u>	1380 secs.
<u>Section</u>	A	<u>H</u>	53.8
		<u>V</u>	7.7
<u>Microscope</u>	Leitz 326620		
<u>Ocular</u>	x6	<u>Objective</u>	x3

Mottled pattern of Jamesonite, as revealed under crossed-nicols.

(Compare with Plate 2.)

PLATE 2

J = Jamesonite  
 A = Arsenopyrite  
 Q = Quartz

Magnification	x 36	Exposure	25	secs.
Section	A	H	53.8	V 7.7
Microscope	Leitz 326620			
Ocular	x6	Objective	x3	

Area of Jamesonite as shown in Plate 1  
only without crossed nicols.

PLATE 3

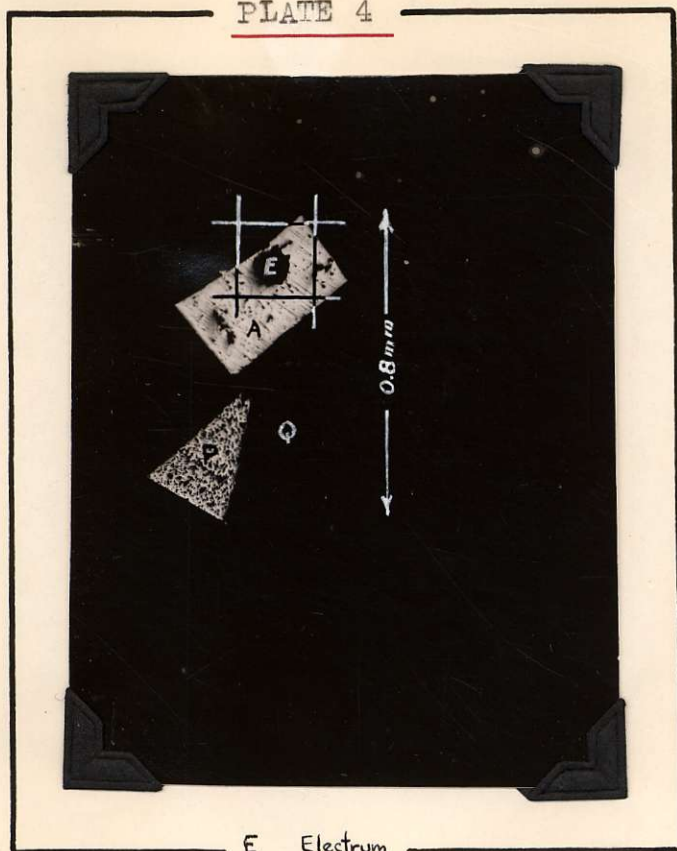


- J Jamesonite
- T Tetrahedrite
- A Arsenopyrite
- C Calcite

Magnification	x40	Exposure	5 secs.		
Section	B	H	54.6	V	12.6
Microscope	52 Leitz				
Ocular	x4	Objective	x3		

Jamesonite sheafs  
with Tetrahedrite.

## PLATE 4



E Electrum  
 A Arsenopyrite  
 P Pyrite  
 Q Quartz.

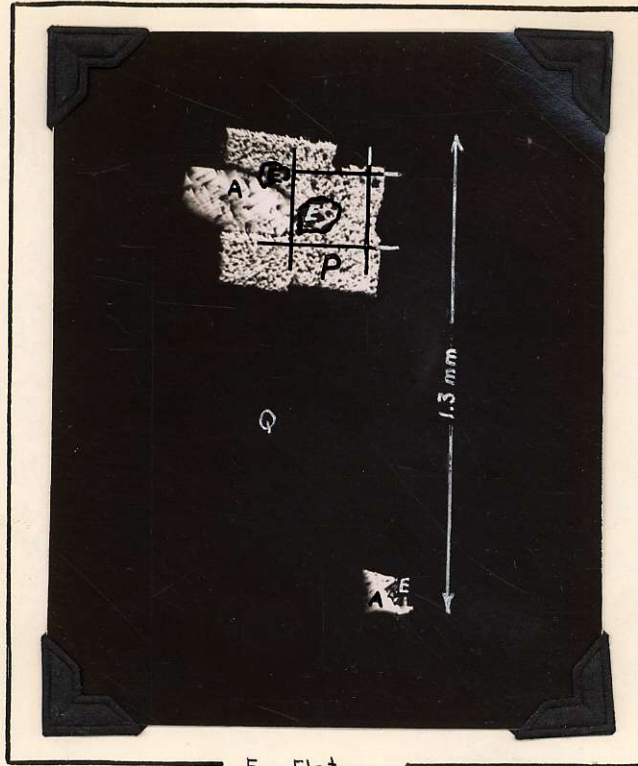
Grid = 150 mesh

<u>Magnification</u>	55	<u>Exposure</u>	10 secs.
<u>Section</u>	D	<u>H</u>	48.1 <u>V</u> 10.6
<u>Microscope</u>	52 Leitz		
<u>Ocular</u>	x4	<u>Objective</u>	x3

Electrum in Arsenopyrite crystal which is residual in Quartz.

(Electrum is black in photo because it had previously been stained with KCN.)

PLATE 5

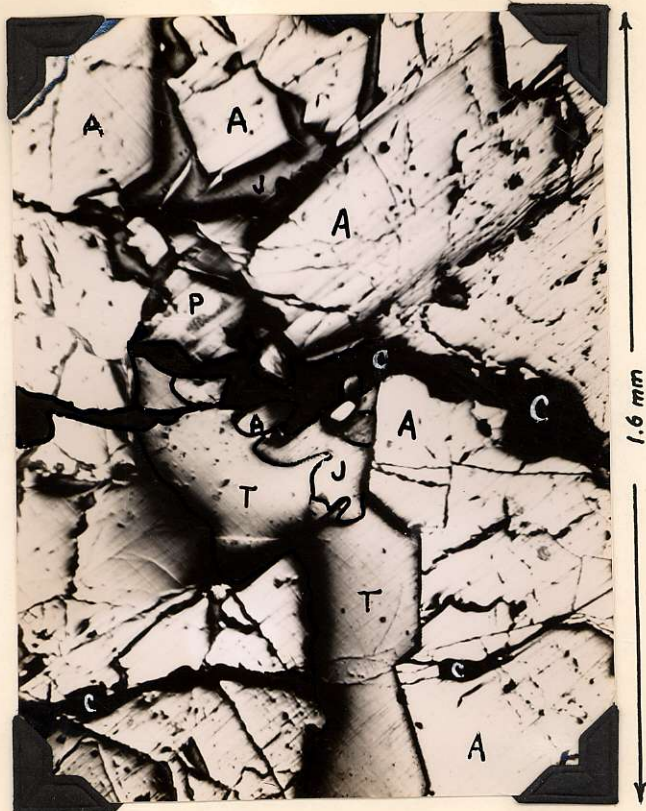


E Electrum  
P Pyrite  
A Arsenopyrite  
Q Quartz

Grid  $\div$  150 mesh

<u>Magnification</u>	52	<u>Exposure</u>	12 secs.		
<u>Section</u>	D	<u>H</u>	48.1	<u>V</u>	7.6
<u>Microscope</u>	52 Leitz				
<u>Ocular</u>	x 4	<u>Objective</u>	x 3		

Electrum in Pyrite and Arsenopyrite.  
(Stained with KCN) —.

PLATE 6

J Jamesonite  
 T Tetrahedrite  
 A Arsenopyrite  
 P Pyrite  
 C Calcite

<u>Magnification</u>	63	<u>Exposure</u>	27 secs.
<u>Section</u>	E	<u>H</u>	— <u>V</u> —
<u>Microscope</u>	52 Leitz		
<u>Ocular</u>	x 2	<u>Objective</u>	x 3

Tetrahedrite, then Calcite, intruding  
Arsenopyrite.

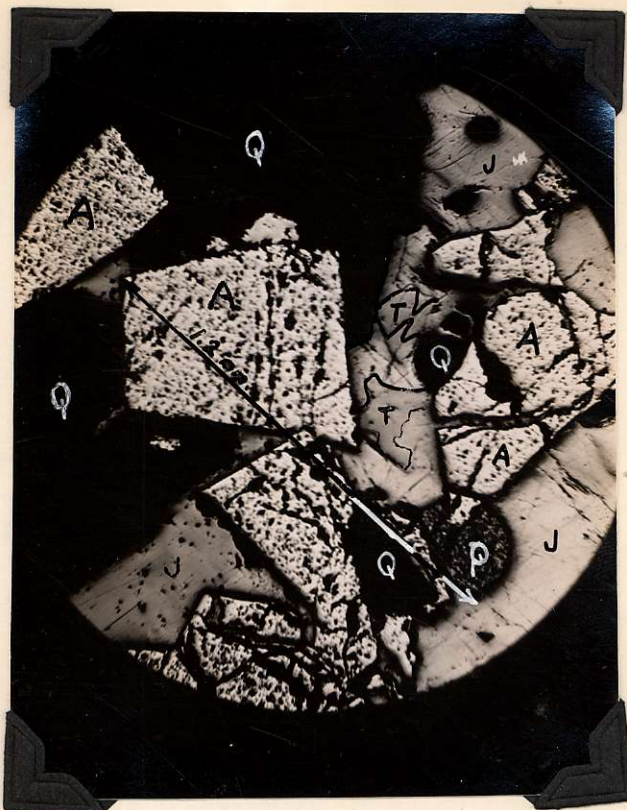
PLATE 7

J Jamesonite  
 A Arsenopyrite  
 T Tetrahedrite  
 P Pyrrhotite.

<u>Magnification</u>	36	<u>Exposure</u>	25 secs.
<u>Section</u>	C	<u>H</u>	53.5
<u>Microscope</u>	52 Leitz	<u>V</u>	16.1
<u>Ocular</u>	x4	<u>Objective</u>	x3

Residual inclusions in Jamesonite.



PLATE 8

J Jamesonite  
 T Tetrahedrite  
 A Arsenopyrite  
 Q Quartz  
 P Pyrite

<u>Magnification</u>	53	<u>Exposure</u>	27 secs.
<u>Section</u>	F	<u>H</u>	<u>V</u>
<u>Microscope</u>	52 Leitz		
<u>Ocular</u>	x 4	<u>Objective</u>	x 3

Successive intrusions into Arsenopyrite ;  
 Quartz , then Jamesonite - Tetrahedrite .

PLATE 9

J Jamesonite  
 A Arsenopyrite  
 Q Quartz

<u>Magnification</u>	53	<u>Exposure</u>	30 secs.
<u>Section</u>	F	<u>H</u>	<u>V</u>
<u>Microscope</u>	52 Leitz		
<u>Ocular</u>	x4	<u>Objective</u>	x3

Arsenopyrite intruded first by Quartz, then  
 by Jamesonite.

MICROPHOTOGRAPHY DATA.

PLATE	SECTION	Mounted with label to -	Stage Position		SUBSTAGE VERNIER at	MICROSCOPE	OBJECTIVE LENS	OCULAR LENS	MAGNIFICATION (Approx.)	ILLUMINATION	FILTER	PLATE	EXPOSURE (SECONDS)	ILLUSTRATION IN REPORT.
			H	V										
1	A	R	53.8	7.7	90	Leitz 326620	3x	6x	36 $\phi$	6v.; 6amp	Daylite	Wratten "M"	1380	PLATE # 1
2	A	R	"	"	"	"	"	"	"	"	"	"	25	" 2
3	B	R	54.6	12.6	"	52 Leitz	"	4x	39 $\phi$	18W	Blue	"	5	" 3
4	D	R	48.1	10.6	"	"	"	"	54 $\phi$	"	"	"	10	" 4
5	D	R	48.1	7.6	"	"	"	"	52 $\phi$	"	"	"	12	" 5
6	E	R	"	"	"	"	"	"	63 $\phi$	"	"	"	27	" 6
7	C	R	53.5	16.1	"	"	"	2x	36 $\phi$	"	"	"	25	" 7
8	F	R	"	"	"	"	"	4x	53 $\phi$	"	"	"	27	" 8
9	F	R	"	"	"	"	"	"	"	"	"	"	30	" 9

SUPPLEMENT  
ASSAY RETURNS ( See page 7 )

	GOLD (oz/T)	SILVER (oz/T)	ARSENIC (%)	ANTIMONY (%)
QZ. TAILS	0.275	7.50	11.24	1.90
+48	0.64	44.00	30.90	11.04
+65	0.70	33.00	33.04	7.04
+100	0.65	34.25	33.81	14.29
+150	0.83	32.8	32.28	13.93
+200	1.05	28.15	35.49	13.93

As can be seen, the precious metal values run with the sulphides as opposed to the quartz.

The silver assay is higher where the Jamesonite increases in proportion to the Arsenopyrite, as in +48.

The jump in the gold values after +150 mesh would corroborate the presence of "high-gold" electrum, the particles of which are less than 150 mesh, — as seen in Plates 4 and 5.

The assays are too inconsistent to make any further assumptions without more investigations along this line.

