600115

3734 West King Edward Avenue,
Vancouver 8, B. C.,
February 26, 1960.

Dr. R. M. Thompson,
Associate Professor,
University of Brithish Columbia,
Vancouver 8, B. C.

Dear Sir:

I hereby submit a report entitled "A tailings problem at the Boundary Mining Camp, Phoenix, B. C.", in partial fulfillment of the requirements of the course in Geology 409.

Yours Sincerely,

B. F. Matsen.

B.F. MATSEN

"A TAILINGS PROBLEM AT THE

BOUNDARY MINING CAMP,

PHOENIX, B. C."

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ILLUSTRATIONS

INTRODUCTION

The tailings from the boundary camp are being investigated because the assay for copper was found to be too high. The recovery of Chalcopyrite at the mill is approximately 85 percent but normally this figure should be much higher than it is. Therefore, the problem is to find out why the amount of chalcopyrite in the tailings is so great. The Chalcopyrite at Phoenix is associated with pyrite, specularite, magnetite, and gangue. Three mesh sizes have been sent from Phoenix, (+65, +200, and -325), to be studied.

The writter wishes to express his thanks to professor R.M. Thompson for his many helpful suggestions and for his help in photographing the polished sections.

CONCLUSIONS

The results of this investigation indicates that the problem at Phoenix is two-fold. Firstly, there appears to be a crushing problem as indicated by plates 1-12. The free Chalcopyrite in these plates and found throughout the +65 mesh polished sections are too large to be removed by the floatation process. -65 mesh and smaller can be removed by floatation but pieces larger than this cannot be floated. Also, in the +65 mesh, much of the Chalcopyrite is found not as free material but is found associated with pyrite, specularite, and gangue. This indicates that a crushing problem exists in the +65 mesh and larger. The second problem, floatation, exists in the +200 and -325 mesh, as indicated by plates 13, 16, 19, 21, and 22. In these mesh sizes, the Chalcopyrite is found mainly as free material. Also, the grains are small enough to be removed by the floatation process. The Chalcopyrite is also found associated with gangue, specularite and pyrite as indicated in plates 14, 15, 17, 18 and 20 but this amount is very small compared with the free Chalcopyrite. (See tables for the exact figures).

In summary, a crushing problem appearsto exist in the +65 mesh and larger. But, a floatation problem seems to exist in the +200 and -325 mesh.

PREVIOUS WORK DONE

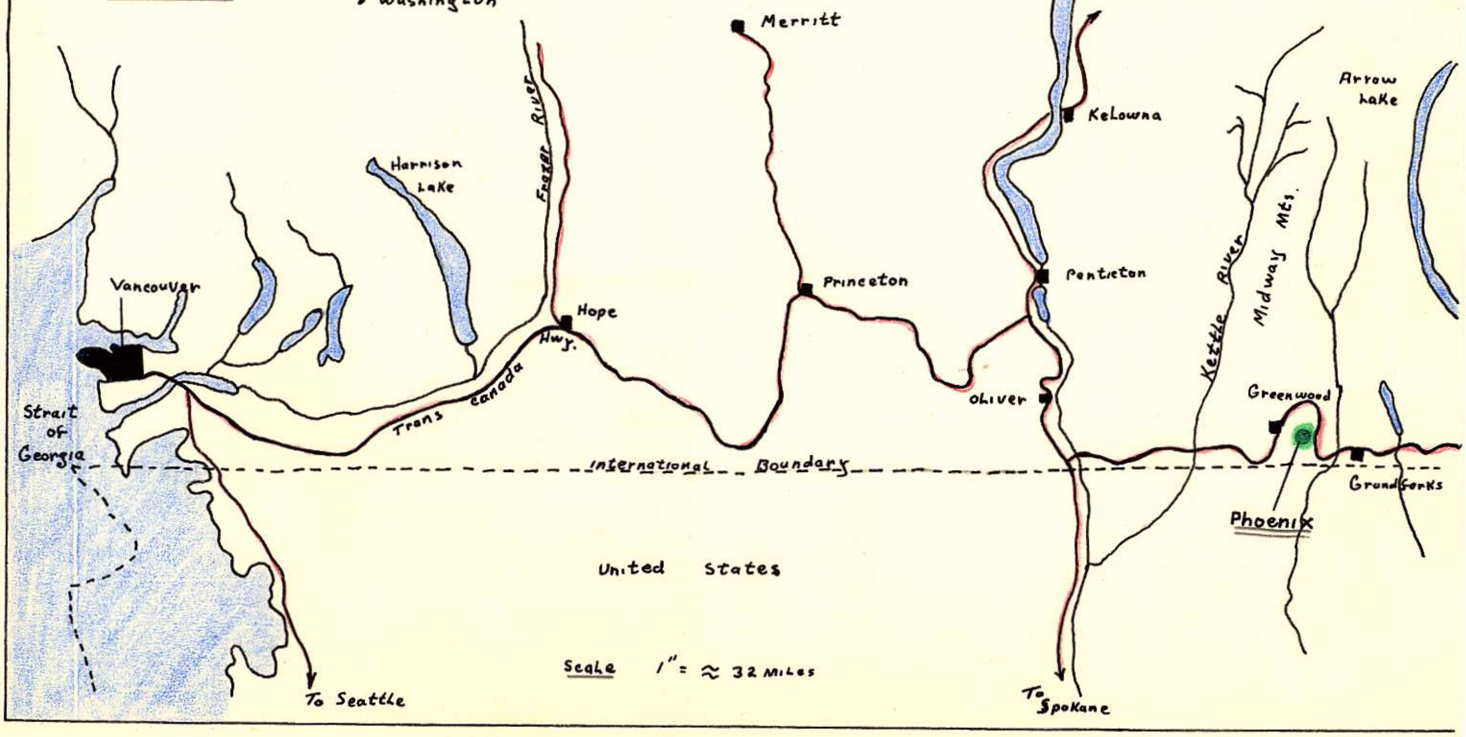
Dr. R. W. Brock of the Geological Survey Staff in 1901 made a reconnaissance survey of a portion of the Boundary district and in 1902 geologically mapped a belt about 13 miles wide along the International Boundary extending from Grandforks west to Midenay.

O.E. LeRoy of the Geological Survey mapped and studied the area in great detail during the years 1909 - 1912. Recently, R. H. Serphim with the help of Dr. W. H. White wrote a report on the Boundary District in 1956. Also, about the same time, geochemistry and geophysics tests were carried on in the area by the Granby Mining Company.

LOCATION

The Boundary mining district of B. C. is located in the Kettle River Valley approximately 265 miles from Vancouver on the Trans Canada highway. (figure 1). The old town of Phoenix is situated approximately five miles east of Greenwood, partly in the basin at the head of Twin Creek and partly on the divide between Twin, an unnamed tributary of fourth of July Creek, and Deadman Creek. The immediate vicinity is broadly dome-shaped, broken by the basin of Twin Creek which is surrounded by a rim of relatively prominent ridges grouped in the form of a compressed cresent open to the west.

Figure 1. Map of South-West B.C. & Washington



ECONOMIC HISTORY OF THE PHOENIX MINING AREA:

This information has been taken from a report on the area by R.H. Seraphim (1956 PP 684-694) and A.R.C. James (1958).

Prospectors were active in the vicinity of Greenwood in 1891 and by the end of the year most of the area covering the valuable ore bodies had been staked.

Surface work done in the early years indicated that the values in copper, gold, and silver were low but the discovery that the ore was practically self-fluxing greatly enhanced the value of the deposits.

Large capital investments were required to develop the ore bodies and build smelters. Therefore, development of the Knob Hill-Old Ironsided ore body commenced in 1896 by the Granby Consolidated Mining, Smelting, and Power Company, who had purchased and now controlled most of the important ground in Phoenix. Granby started the first furnace of its Grandforks smelter in August 1900. Fourteen million tons of ore were treated in this smelter. The remaining valuable properties in Phoenix and the boundary district were controlled by the New Dominion Copper Company, the Consolidated, Mining and Smelting Company, and the B. C. Copper Company.

In 1898 the Canadian Pacific Railway and in 1904 the Great Northern Railway extended their lines to reach the town of Phoenix, which was incorporated in 1900.

Production reached its peak in 1913, when 1,300,000 tons of ore were mined and shipped. The camp was abandoned in 1919, when the available ore reserves were approching exhaustion, and when labour strikes in the Crowsnest coalfields cut off the supply of coke for the Smelters. Up to this time the Boundary Camp had produced about 22,000,000 tons of ore averaging slightly over 1.5 percent copper and about 0.03 oz. per ton in gold and 0.5oz. per ton in silver.

However, the Granby Company resumed work on this property in 1955 after an interval of thirty-six years. Interest was stimulated by the then prevailing high price of copper, (June 1955 - 34.4 ¢/lb), and (June 1956 - 46 ¢/lb - prices from Western Miner) and the possibility of cheap open-pit mining.

In 1958 installation of machinery and equipment for the curshing plant and 750 ton mill was continued. Mining was confined to the removal of waste rock and overburden from the Snowshoe area in preparation for open pit mining. The main roads from the pit to the mill were improved and widened. Production started in 1959 with the price of copper at 30¢/lb. The only new ore bodies found to date are extensions of deposits discovered by the early prospectors.

Therefore, all of the ore produced now comes from open pit operations at the old Ironsides and Snowshoe mines. There is approximately 1,000,000 tons of .8% Chalcopyrite ore left in reserve and it is being produced at a rate of 1000 tons/day. This ore is still shipped to Greenwood and Grandforks for smelting. ?

REGIONAL GEOLOGY

Information has been obtained from reports on the area by R.H. Seraphim (1956 PP 684 - 694 and O.E. LeRoy (1912).

TABLE OF FORMATIONS

TERTIARY	MIDWAY VOLCANICS AND HYPABYSSAL ROCKS	Dacitic to Basalitic flows with associated dykes and sills of Syenite and Augite Porphory.
	KETTLE RIVER ARKOSE, ETC.	Arkose, with minor shales and conglomerate, in places containing coal.
JURASSIC-CRETACEOUS	INTRUSIVES	Quartz Diorite and Diorite.
LATE PALOEZOIC	ATTWOOD SERIES: BROOKLYN FORMATION	Sharpstone conglomerate, limestone and/or andesite. Tuff, with minor shale and Basalt.
	RAWHIDE FORMATION	Shale
EARLY PALEOZOIC?	KNOB HILL FORMATION	Chert and Andesite, with minor Limestone, Shale, and Serpentine.

The basement Knob Hill formation probably of marine deposition, was partially uplifted and severely folded before Brooklyn time. The uplift probably formed rugged mountains, bordered by inlets and bays of the sea. These bays and inlets were the site of the Brooklyn deposition.

Rapid erosion produced conglomerates and greywackes. Also, limestone with minor shale and siltstone was deposited during a period of less rapid erosion, but in deeper water.

Volcanic activity during Brooklyn time and continuing past Brooklyn is manifested by the thin flows of andesite and/or basalt lying conformably above the Brooklyn.

The Knob Hill and Brooklyn formations were intruded in Jurassic-Cretaceous time by diorite and quartz diorite. All of the camps in the district, with the exception of the largest, Phoenix, and the smallest, B.C., are close to Jurassic-Cretaceous intrusives.

Early Tertiary basins at Phoenix and on Fisherman Creek, a few miles north of Phoenix, were filled by Arkose. Late Tertiary flows were laid down on top of the Arkose and associated hypabyssal intrusives, feeders to the flows, cut the Arkose and underlying rocks. Also, Post-Tertiary diastrphism is evident from the many faults found cutting the tertiary rocks.

Accompanying the folding was a regional tilting of at least 30 degrees to the East. Evidence for this tilting comes from the attitude of the Arkose beds, which dip up to 45 degrees easterly both at Phoenix and on Fisherman Creek.

ORE BODIES AT PHOENIX

The copper ore bodies are all replacements of limestone or impure limy rock at or near contacts with the rocks. Chalcopyrite is the ore mineral in all of the deposits. Other metallic and sub-metallic minerals are pyrite, specular hematite, and magnetite. Non-metallic minerals are epidote, carbonate, amphibole, chlorite, quartz, garnet, pyroxene, and earthy hematite. From investigation of the polished sections, calcite was found to be the main gangue mineral. The relative percentage of the minerals listed above varies considerably along strike and down dip in each deposit. Also, some minerals are far more abundant in some deposits than in others. Chalcopyrite mineralization is most abundant in the carbonate-rich bands and in narrow carbonate veinlets traversing the banding. No noticeable increase in chalcopyrite was found near faults.

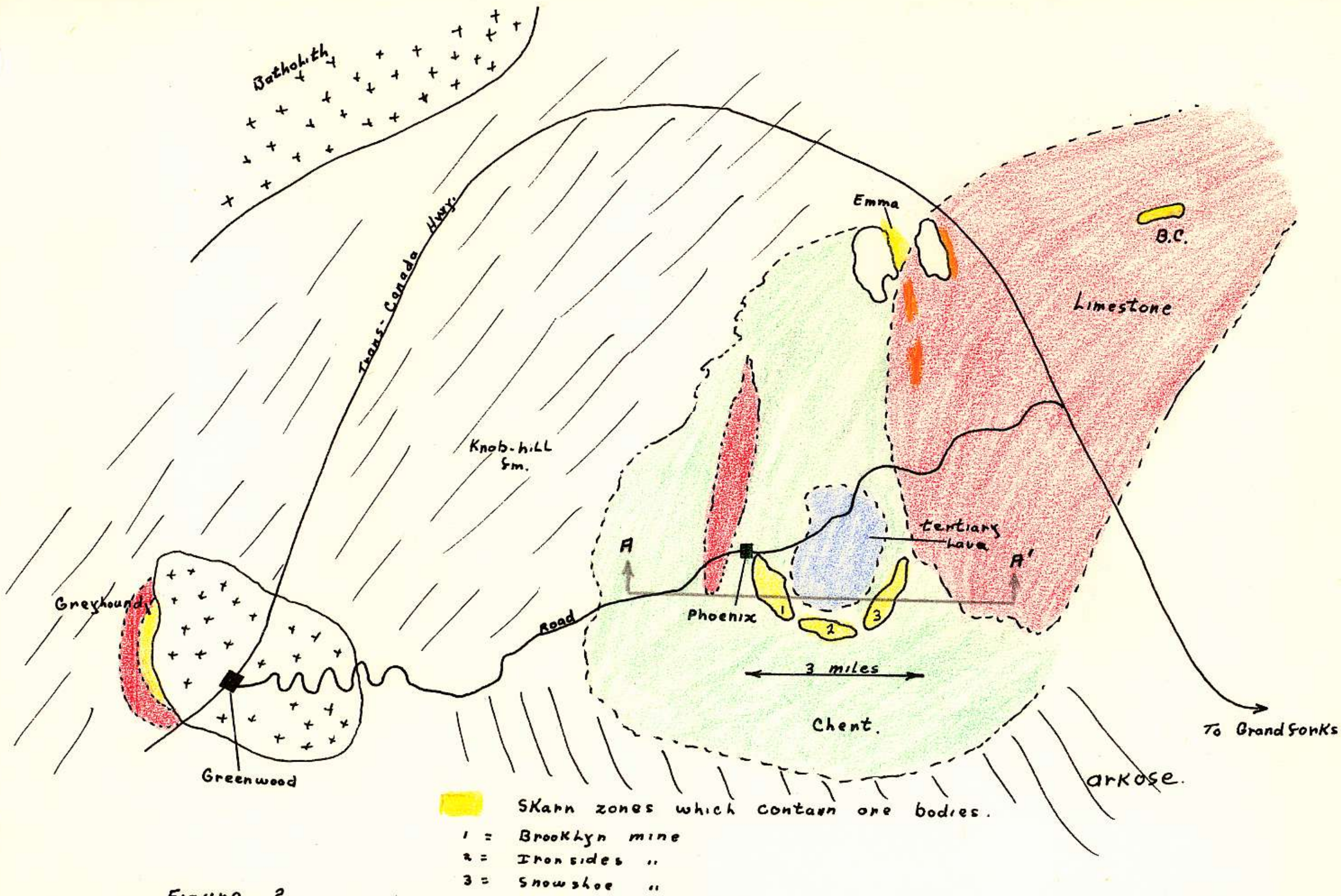


Figure 2.

Plan View of Phoenix Area, showing Geology & ore zones

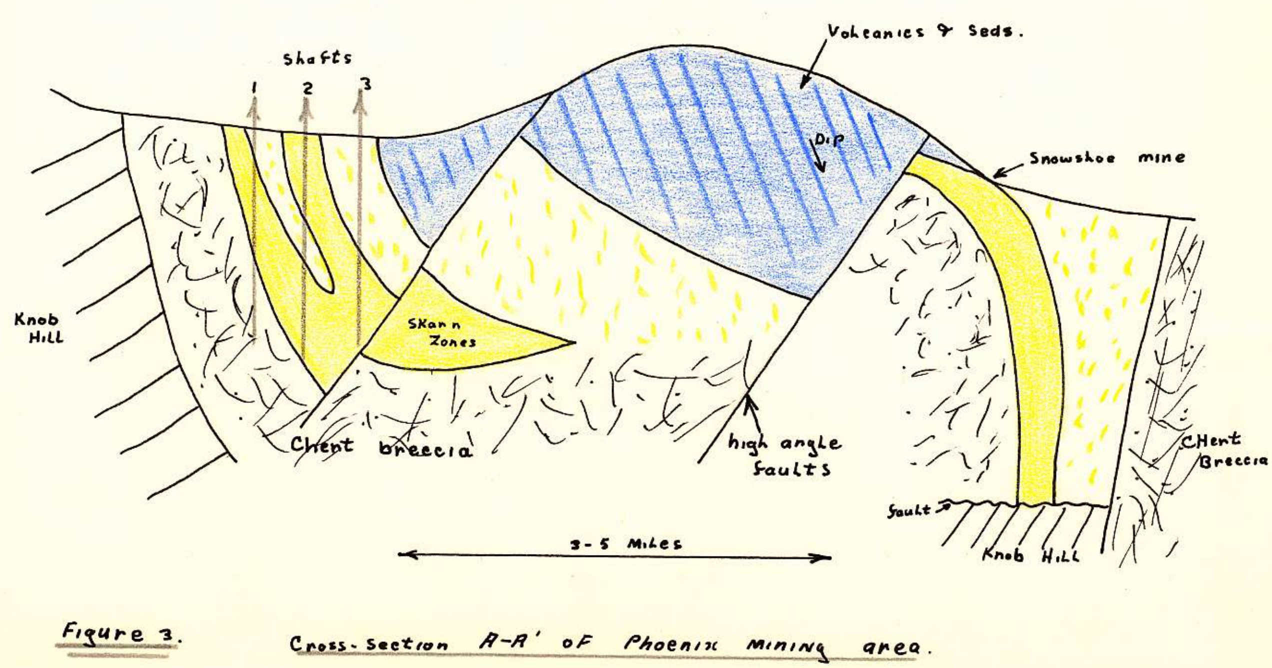


Figure 3.   Cross-section A-A' of Phoenix mining area.

METHODS OF INVESTIGATION

The problem consisted of three mesh sizes, +65, +200, and -325, that were taken from the tailings at the Phoenix mine. Each mesh size was superpanned to give three fractions, tip, middling, and tail. The grains from each successive fraction was mounted in bakelite and polished. From the polished sections, a statistical analysis was taken of the chalcopyrite grains to determine how the chalcopyrite occurred in each mesh size. All polished sections were studied under a mineralographic microscope. Results of this investigation are tabled below. Pictures were taken of each polished section to be used as illustrations in pointing out problems that exist.

TABLE 1

Mesh - +65 Tip

OCCURRENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	24.7	Chalcopyrite grains counted. 162
+ Specularite -----	21.2	
+ Magnetite--------	7.4	Maximum & Minimum Size of Grains 426μ- 28.4μ
+ Gangue-----------	23.9	
Free Chalcopyrite	22.8	Average Grain Size 284 μ

Mesh - +65 Middling

OCCURRENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	3.8	Chalcopyrite grains counted 130
+ Specularite-----	20.8	
+ Magnetite-------	0	Maximum & Minimum Size of Grains 284μ- 28.4μ
+ Gangue----------	63.7	
Free Chalcopyrite	11.7	Average Grain Size 184.6 μ

Mesh - +65 Tail

OCCURRENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	0	Chalcopyrite grains counted. 53
+ Specularite-----	3.8	
+ Magnetite-------	0	Maximum & Minimum Size of Grains 213μ- 14.2μ
+ Gangue----------	86.8	
Free Chalcopyrite	9.4	Average Grain Size 85.2 μ

TABLE 2

Mesh - +200 Tip

OCCURENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	7.3	Chalcopyrite grains counted. 178
+ Specularite-----	33.8	
+ Magnetite-------	1.4	Maximum & Minimum Size of Grains 142μ- 28.4μ
+ Gangue----------	1.0	
Free Chalcopyrite	56.5	Average Grain Size 113.6μ

Mesh - +200 Middling

OCCURRENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	7.7	Chalcopyrite grains counted. 156
+ Specularite-----	18.6	
+ Magnetite-------	1.3	Maximum & Minimum Size of Grains 127μ- 28.4μ
+ Gangue----------	8.3	
Free Chalcopyrite	64.1	Average Grain Size 71.0μ

Mesh - +200 Tail

OCCURRENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	1.7	Chalcopyrite grains counted. 58
+ Specularite-----	5.2	
+ Magnetite-------	0.0	Maximum & Minimum Size of Grains 113.6μ- 14.2μ
+ Gangue----------	68.5	
Free Chalcopyrite	24.6	Average Grain Size 56.8μ

TABLE 3

Mesh - -325 Tip

OCCURRENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	0.8	Chalcopyrite grains counted. 112
+ Specularite-----	0.0	
+ Magnetite-------	0.0	Maximum & Minimum Size of Grains 99.4μ- 28.4μ
+ Gangue----------	0.0	
Free Chalcopyrite	99.2	Average Grain Size 49.7μ

Mesh - -325 Middling

OCCURENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	0.0	Chalcopyrite grains counted. 63
+ Specularite-----	0.0	
+ Magnetite-------	0.0	Maximum & Minimum Size of Grains 56.8μ- 14.2μ
+ Gangue----------	0.0	
Free Chalcopyrite	100.0	Average Grain Size 28.4μ

Mesh - -325 Tail

OCCURRENCE OF CHALCOPYRITE	% OF EACH	
+ Pyrite----------	0.0	Chalcopyrite grains counted. 19
+ Specularite-----	0.0	
+ Magnetite-------	0.0	Maximum & Minimum Size of Grains 3.7μ- 28.4μ
+ Gangue----------	0.0	
Free Chalcopyrite	100.0	Average Grain Size 7.1μ

REFERENCES

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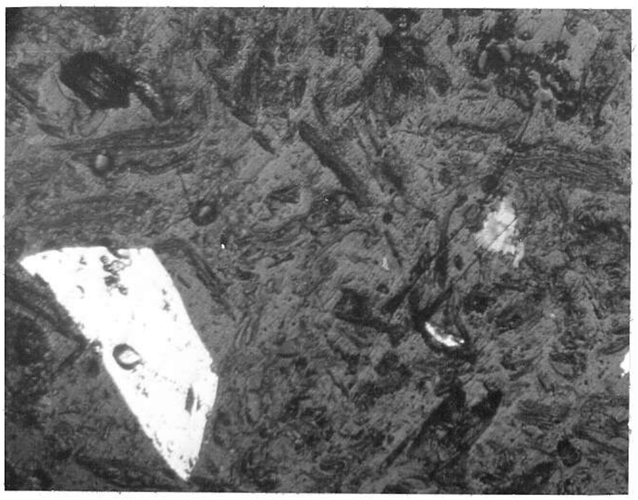


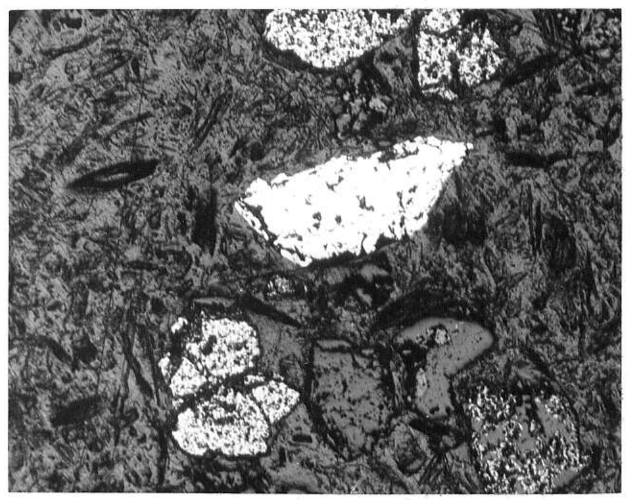
|— 260 γ —|　　　|-50γ-|

Plate 1. (+65 Tip)

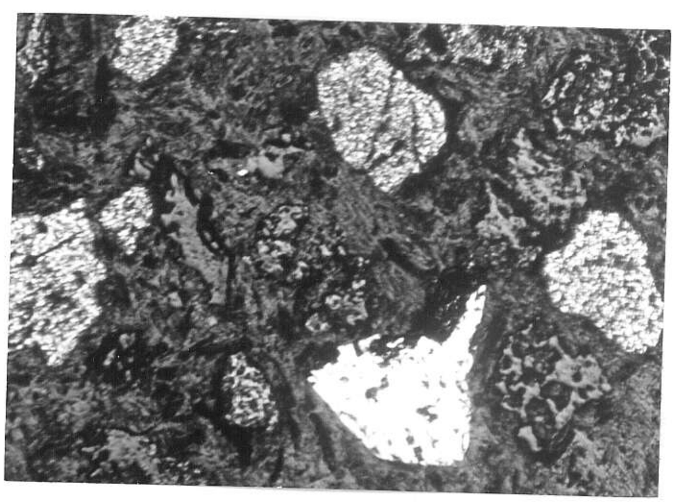
Covellite and free Chalcopyrite.

Plate 2. Low power (+65 Tip)

Free chalcopyrite, Pyrite, Specularite



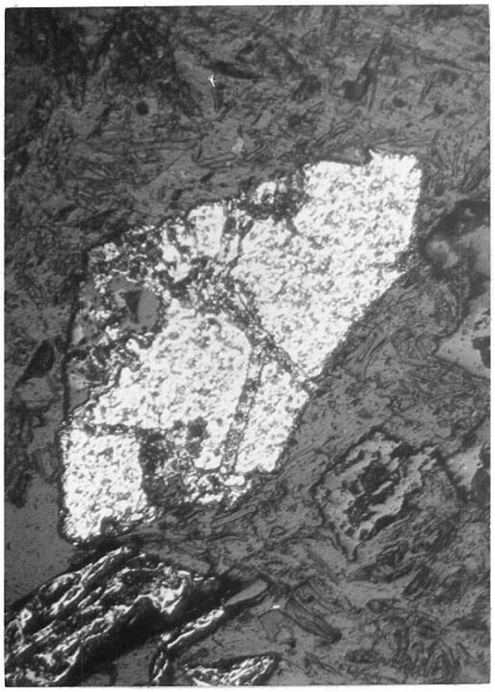
|— 400 γ —|



|—352γ—|

Plate 3. Low power (+65 Tip)

Free chalcopyrite



├── 504 μ ──┤

Plate 4. Chalcopyrite veining in pyrite (+65 Tip)

├── 479 μ ──┤

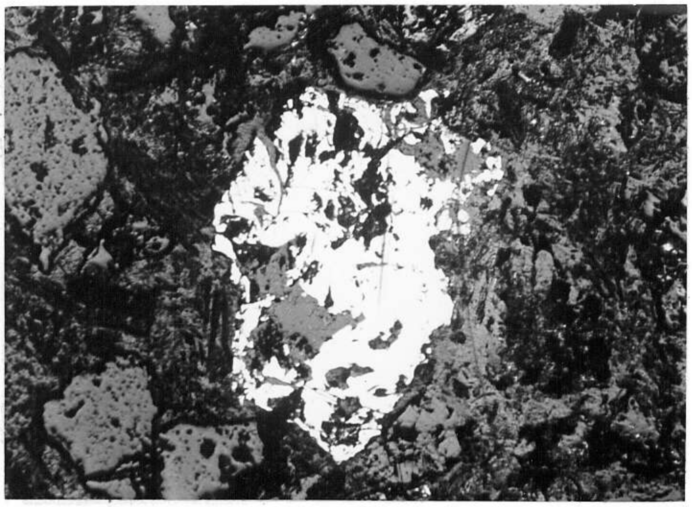
Plate 5. Chalcopyrite associated with gangue (+65 Tip)

├── 254 μ ──┤

Plate 6. (+65 Tip) Chalcopyrite associated with Pyrite

├── 310 μ ──┤

Plate 7. (+65 Tip) Chalcopyrite associated with specularite



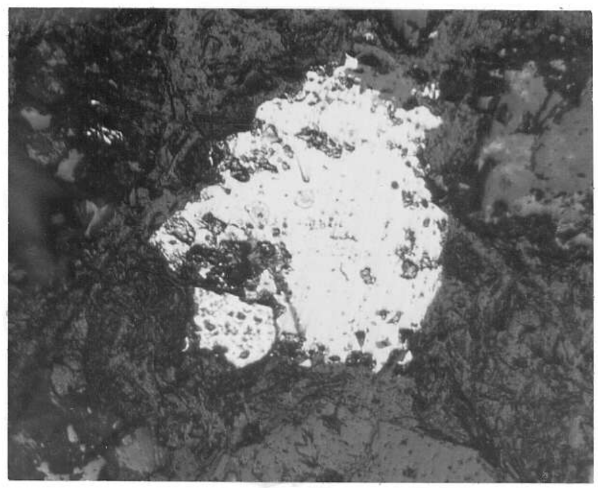
688 μ

Plate 8. (+65 Middling)
Low power

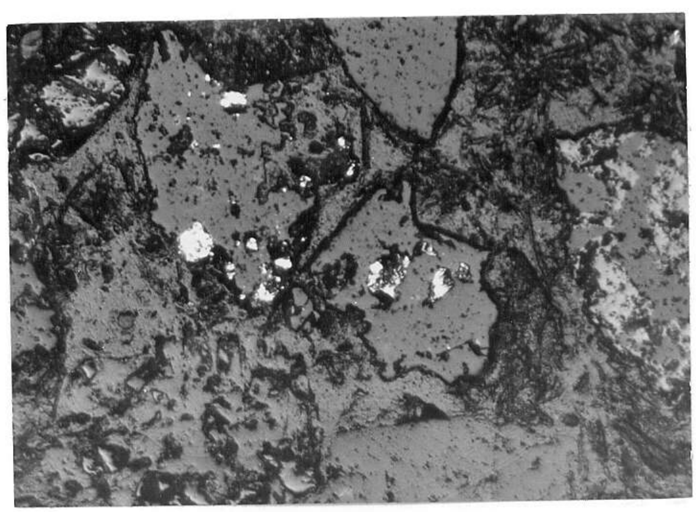
Free chalcopyrite

Plate 9. (+65 Middling)

Chalcopyrite associated with pyrite



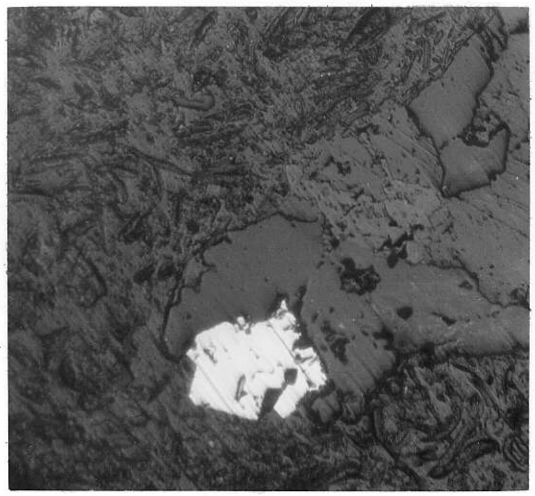
319 μ



34 μ

Plate 10. (+65 Middling)

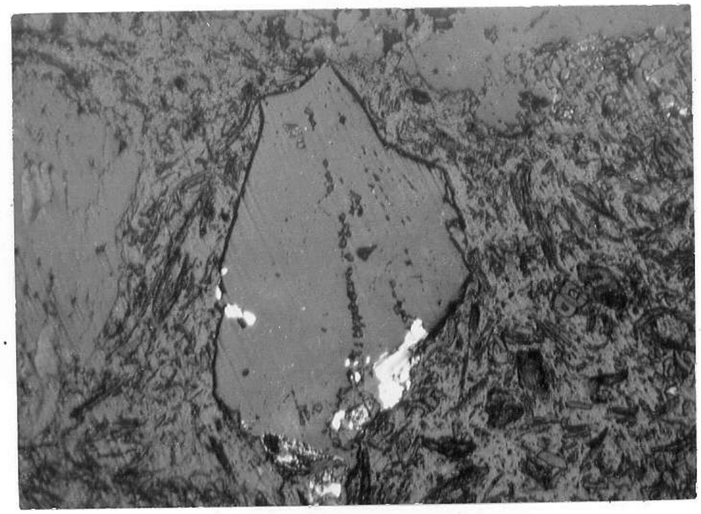
Chalcopyrite associated with gangue



|—134 μ—|

Plate 11. (+65 tail)

Chalcopyrite associated with gangue



|— 420 μ —|

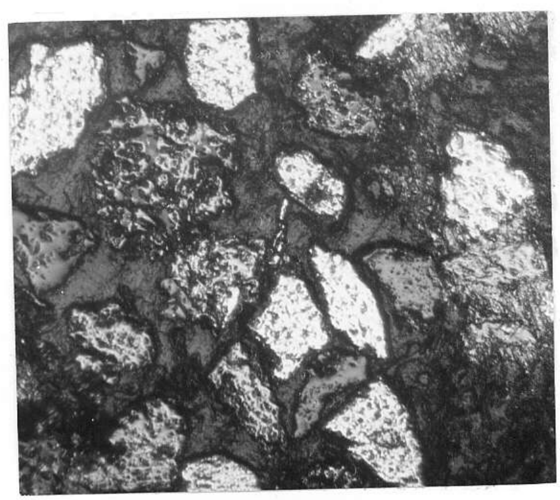
Plate 12. (+ 65 tail)

Chalcopyrite associated with gangue

|— 84μ —| |— 84μ —|

Plate 13. (+200 tip)

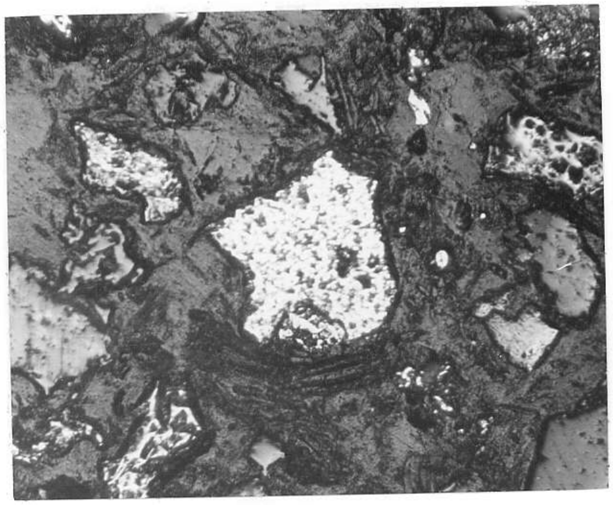
Free Chalcopyrite, Pyrite, Specularite



|— 90 μ —|

Plate 14. (+200 tip)

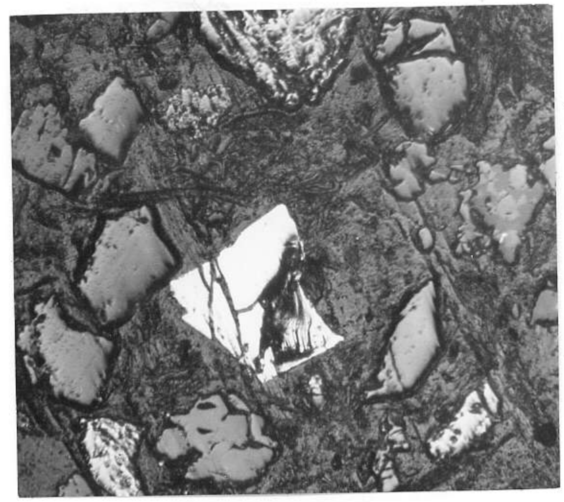
Chalcopyrite associated with specularite



185 μ

Plate 15. (+ 200 middling)

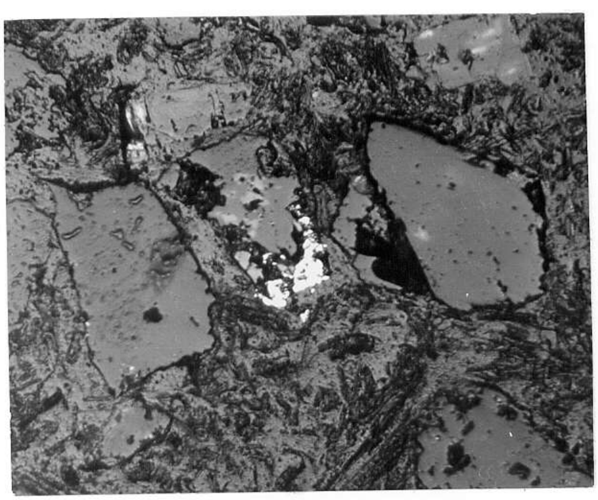
Chalcopyrite associated with pyrite



151 μ

plate 16. (+200 middling)

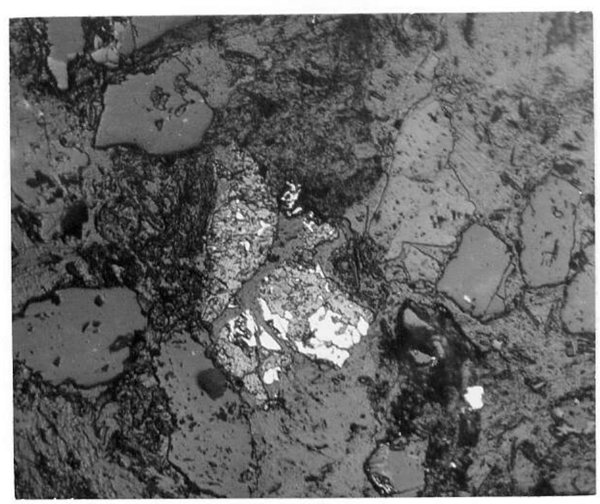
free chalcopyrite



67 μ

Plate 17. (+ 200 tail)

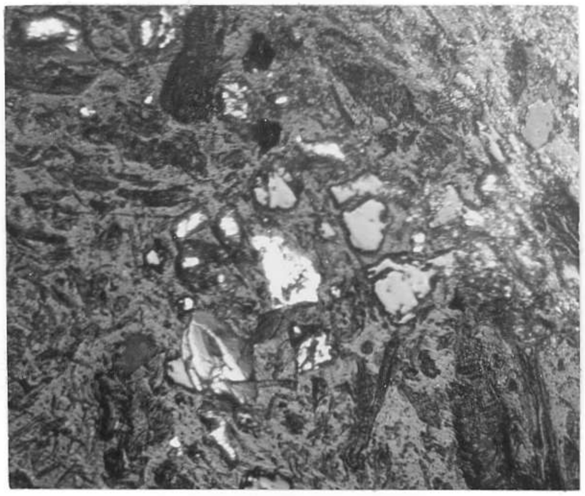
Chalcopyrite associated with gangue



176 μ

Plate 18. (+200 tail)

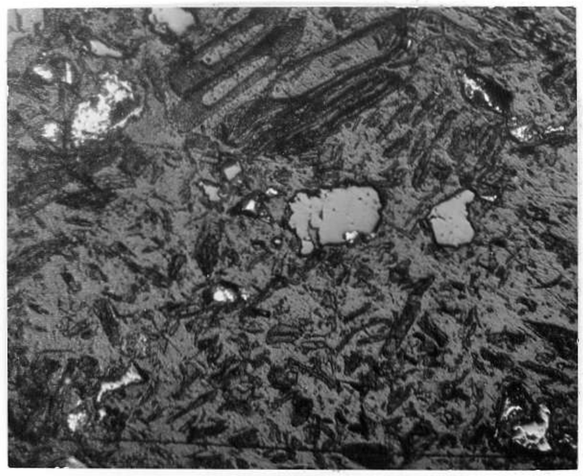
Chalcopyrite associated with speculanite



├ 84μ ┤

Plate 19. (−325 tip)

Free chalcopyrite



├ 93μ ┤

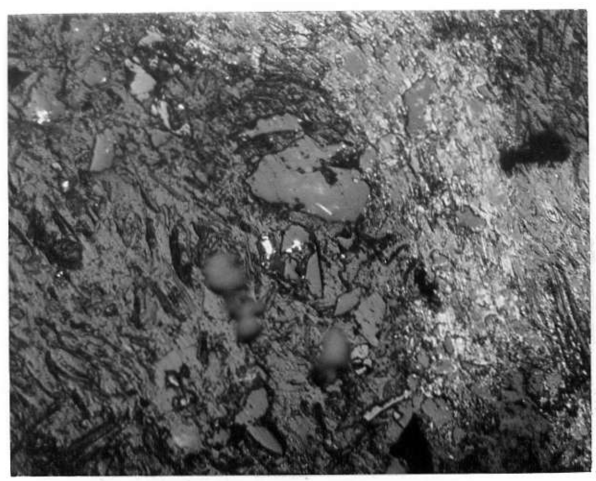
Plate 20. (−325 tip)

Chalcopyrite associated with gangue

├ 93μ ┤

Plate 21. (−325 middling)

Free chalcopyrite



├ 18μ ┤

Plate 22. (−325 tail)

Free chalcopyrite and chalcopyrite associated with gangue