Mines Branch Information Circular IC 303

MINERALOGICAL AND TEXTURAL STUDY OF THE COPPER-IRON DEPOSIT OF CRAIGMONT MINES LTD., SOUTH-CENTRAL BRITISH COLUMBIA*

by

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SUMMARY

A suite of samples from the copper-iron deposit of Craigmont Mines Ltd. was studied mineralogically and texturally using the reflecting ore microscope.

The assemblage of ore minerals and their textural relationships are relatively simple. Chalcopyrite and magnetite are the two ore minerals of major interest and both occur as impregnations in a skarn host. Pyrite is relative sparse in this deposit. Textural relationships suggest at least two ages of hematite relative to magnetite. The remaining ore minerals are present in relatively minor amounts.

Zoning occurs in the mine, and is characterized by a greater proportion of magnetite at the east end, and by hematite predominating at the west end.

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Direction des mines

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L'ÉTUDE MINÉRALOGIQUE ET TEXTURALE DU GISEMENT DE CUIVRE-FER DE "CRAIGMONT MINES LTD." AU SUD-CENTRAL DE LA COLOMBIE BRITANNIQUE*

par

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RÉSUMÉ

L'auteur a fait une étude d'une série d'échantillons du gisement de cuivre-fer de "Craigmont Mines Ltd." du point de vue minéralogique et textural en utilisant le microscope à réflexion de minerai.

L'assemblage des minéraux métalliques et leurs rapports texturaux sont relativement simples. La chalcopyrite et la magnétite sont deux minéraux métalliques d'un intérêt majeur et toutes les deux se trouvent imprégnées dans le skarn original. La pyrite est relativement peu abondante dans ce gisement. Les rapports texturaux suggèrent au moins deux âges d'hématite en relation avec la magnétite. Le restant des minéraux métalliques se trouvent dans des montants relativement petits.

La minéralisation change et est caractérisée par une plus grande proportion de magnétite à l'est de la mine et par une plus grande proportion d'hématite à l'ouest de la mine.

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INTRODUCTION

A mineralogical study of the copper-iron skarn deposit of Craigmont Mines Limited was undertaken as part of a study of selected stock-work and skarn deposits in south-central British Columbia.

The Craigmont deposit is located approximately 10 miles northwest of the town of Merritt and about 240 miles northeast of Vancouver at latitude 50° 12' 28" north, and longitude 120° 54' 28" west.

The deposit was visited in the fall of 1969 by Dr. W. Petruk of the Mines Branch, Ottawa. Samples collected during this visit have been used in this investigation.

GENERAL GEOLOGY AND ORE DESCRIPTION

The general geology has been described by Bristow (1968), and what follows is, in part, a summary of that description. The Craigmont deposit is located in a broad copper province extending from northern Washington in the United States to at least north of Kamloops in south-central British Columbia. Throughout the belt, Jurassic intrusive bodies of granodiorite, quartz diorite, and diorite intrude the Upper Triassic rocks of the Nicola series. This series consists mainly of coarse volcanic and clastic rocks with interbedded volcanic flows. Sedimentary horizons, consisting of grits, limestones, and greywackes, make up approximately 20% of the series. In the immediate mine area, the greywackes of the Nicola group have been hornfelsed by the intrusion of the Guichon batholith. South of the hornfelsed zone, a Cu-Mg-Fe-Si metasomatic skarn zone is present and is considered to be the down-dip continuation of the mine limestones.

The main orebody occurs within the skarn zone which varies in composition according to the relative proportions of magnetite, hematite, epidote, actinolite, chlorite, calcite, orthoclase, quartz, and tourmaline. Except for garnet and magnetite, these same minerals occur outside the skarn zone as veins and disseminations in the wallrocks (Drummond, 1966).

Two main ore types characterize the orebody and include a chalcopyrite-magnetite type and a chalcopyrite-hematite type. A third ore type which occurs in minor amounts consists of chalcopyrite-filled fractures in a porcelanite-like crackled chert.

The main orebody is roughly zoned according to the distribution of the two main ore types with the ore becoming increasingly richer in magnetite and correspondingly poorer in hematite, as it extends eastward (Carr, 1966).

MINERALOGY AND TEXTURAL RELATIONSHIPS OF THE ORE SAMPLES

The general mineralogy of the deposit has been previously described (Bristow, 1968; Chrismas, 1968; Carr, 1966; Drummond, 1966; Rennie et al, 1961). From a summary of their findings, several mineralogical relationships become apparent. Chalcopyrite is the principal copper-bearing ore mineral and occurs as veins, streaks, patches and coarse disseminations. Bornite is present in minor amounts and in close association with the chalcopyrite. Pyrite occurs generally as subhedral grains peripheral to the ore zone but seldom within the orebody. Locally, the pyrite forms coarse, euhedral crystals up to 1 cm in diameter. Minor pyrrhotite occurs in the garnetiferous skarn and altered limestone. Magnetite is the principal iron-bearing ore mineral and occurs as granular clusters throughout the skarn. Euhedral magnetite grains are abundant and range in size up to several millimeters in diameter. Hematite, predominantly of the specularite variety, occurs as clusters of fibrous grains along shears and fracture fillings.

In the present study, the non-silicate minerals were examined to determine their identity and to characterize their textural relationships. Eighteen polished sections, prepared from nine samples that are representative of the different ore types, were studied by means of the ore microscope. One sample of zoned magnetite was analysed by means of the electron microprobe, and the following eleven ore minerals were identified:

Mineral Name	Composition	Mineral Name	Composition
Chalcopyrite	$CuFeS_2$	Pyrite	FeS_2
Bornite	Cu_5FeS_4	Pyrrhotite	$Fe_{1-x}S$
Covellite	CuS	Marcasite	FeS_2
		Mackinawite	FeS
Rutile	TiO_2	Magnetite	Fe_3O_4
Ilmenite	$FeTiO_3$	Hematite	Fe_2O_3

Chalcopyrite ($CuFeS_2$)

Chalcopyrite occurs mainly as an interstitial filling between other ore minerals, and/or silicates, particularly magnetite (Figure 1). The interstices vary in shape, are up to 0.5 mm wide, and determine the relative grain size of the chalcopyrite.

Minor amounts of chalcopyrite occur in fractured pyrite as irregular veinlets up to 0.3 mm wide (Figure 2). In some cases, this veining forms an "ice-cake" texture of strongly corroded pyrite grains in a chalcopyrite matrix. Trace amounts of chalcopyrite also occur as distinct, rounded inclusions, up to 25 μ in diameter, in discrete pyrite grains that often contain numerous well-rounded silicate inclusions.

Magnetite (Fe_3O_4)

Magnetite occurs predominantly as granular aggregates of euhedral to subhedral grains, some of which are distinctly octahedral in cross-section. The individual grains are up to 5 mm in diameter and are generally free of sulphide inclusions (Figure 3); however, in some cases, zones of silicate inclusions tend to follow the crystallographic outline of an individual grain.

Several magnetite samples, etched for several seconds with concentrated HCℓ, revealed zoning within individual grains (Figure 4). One zoned magnetite grain (Figure 5) was analysed by means of the electron microprobe. Five distinct zones were examined and spot analyses taken, starting at the margin of the grain at Zone 1 and moving towards the centre of the grain through Zones 2, 3, 4, and 5. Zone 5 is the nearest to the apparent centre of the grain. Ca, Al, and Si were detected in increasing amounts towards the centre (Table 1). Other elements analysed for, but not detected, include Mn, Mg, Ti, Cr, V, and Ni. As seen from Figure 5, the zoning is more frequent than the five zones selected for analyses; however, many of the zones are too narrow to permit quantitative electron microprobe analyses.

Magnetite occurs less frequently as bundles of platy grains up to 7 mm long associated with hematite. The hematite occurs as relict inclusions within individual magnetite plates and in, some cases, these inclusions are elongated parallel to the edge of the plate (Figure 6).

Occasionally magnetite occurs as vein-like clusters of euhedral to subhedral grains up to 50 μ in diameter which enclose irregular pyrite grains (Figure 8).

Table 1

Partial Electron Microprobe Analysis of Magnetite

Zone	Al (Wt %)	Si (Wt %)	Ca (Wt %)
1	0.0	0.0	0.0
2	0.25	0.35	0.13
3	0.26	0.52	0.21
4	0.28	0.50	0.22
5	0.31	0.72	0.33

Hematite (Fe_2O_3)

Hematite is present essentially as the specularite variety and commonly occurs as clusters of blade-like grains up to 7 mm long in shears and/or veinlets (Figure 9).

In some cases, the hematite grains suggest replacement by magnetite, thus producing a pseudomorphous arrangement of distinctly bladed magnetite grains (Figure 6). Occassionally, vein-like bands of hematite can be observed cutting across bundles of the bladed magnetite grains (Figure 7).

Mackinawite (FeS)

Mackinawite was observed only in association with rounded chalcopyrite inclusions in pyrite. It occurs as irregular, spindle-like inclusions, less than 5 μ long, within the chalcopyrite or along the margin of the chalcopyrite inclusions, where they are in contact with pyrite.

Pyrrhotite ($Fe_{1-x}S$)

Pyrrhotite in trace amounts was observed in pyrite as well-rounded inclusions up to 10 μ in diameter. In some cases, these inclusions are actually intergrowths of pyrrhotite and chalcopyrite.

Bornite (Cu_5FeS_4), Covellite (CuS)

Bornite and covellite occur together in trace amounts and form irregular veinlets along fractures in the chalcopyrite.

Marcasite (FeS_2)

Small amounts of marcasite generally occur together with pyrite either as granular aggregates or as relict grains within a pyrite host.

DISCUSSION

The ore mineral assemblages from the Craigmont deposit are relatively simple. Chalcopyrite accounts for essentially all of the copper, except for the trace amounts of bornite and covellite which are intergrown with the chalcopyrite and are probably recovered with it by flotation Magnetite and hematite can be recovered for their iron content, but magnetite predominates and would be the more easily recovered. Both these iron-oxide minerals are relatively free of sulphide inclusions and are generally coarse-grained. Over-all, the values are easily liberated and the ore is easy to mill.

The apparent zoning, resulting in magnetite at the east end of the mine and hematite at the west, is probably due, as indicated by Drummond (1966), to a relative increase in temperature and/or decrease in the partial pressure of oxygen from west to east at the time of formation of the ore. The higher temperature at the east end of the mine appears to be related to the proximity of the skarn zone to the diorite (Bristow, 1968).

Previous workers have interpreted two distinct stages of mineralization with specular hematite-chalcopyrite assemblage superimposed on a magnetite-chalcopyrite assemblage. This has been confirmed in this study; however, the apparent pseudomorphic replacement of hematite by magnetite suggests that this event occurred before the formation of the specular hematite, which cuts across the magnetite. The major proportion of the ore is represented by the magnetite-chalcopyrite stage of mineralization, which occurs as impregnations in the skarn and, thus, appears to be an intimate part of the skarn-forming event. The hematite-chalcopyrite veinlets, which occur in chloritic shears, appear to be related to a post-skarn period of mineralization.

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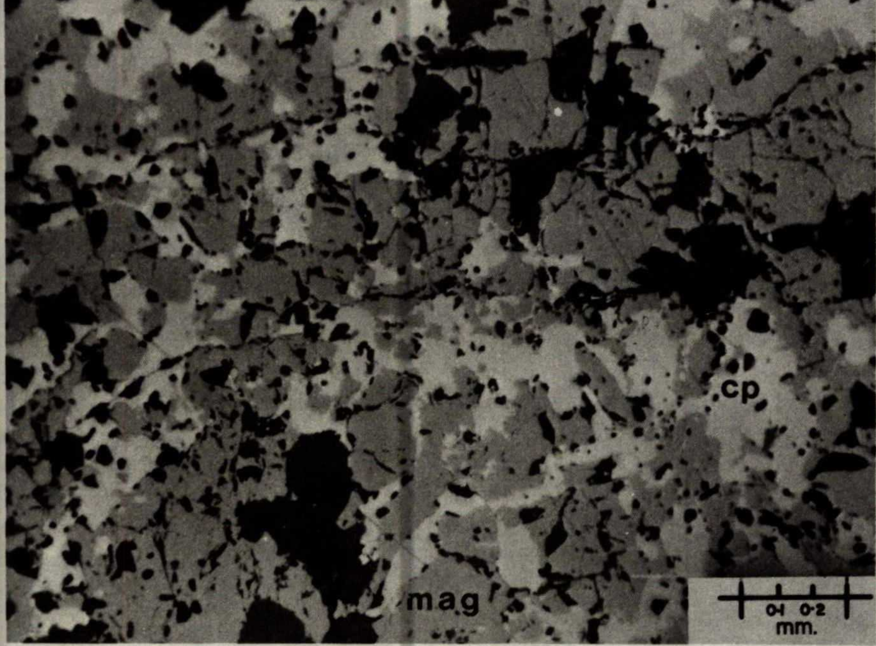

Figure 1. Photomicrograph showing interstitial chalcopyrite (cp) with magnetite (mag). Black areas represent gangue and/or pits.

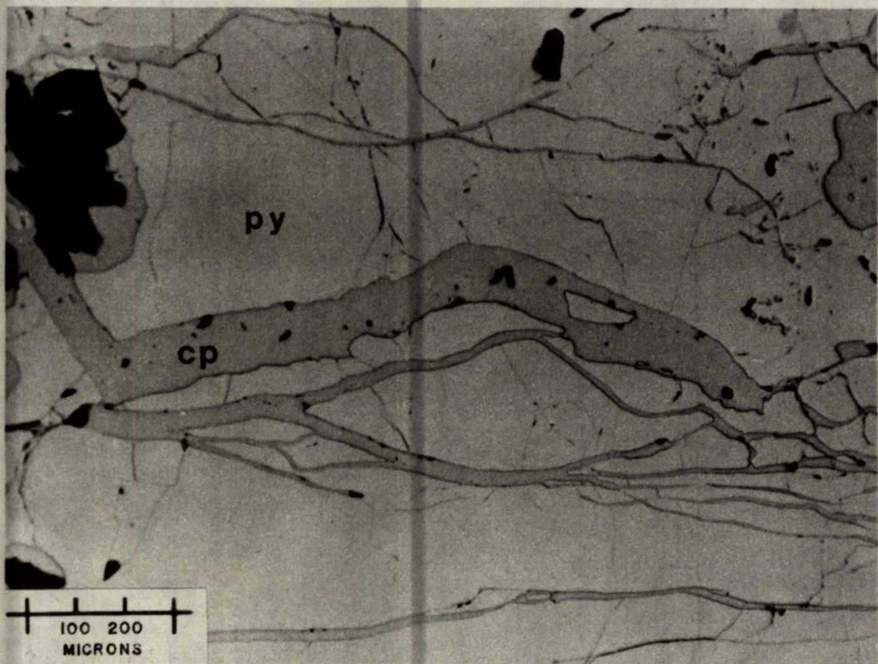

Figure 2. Photomicrograph showing chalcopyrite (cp) veining fractured pyrite (py). Black areas represent pits.

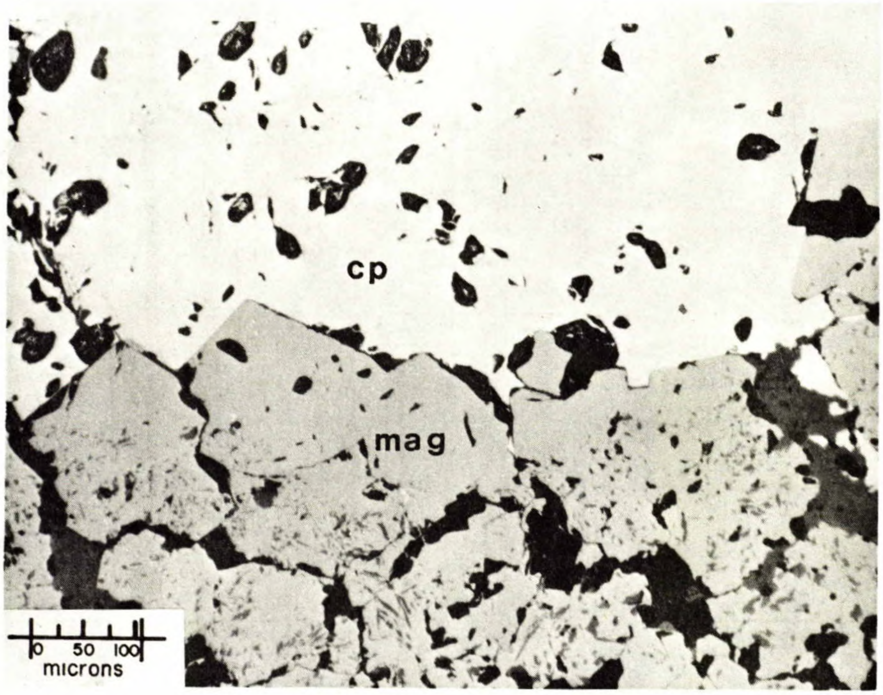

Figure 3. Photomicrograph showing subhedral magnetite grains (mag) in sharp contact with chalcopyrite (cp). Dark grey and black areas represent gangue and pits, respectively.

Figure 4. Photomicrograph showing complex zoning in magnetite, revealed by etching with concentrated HCℓ.

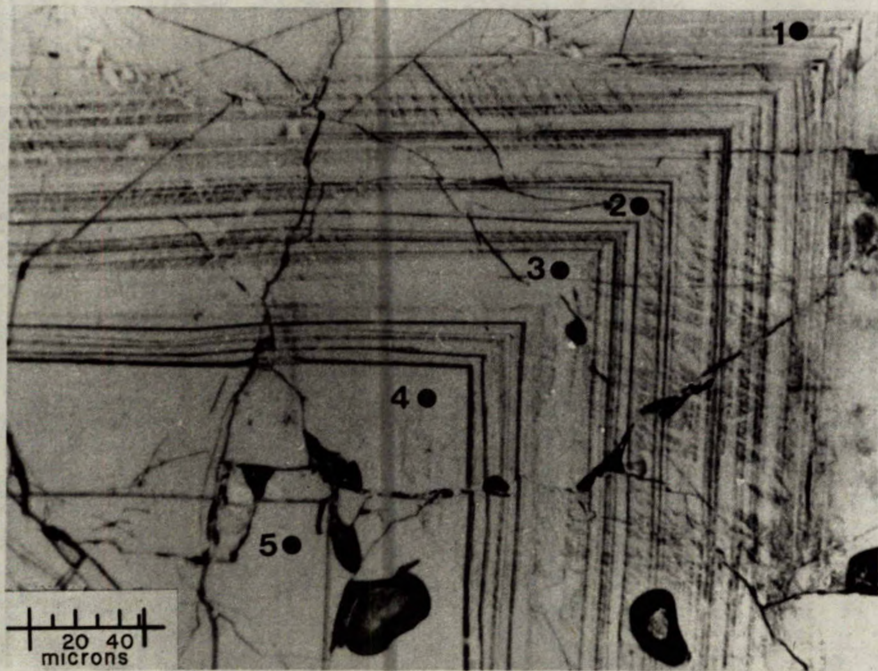

Figure 5. Photomicrograph showing zoned magnetite as analysed (see Table 1).

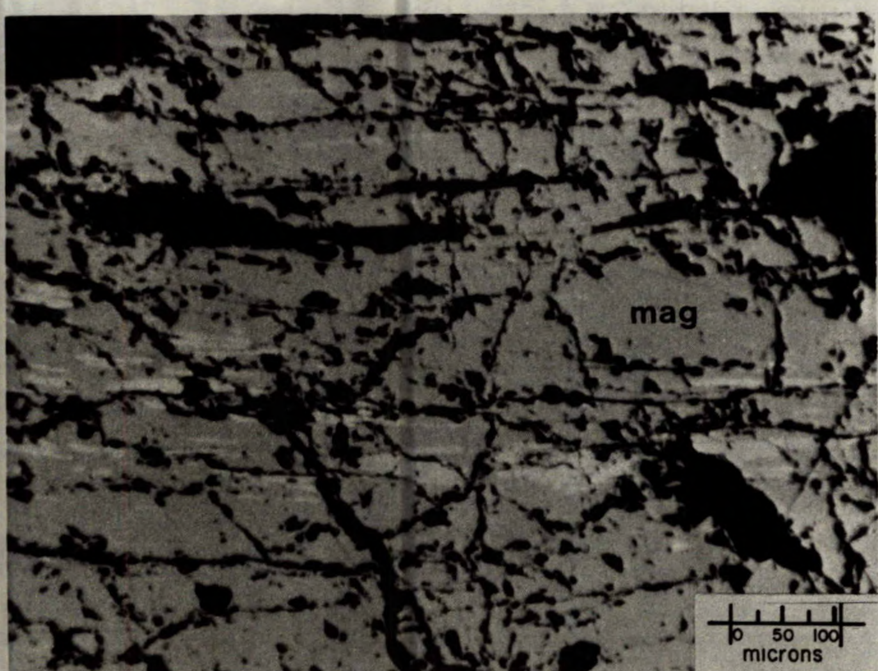

Figure 6. Photomicrograph showing relict lath-like inclusions of hematite in a matrix of platy magnetite (mag) grains.

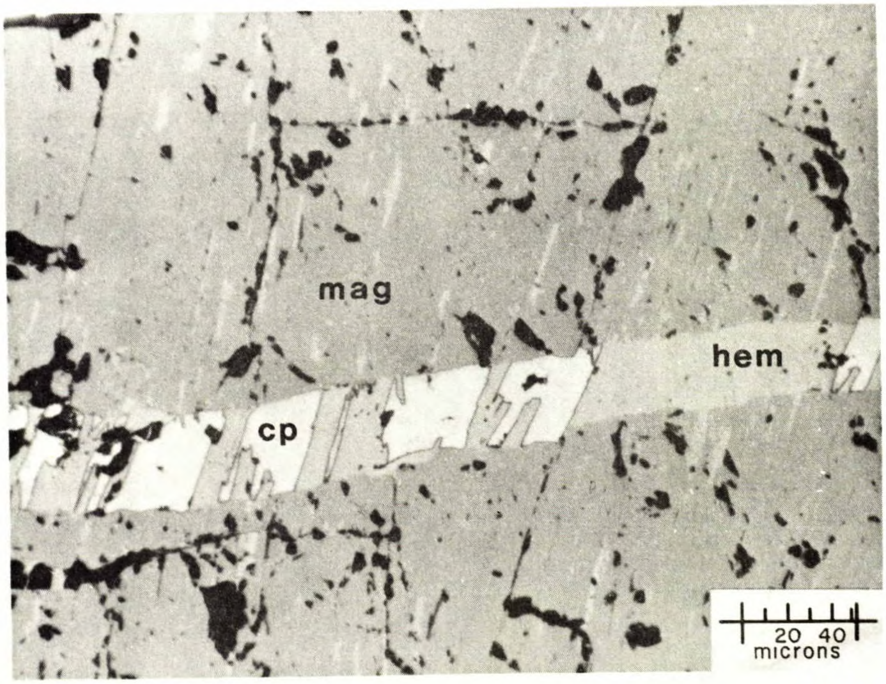

Figure 7. Photomicrograph showing a band of hematite (hem) and minor chalcopyrite (cp) cutting across a cluster of platy magnetite grains (mag) which contain traces of oriented hematite. Black areas represent pits.

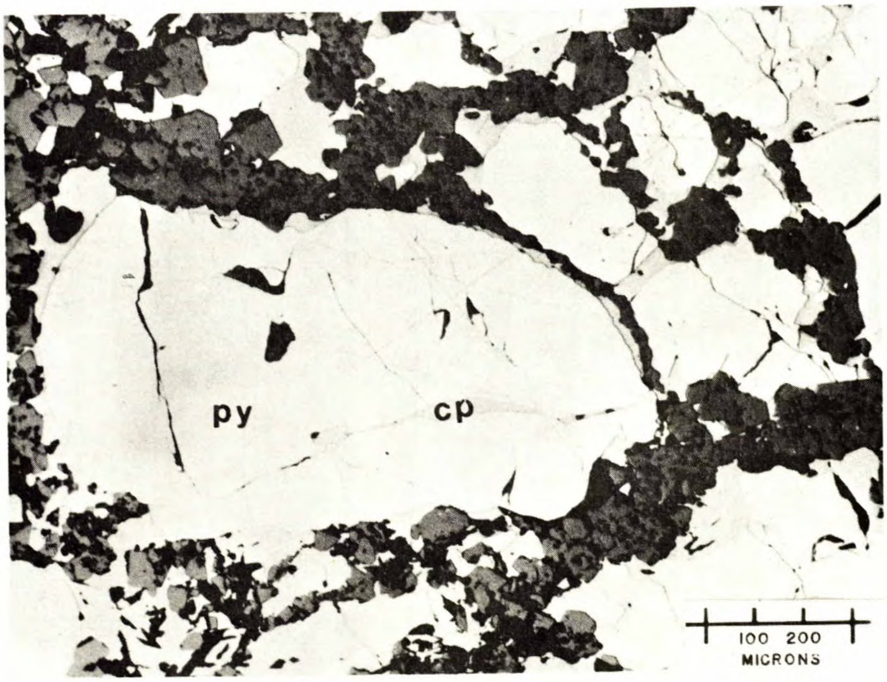

Figure 8. Photomicrograph showing clusters of subhedral magnetite (dark grey) enclosing irregular grains of pyrite (white) which contain irregular chalcopyrite (cp) inclusions.

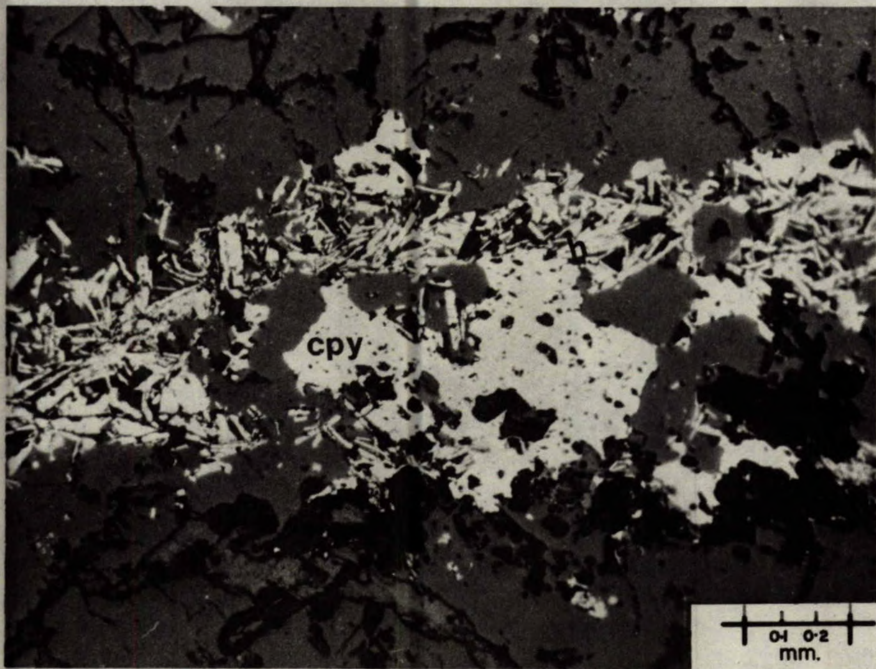

Figure 9. Photomicrograph showing clusters of bladed specularite grains (hem) aligned along a minor shear and cutting patches of chalcopyrite (cp).