Mines Branch Information Circular IC 302

MINERALOGICAL AND TEXTURAL STUDY OF THE COPPER-MOLYBDENUM DEPOSIT OF BRENDA MINES LIMITED, SOUTH-CENTRAL BRITISH COLUMBIA*

by

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SUMMARY

Samples from the copper-molybdenum deposit of Brenda Mines Limited were studied mineralogically using, in some instances, the reflecting ore microscope for identification and, in others, the electron-microprobe for identification by quantitative analyses.

The assemblage of ore minerals and their textural relationships are relatively simple. Chalcopyrite and molybdenite are the two ore minerals of major interest and both occur interstitially within quartz-filled fractures[1]. Pyrite occurs sporadically within the quartz veins and as disseminations in the country rock. Chalcopyrite appears to be of more than one age as shown by its textural relationship to pyrite. The remaining ore minerals are present in relatively minor amounts.

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1. Quartz-filled and quartz-K feldspar filled fractures are two of the classifications employed by the Brenda Mines Limited Staff. In this report they are collectively referred to as quartz-filled fractures.

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Direction des mines

Circulaire d'information IC 302

L'ÉTUDE MINÉRALOGIQUE ET TEXTURALE DU GISEMENT DE CUIVRE-MOLYBDÈNE DE "BRENDA MINES LIMITED", AU SUD-CENTRAL DE LA COLOMBIE BRITANNIQUE

par

A.E. Johnson**

RÉSUMÉ

L'auteur a fait une étude des échantillons du gisement de cuivre-molybdène de "Brenda Mines Limited" du point de vue minéralogique en utilisant, dans certaines instances, le microscope à réflexion de minerai pour l'identification et dans d'autres instances, la micro-sonde électronique pour l'identification par les analyses quantitatives.

L'assemblage des minéraux métalliques et leurs rapports texturaux sont relativement simples. La chalcopyrite et la molybdénite sont deux minéraux métalliques d'un intérêt majeur et toutes les deux se trouvent insterstitiellement dans les cassures remplies de quartz.[1] La pyrite se trouve sporadiquement dans les veines de quartz et comme disséminée dans la roche encaissante. La chalcopyrite semble avoir plus qu'un âge, cela se voit par le rapport textural avec la pyrite. Le reste des minéraux métalliques se trouve relativement en quantités plus petites.

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1. Les cassures remplies de quartz et de quartz-feldspath de potassium sont deux des classifications employées par "Brenda Mines Limited". Dans ce rapport, l'auteur les désigne par cassures remplies de quartz.

*Division des sciences minérales - Contribution d'études de gisement minéral No. 9.

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INTRODUCTION

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

The Brenda deposit is located approximately 140 miles east-north-east of Vancouver and 14 miles northwest of the small town of Peachland which is situated on Okanagan Lake.

The deposit was visited in the fall of 1969 and the summer of 1971 by Dr. W. Petruk of the Mines Branch, Ottawa. Samples collected on these occasions have been used in this investigation.

GENERAL GEOLOGY AND ORE DESCRIPTION

The Brenda deposit lies entirely within the Brenda Stock which connects the Okanagan Batholith to the south with the Penask Batholith to the north (Carr, 1967).

Chalcopyrite and/or molybdenite mineralization is confined almost entirely to a single phase of the Brenda Stock (Carr, 1967). Several dike systems cut the stock and occur within the orebody. These include: aplite, andesite, trachyte porphyry, and basalt; all except the basalt appear to be pre-ore (Soregaroli, 1971). The mineralization occurs in predominantly quartz-filled fractures as interstitial fillings within the quartz. Pyrite is the most common accessory sulphide and occurs both within quartz veins and as minor disseminations in the host intrusive. Trace amounts of magnetite, the most common accessory oxide, occur together with the sulphides and as disseminations through the host rock.

Generally, the quartz-sulphide veins are between one quarter and several inches thick. The host intrusive is relatively fresh and the strongest evidence of alteration occurs immediately adjacent to the veins. These alterations were potassic, propylitic, and argillic and were recognized by the presence of potash feldspar and biotite, chlorite and epidote, clay, and sericite respectively.

MINERALOGY AND TEXTURAL RELATIONSHIPS OF THE ORE SAMPLES

A total of 25 polished sections from 17 samples was examined by means of the ore microscope. These samples were prepared in order to examine the non-silicate minerals and to characterize their textural relationships. They represent the mineralization exposed in the open pit at the time the visits were made. Because of the time interval between visits, samples were effectively taken from two bench levels; however, they are not intended to represent a vertical section through the deposit, but rather, they represent a line of samples across the pit. Collectively, the samples represent a similar type of mineralization and, therefore, no attempt has been made to show the relative location of these samples.

The following 18 ore minerals were identified and include:

Mineral Name	Composition	Mineral Name	Composition
Chalcopyrite	$CuFeS_2$	Sphalerite	ZnS
Molybdenite	MoS_2	Carrolite[3]	$CuCo_2S_4$
Bornite	Cu_5FeS_4	Native Gold[4]	Au
Chalcocite[1]	Cu_2S	Cubanite	$CuFe_2S_3$
Digenite[2]	$Cu_{1.76}S$	Magnetite	Fe_3O_4
Covellite	CuS	Hematite	Fe_2O_3
Pyrite	FeS_2	Ilmenite	$FeTiO_3$
Marcasite	FeS_2	Rutile	TiO_2
Mackinawite	FeS		
Pyrrhotite	$Fe_{1-x}S$		

1. General uncertainty as to true identity because it can be confused optically with digenite.
2. Identification confirmed by electron microprobe examination.
3. Analysed by electron microprobe.
4. Tentatively identified.

Chalcopyrite ($CuFeS_2$)

The bulk of the chalcopyrite occurs interstitially with the other ore minerals and particularly with the vein quartz (Figure 1). Pyrite, where fractured, is, in some cases, veined by chalcopyrite. Much of the fine veining is visible only under the microscope (Figure 2).

Minor aggregates of chalcopyrite were observed in a sample of basic dike material. Generally, the chalcopyrite is finer-grained at the margin of such aggregates, becoming coarser towards the centre (Figure 3).

Chalcopyrite also occurs as distinct, rounded inclusions in pyrite. These inclusions are generally fine-grained and seldom exceed 50 μ in diameter and can be as small as 1 μ in diameter. Some of these inclusions are composite and include pyrrhotite and/or mackinawite (Figure 4).

Molybdenite (MoS_2)

Molybdenite occurs as bundles of plate-like grains in quartz (Figure 5). It is commonly associated with chalcopyrite insofar as they both occur in the same quartz vein, but texturally they are usually separate. In some cases, the molybdenite forms an apparent concentration at the quartz vein/host rock interface.

A molybdenite concentrate assaying 95.9% MoS_2 (Kobus, 1972) and obtained from Mr. Holmes, Senior Metallurgist, Brenda Mines Limited, was analysed for rhenium and found to contain less than 10 ppm (Lanthier, 1972).

Bornite (Cu_5FeS_4), Covellite (CuS), Chalcocite (Cu_2S), Digenite ($Cu_{1.76}S$)

All four minerals were found in trace amounts only.

Bornite and covellite were identified by means of the reflecting microscope, the bornite generally occurring as rims enclosing chalcopyrite grains (Figure 6).

Because of the similarity in the appearance of chalcocite and digenite under the reflecting microscope, these minerals were identified by means of the electron microprobe.

Pyrite (FeS_2)

Pyrite occurs predominantly as granular aggregates in quartz-filled fractures. The grains are compact and seldom exhibit any euhedral forms. However, they do contain numerous small, rounded inclusions of chalcopyrite (Figure 4). This same pyrite may be fractured and veined by chalcopyrite and, as well, be set in a matrix of chalcopyrite. "Ice-Cake" textures, illustrating strongly corroded, relic pyrite grains in chalcopyrite are common (Figure 7).

Disseminated pyrite occurs throughout the host rock and is particularly evident, together with altered silicates, adjacent to vein walls. This pyrite is characterized by abundant euhedral to subhedral grains, many of which exhibit slightly corroded margins. Individual pyrite grains may contain rutile and/or quartz inclusions (Figure 8) but are generally free of other sulphide inclusions.

Marcasite (FeS_2)

Trace amounts of marcasite were observed as clusters of irregular grains in pyrite. These grains in some cases appear as relict inclusions in pyrite.

Mackinawite (FeS)

Mackinawite occurs only with chalcopyrite when the latter occurs as inclusions in pyrite.

It forms irregular spindle-like inclusions within the chalcopyrite inclusions and, in some cases, appears to develop along preferred orientations.

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

Pyrrhotite is similar to mackinawite in that it occurs together with rounded chalcopyrite inclusions in pyrite. In some cases these same inclusions contain mackinawite. Pyrrhotite alone may also form inclusions which are generally less than 40 μ in diameter and more often between 10 and 30 μ in diameter. It may also occur as distinct rod-like grains with chalcopyrite (Figure 4).

Sphalerite (ZnS)

Trace amounts of sphalerite were noted as irregular grains intergrown with chalcopyrite.

Carrolite ($CuCo_2S_4$)

Several subhedral grains of carrolite,up to 15 μ in diameter and in a chalcopyrite matrix,were noted. Electron microprobe analyses indicate a composition of Co=38.5 wt %; Cu=16.9 wt %; Ni=3.3 wt %; and S=42.5 wt %.

Native Gold (Au)

A single grain,approximately 3 μ in diameter, was tentatively identified as native gold using the ore microscope. It occurs as a rounded inclusion in chalcopyrite but, because of its small size, could not be positively identified by means of the electron microprobe.

Cubanite ($CuFe_2S_3$)

After examination with the ore microscope, a single strongly anisotropic grain between 10 and 20 μ in diameter was identified as cubanite by means of the electron microprobe.

Magnetite (Fe_3O_4)

Magnetite occurs as disseminations of discrete, euhedral grains throughout the country rock and, to a lesser extent, in the quartz veins.

Some of these grains are distinctly rounded and in some cases,are contaminated with inclusions of pyrite and the occasional inclusion of chalcopyrite and sphalerite (Figure 9).

Hematite (Fe_2O_3)

Hematite is commonly associated with magnetite as irregular granular intergrowths, as lamellae within magnetite, or as rims on magnetite grains. The lamellae intergrowths appear to be related to crystallographic features of the magnetite.

Hematite is present as discrete blade-like grains which occur both as disseminations in the country rock and as aggregates in the quartz veins. Generally the disseminated grains are finer than those in the veins.

Hematite also occurs as regular exsolution laths in rounded ilmenite grains (Figure 10). These grains occur in minor amounts and as disseminations in the country rock but not in the veins.

Ilmenite ($FeTiO_3$) and Rutile (TiO_2)

Ilmenite and rutile both occur as discrete grains and aggregates in the weakly altered country rocks and do not appear to be a part of the assemblage of vein minerals.

DISCUSSION

The assemblage of recoverable ore minerals in the Brenda deposit is relatively simple. Chalcopyrite and molybdenite account for the copper and molybdenum,respectively. The other copper minerals identified occur in relatively small amounts and, because they are intimately associated with chalcopyrite, they can be recovered with the chalcopyrite.

Chalcopyrite and molybdenite are confined to the quartz veins but form relatively independent intergrowths with the quartz which benefits the over-all milling and separation of "free-grain" concentrates of each mineral.

Pyrite is the main non-silicate gangue mineral and its sporadic occurrence within the quartz veins is more closely associated with chalcopyrite than molybdenite. There appears to be at least two possible ages of chalcopyrite relative to pyrite. One of these is represented by chalcopyrite veining and by forming a matrix in which the pyrite grains occur. The other is represented by discrete sub-rounded chalcopyrite inclusions within pyrite grains.

The economic mineralization is directly related to quartz veins in contrast to the host rock itself, which is relatively barren.

ACKNOWLEDGEMENTS

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The author thanks Messrs. Y. Bourgoin and P. O'Donovan for the preparation of polished sections and Mr. E.J. Murray for the X-ray diffraction identification of the hexagonal variety of molybdenite. Acknowledgements are also extended to Messrs. G. H. G. Laflamme, D.R. Owens and Dr. D. C. Harris for the electron microprobe analyses.

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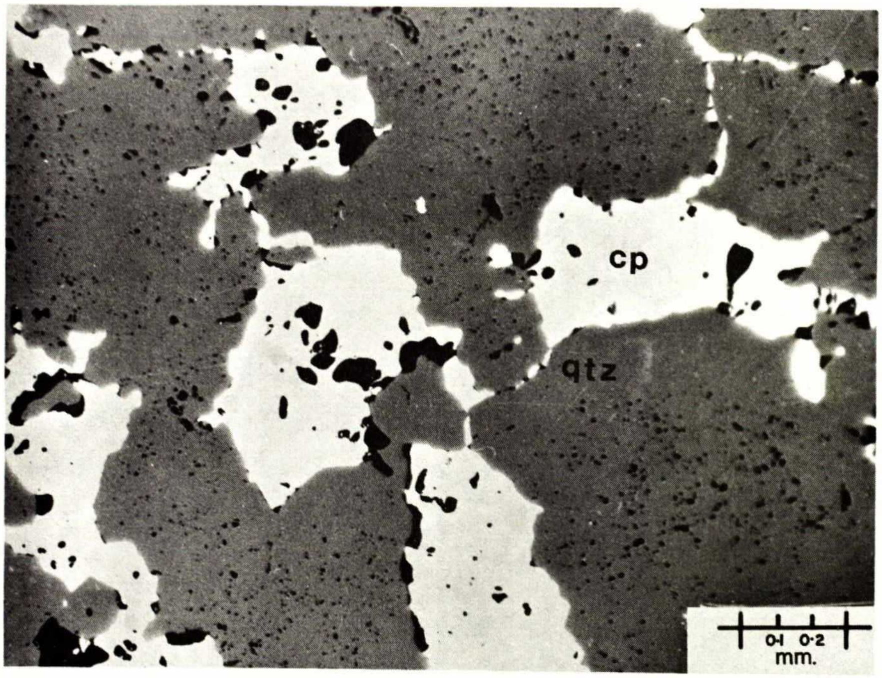

Figure 1. - Photomicrograph showing interstitial chalcopyrite (cp) in quartz (qtz) gangue. Black areas represent pits.

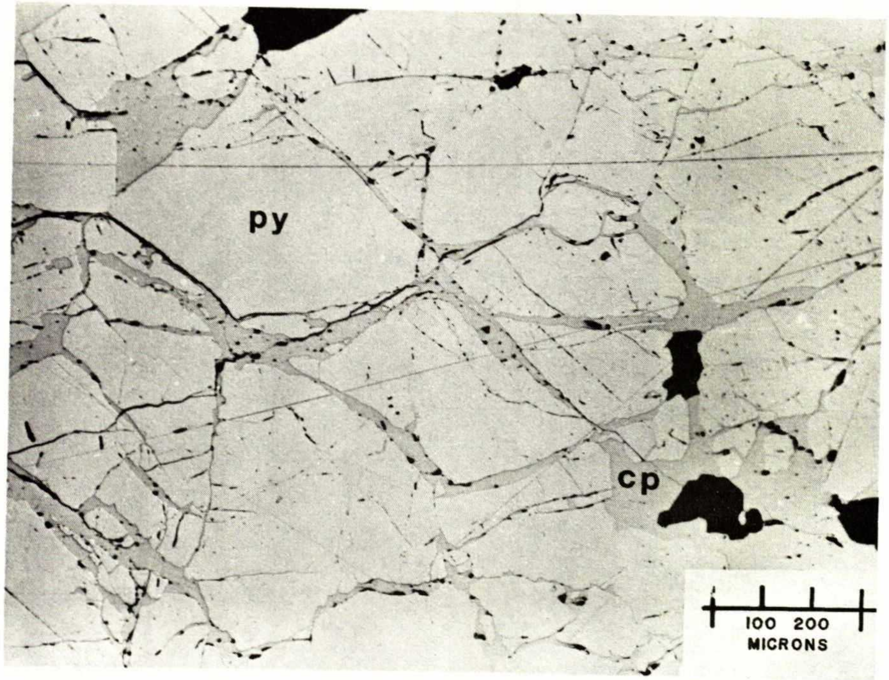

Figure 2. - Photomicrograph showing fractured pyrite (py) veined by chalcopyrite (cp). Black areas represent pits.

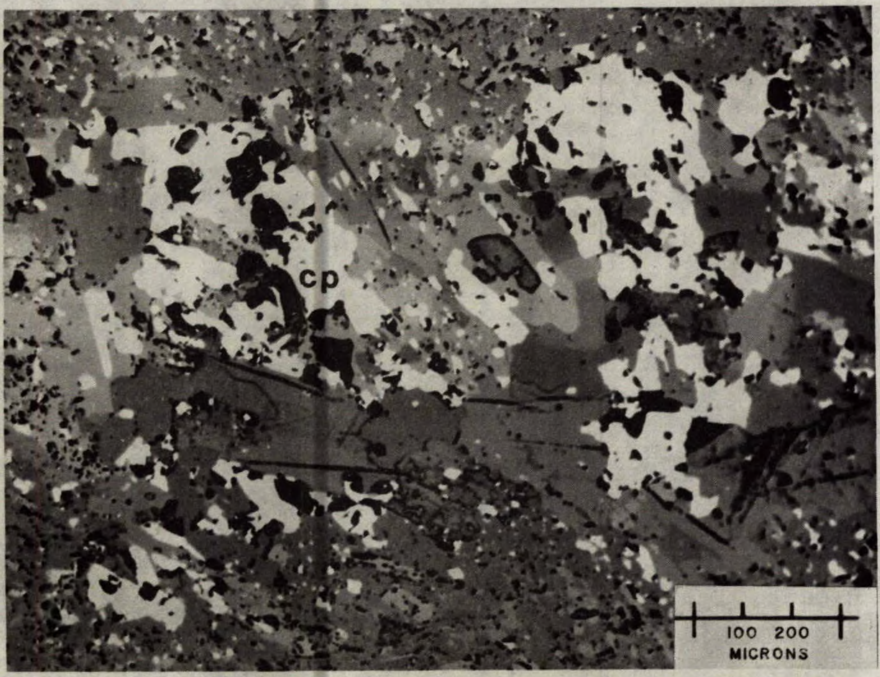

Figure 3. - Photomicrograph showing a cluster of chalcopyrite (cp) grains in altered dike rock. Note the decreasing grain size of the chalcopyrite towards the periphery of the cluster. Black areas represent pits.

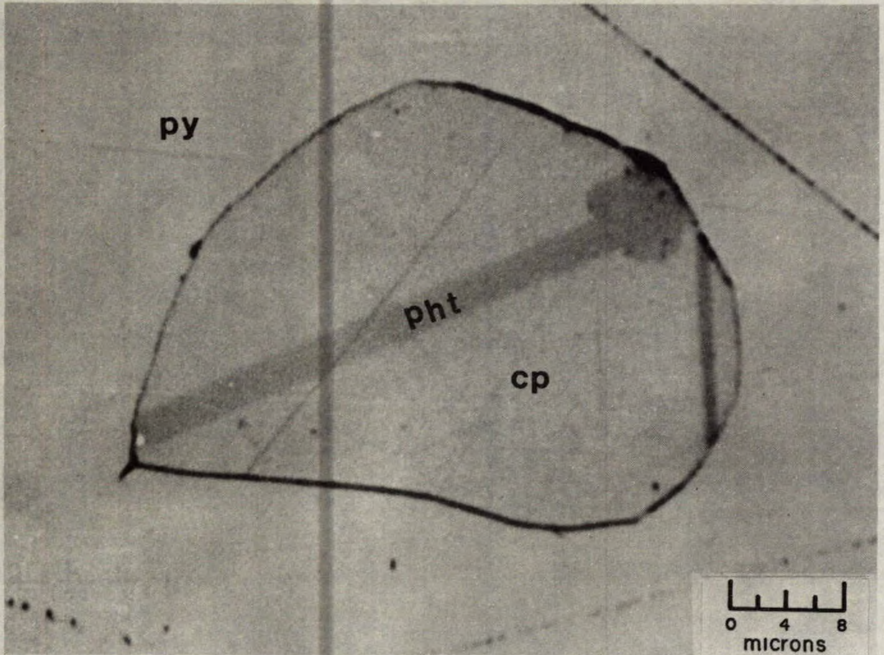

Figure 4. - Photomicrograph showing a rounded chalcopyrite (cp) inclusion containing a rod-like pyrrhotite (pht) grain, in pyrite (py).

Figure 5. - Photomicrograph showing bundles of plate-like molybdenite (mol) grains in a predominantly quartz matrix.

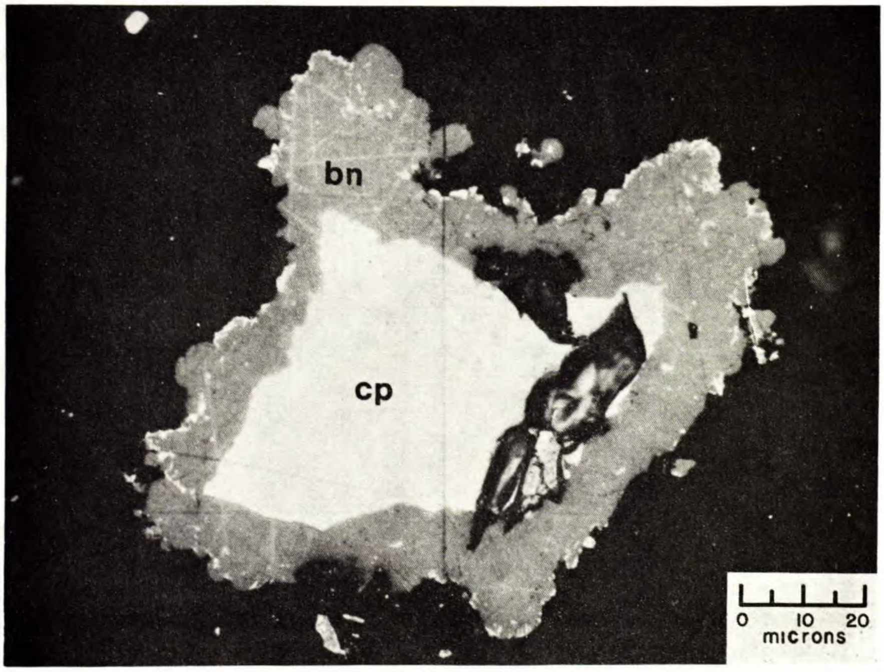

Figure 6. - Photomicrograph showing an irregular chalcopyrite (cp) grain rimmed by bornite (bn).

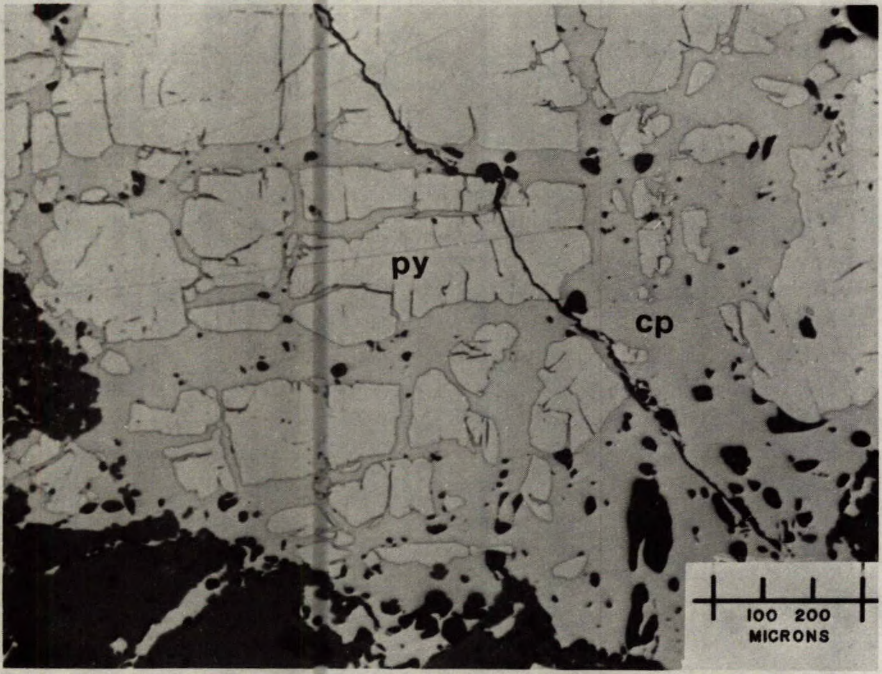

Figure 7. - Photomicrograph showing "ice-cake" texture between corroded pyrite (py) grains in a chalcopyrite (cp) matrix. Black areas represent pits.

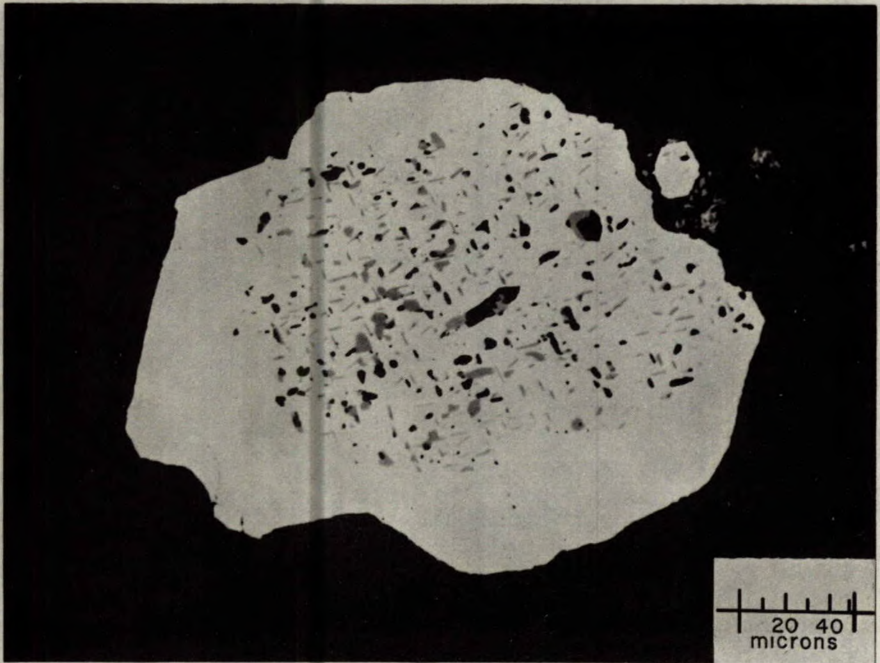

Figure 8. - Photomicrograph showing rutile as irregular, and oriented spindle-like inclusions in a subhedral pyrite grain.

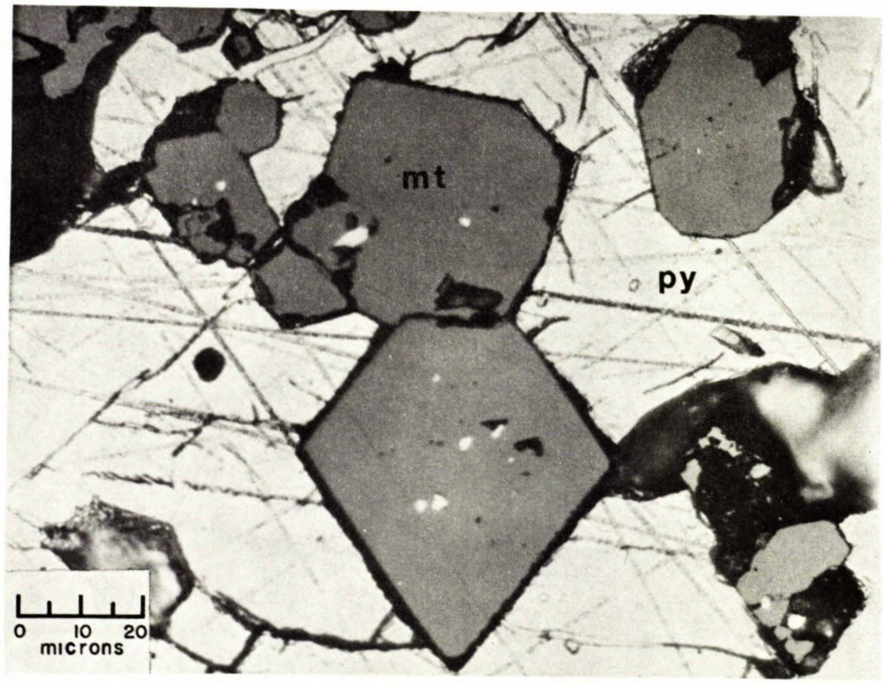

Figure 9. - Photomicrograph showing euhedral magnetite (mt) grains, containing rounded pyrite and pyrrhotite inclusions, in pyrite (py).

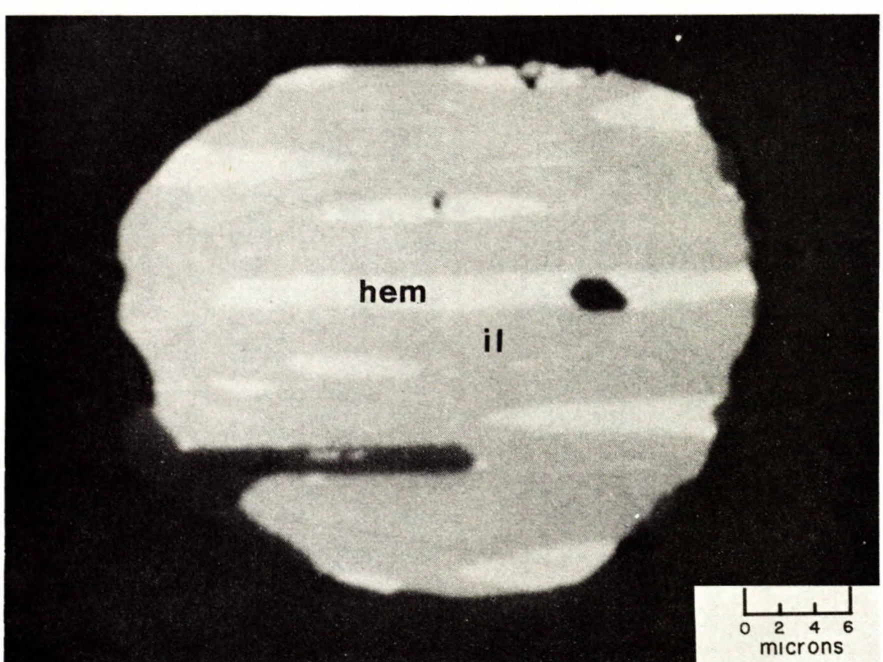

Figure 10. - Photomicrograph showing hematite lamellae in a rounded ilmenite grain, in a gangue matrix.

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