

DISTRICT	Rosebud
DIST_NO	4010
COUNTY If different from written on document	Pershing
TITLE If not obvious	Polished section examination of head and gravity rougher concentrate samples, Rosebud Project, December 17, 1993
AUTHOR	Hornea R ; Mary F.
DATE OF DOC(S)	1993
MULTI_DIST Y / N?	
Additional Dist. Nos:	
QUAD_NAME	Sulphur 7½'
P_M_C_NAME (mine, claim & company names)	Rosebud Mine ; Rosebud Project
COMMODITY If not obvious	gold; silver
NOTES	Petrographic report; photographs; correspondences; handwritten notes  88 p.

Keep docs at about 250 pages if no oversized maps attached  
(for every 1 oversized page (>11x17) with text reduce  
the amount of pages by ~25)

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Polished Section Examination  
of  
Head and Gravity Rougher Concentrate Samples,  
Rosebud Project

Russel M. Honea  
December 17, 1993

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of  
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December 17, 1993

Frank A. Macy  
McClelland Laboratories, Inc.  
1016 Greg Street  
Sparks, Nevada 89431

Re: Gold occurrence in head ore  
and products of Zone 2 and 6  
samples, Rosebud property

Dear Frank:

*Note: Zone 2 & 6  
roughly correspond  
to South Zone  
Chimney & East  
Zone, respectively.  
cvm*

Enclosed are results of polished section examination of the Zone 2 and Zone 6 sample sets from Doug Halbe's project on Hecla's Rosebud property, Nevada - and forwarded under your cover letter of November 30, 1993. Sorry for the delay in getting the final report to you, and hope the preliminary summary by phone last week was of help. In the effort to obtain as much information as possible regarding precious metals occurrence two polished sections were examined for each of the samples - one of the sample "as received" and one of a panned concentrate prepared therefrom.

The two sample sets are quite different mineralogically - with the Zone 2 sample being characterized by abundant native silver and a particularly complex and abundant suite of silver sulfosalt minerals plus gold in electrum. There is some suggestion that gold is present in solid solution in the strongly silver-dominant native silver. The Zone 6 sample, on the other hand, contains very little native silver, has gold dominantly in the more gold-rich electrum phase, and has only minor amounts of the silver sulfosalts so abundantly present in the Zone 2 sample material.

The Zone 2 Head and Gravity Rougher Concentrate samples contain relatively common native silver, a few locked grains of silver-rich electrum,, and a silver mineral suite that includes pyrargyrite- $\text{Ag}_3\text{SbS}_3$ , miargyrite- $\text{AgSbS}_2$ , stephanite- $\text{Ag}_5\text{SbS}_4$ , polybasite- $(\text{Ag,Cu})_{16}\text{Sb}_2\text{S}_{11}$ , and acanthite- $\text{Ag}_2\text{S}$ . Accompanying the silver minerals are dominant pyrite and lesser amounts of marcasite, arsenopyrite, chalcopyrite, and sphalerite. The CIL/ $\text{CN}^-$  leach residue from the Head sample and intensive  $\text{CN}^-$  leach residue from the Gravity Rougher Concentrate sample show very effective leach removal of native silver, electrum, and acanthite. However,



F. A. Macy  
Page 2

significant amounts of silver remain in the residues as silver sulfosalt mineral grains (pyrargyrite, miargyrite, and polybasite) - and minor silver occurs as small native silver and acanthite particles locked or encapsulated by pyrite and polybasite host fragments.

The Zone 6 Head and Gravity Rougher Concentrate samples show liberated and locked electrum (in marcasite and pyrite) as the gold phase, and a less abundant silver sulfosalt suite with pyrargyrite and freibergite- $(\text{Ag,Cu,Fe})_{12}\text{Sb}_4\text{S}_{13}$  (the silver-rich analogue of tetrahedrite). Associated sulfides include dominant pyrite plus lesser amounts of marcasite, arsenopyrite, chalcopyrite, sphalerite, pyrrhotite, and galena. Leach residues from the Head and Gravity Rougher Concentrate samples both show complete removal of liberated electrum - and the presence of silver in residues as traces of locked or encapsulated native silver in pyrite or polybasite and as unleached fragments of the silver sulfosalt minerals polybasite, miargyrite, and stephanite.

In both Zone 2 and 6 samples there appears to have been very effective removal of gold in electrum. The regrind of the Gravity Rougher Concentrate has apparently been effective in making available the locked electrum noted in the Concentrate. High silver in residues is a greater problem in higher silver assemblage from Zone 2, but may also be significant in the Zone 6 sample.

Please let me know if there are questions or comments regarding the data. I have an extra copy of the report along with original photomicrographs should it be required. Best Wishes for the Holiday Season!

Sincerely,

Encl.

Russell M. Honea

Zone 2 (Head). Liberated and locked native silver with minor locked electrum associated with complex silver sulfosalt suite plus dominant pyrite and lesser amounts of marcasite-chalcopyrite-sphalerite and silicate gangue.

Native silver - -1% - White with slight creamy tint, isotropic but does not show complete extinction because of polishing scratches, low hardness and is moderately well polished, tarnishes rather quickly on exposure to air. Present as larger grains bordered by silver sulfosalts and as smaller grains locked or encapsulated by silver sulfosalts - or more rarely by pyrite. The color in some of grains suggests possible small gold content.

Electrum - -1% - Pale golden yellow - indicating high silver content, isotropic but does not show complete extinction because of polishing scratches, low hardness and is well polished. Identified with certainty as 5 very small inclusions (3 to 10 microns) locked or encapsulated by chalcopyrite fragment. As noted above, some gold may also be present in the very silver-rich particles as well.

Pyrargyrite - -1% - Pale bluish gray, anisotropic but with polarization colors masked by strong dark red internal reflections, low hardness and is well polished, brittle. Present alone and in association with miargyrite and stephanite as fragments that enclose minor native silver and that border that mineral.

Miargyrite - -1% - Light bluish gray, anisotropic and with polarization colors of bluish gray to brown, deep red internal reflections - but less well developed than for pyrargyrite, hardness slightly greater than for pyrargyrite. Scarce separate grains and as composites with both pyrargyrite and stephanite. Encloses minor native silver.

Stephanite - -1% - Light gray with distinct pinkish violet tint, strongly anisotropic and with polarization colors of grayish green to violet, low to moderate hardness (greater than for pyrargyrite) and is well polished. Occurs in small amount as intergrowths with both pyrargyrite and miargyrite. Not seen as separate grains.

Zone 2 (Head).

Polybasite - -1% - Light gray and with bluish to slightly greenish tint, moderately anisotropic and with polarization colors of yellowish green to blue to brown, poorly developed deep red internal reflections (similar to those for miargyrite), low hardness and is well polished. Scarce composite grains in which associated with pyrargyrite and at times enclosing or bordered by chalcopyrite.

Acanthite - -1% - Light to medium gray and with slight greenish tint, weakly anisotropic but without distinctive polarization colors, very low hardness and is only moderately well polished, shows light etching. Present in trace amount as composites in which mostly enclosed by marcasite.

Pyrite - 6% - Pale yellow, either isotropic or with weak anomalous anisotropism and faint blue to brownish polarization colors, hard and is well polished. Occurs as small euhedral to broken cubic crystals and as scarce very fine grained aggregate-textured fragments. Also some as anhedral grains that are at times bordered by marcasite. A few of fragments enclose small native silver particles.

Marcasite - 1% - Very pale yellow to almost white, weakly bireflectant, strongly anisotropic and with polarization colors of blue to green to violet, hard and is well polished, often twinned. Present both alone and bordering pyrite in aggregate-textured fragments. Rarely contains poorly developed prismatic texture in some aggregates. Textures suggest deposition later than for pyrite.

Chalcopyrite - -1% - Bright yellow, weakly anisotropic and with faint blue to green polarization colors, moderate hardness and is well polished, brittle. Occurs mostly as separate liberated fragments. In one instance contains small locked or encapsulated electrum particles. Also rarely locked by pyrite fragments.

Sphalerite - -1% - Medium gray, isotropic and with strong pale yellowish to brownish internal reflections, moderate hardness and is well polished. Occurs as scarce



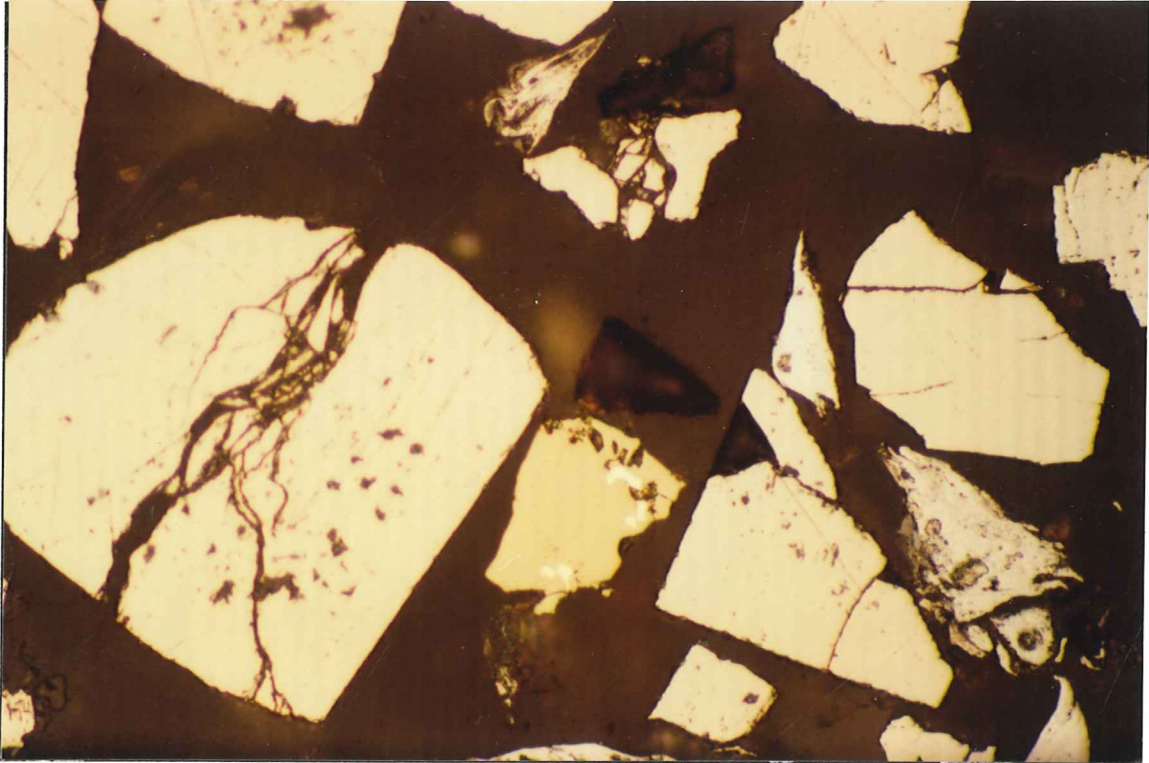
Zone 2 (Head).

separate fragments and as rare composite grains with pyrite and pyrargyrite. Does not contain chalcopyrite inclusions so often observed in the mineral.

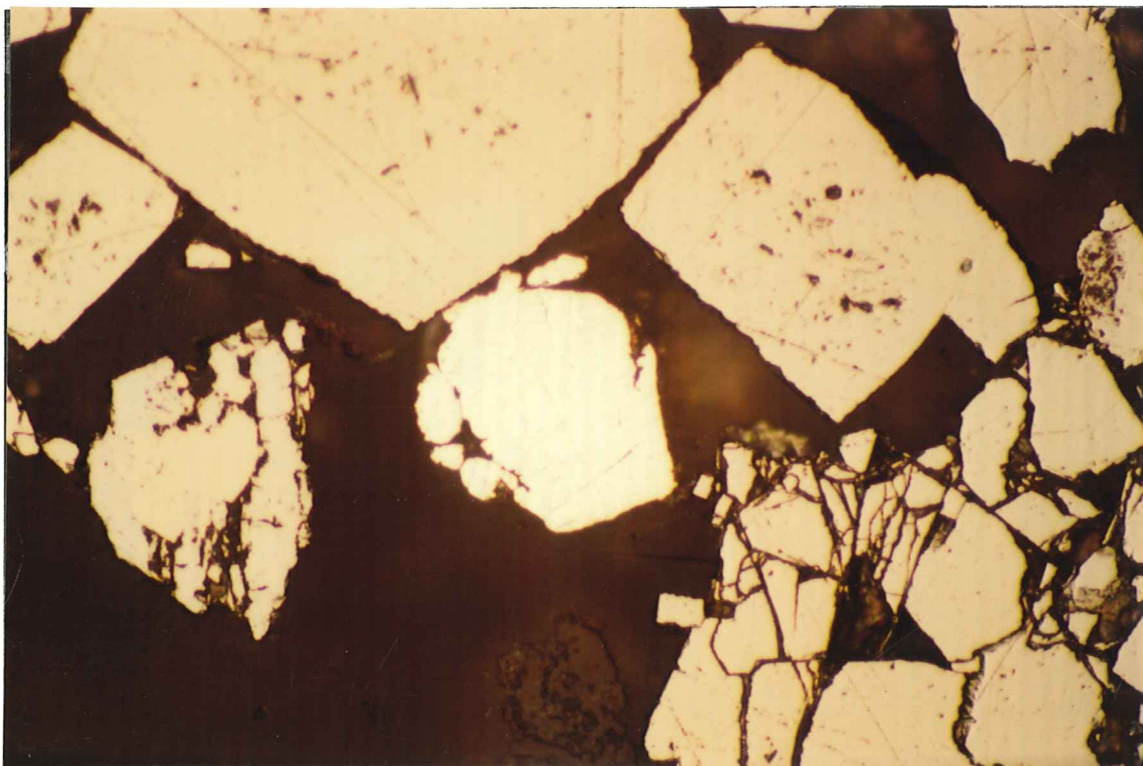
Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished. Tarnishes rather quickly on exposure to air. Added as a contaminant during sample preparation.

Non-metallic gangue - 92% - Comprised dominantly of host silicates.

\*Note: Two polished sections were prepared and examined - one of the "as received" material ground to -70 mesh and one of a panned concentrate prepared therefrom.

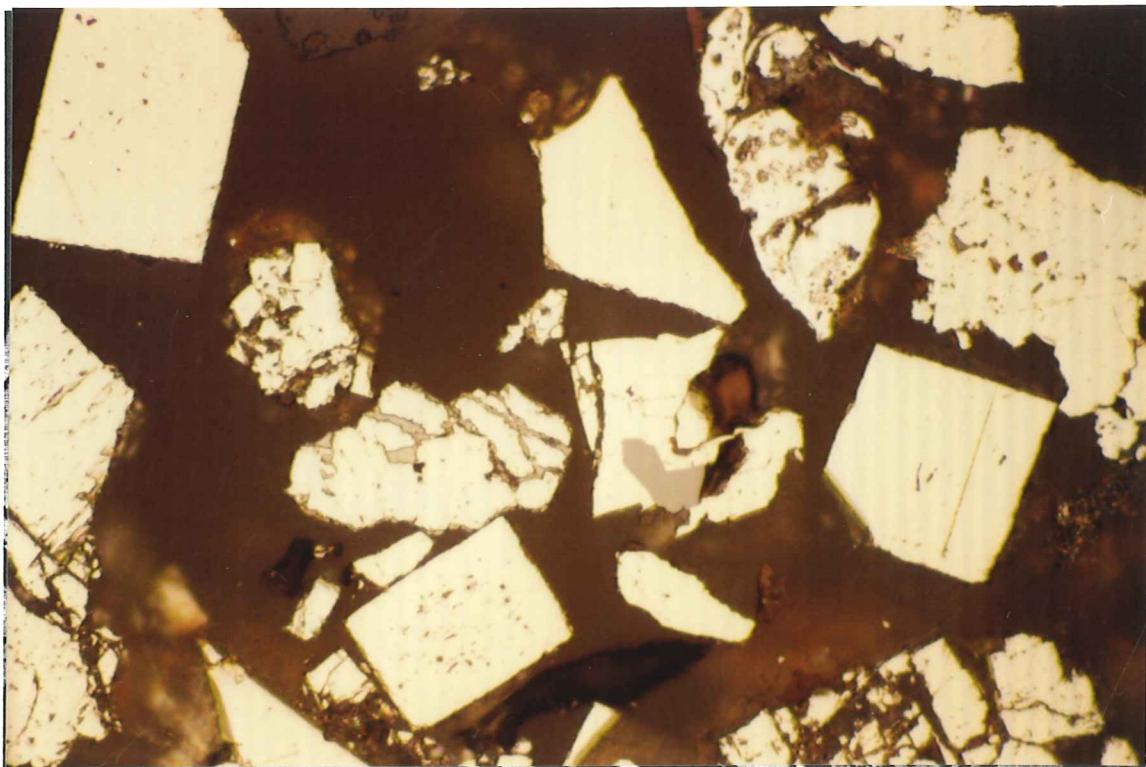


Zone 2 (Head). Polished section photomicrograph of chalcopyrite encapsulating or locking three small electrum particles (lower center) and associated with pyrite and trash iron (lower right). Plain light, X440.

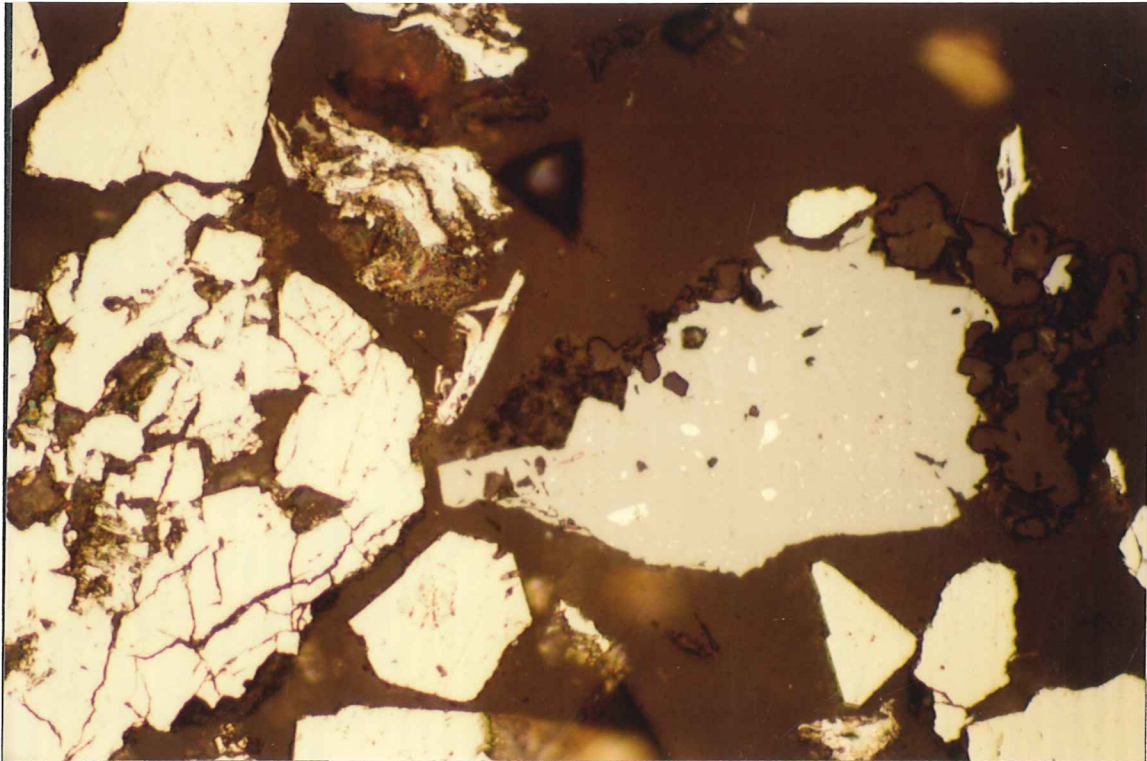


Zone 2 (Head). Polished section photomicrograph of native silver particle (center) with associated marcasite (left) and pyrite fragments. Plain light, X440.

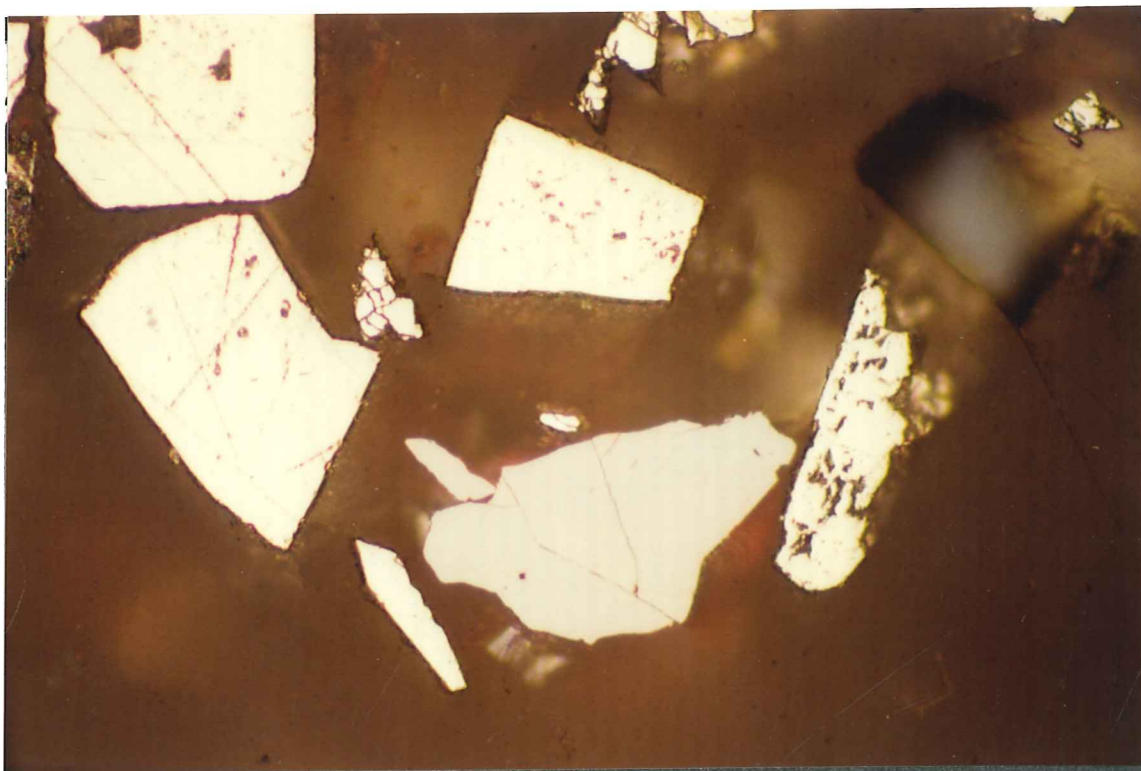




Zone 2 (Head). Polished section photomicrograph showing composites of acanthite with marcasite (left center) and sphalerite with pyrite (center) associated with separate fragments of pyrite and trash iron. Plain light, X440.

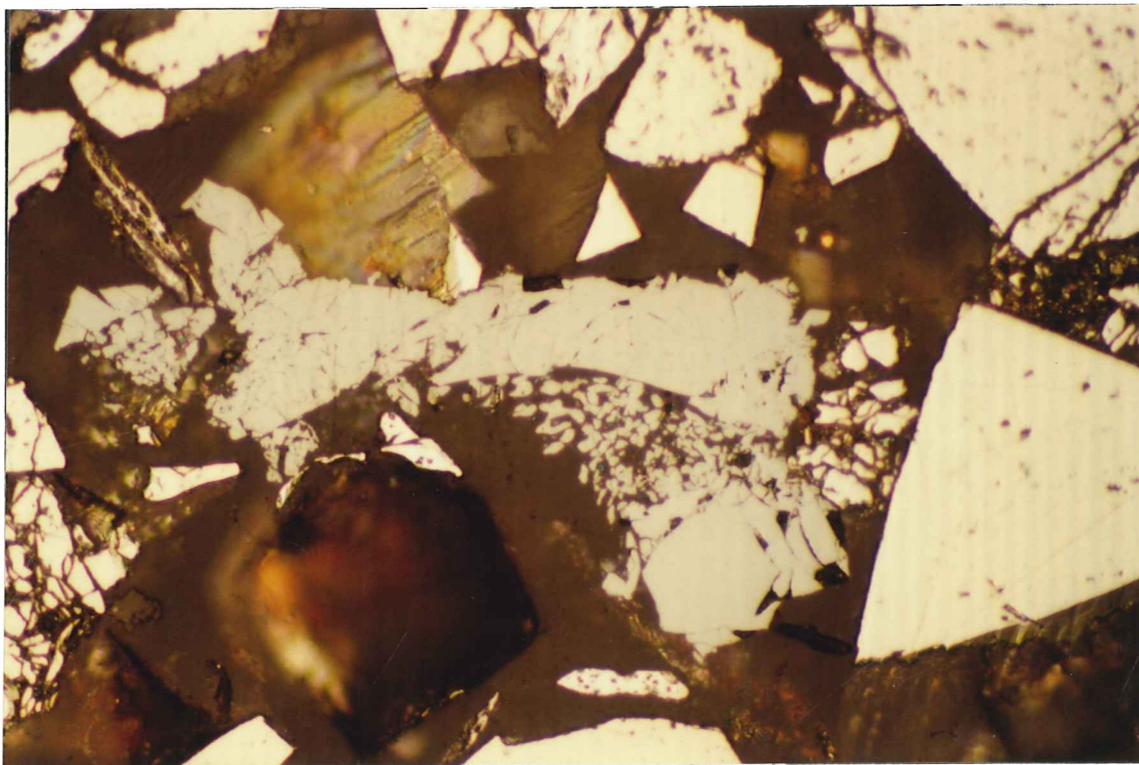


Zone 2 (Head). Polished section photomicrograph of polybasite enclosing native silver (right) and associated with pyrite, marcasite, and trash iron. Plain light, X440.

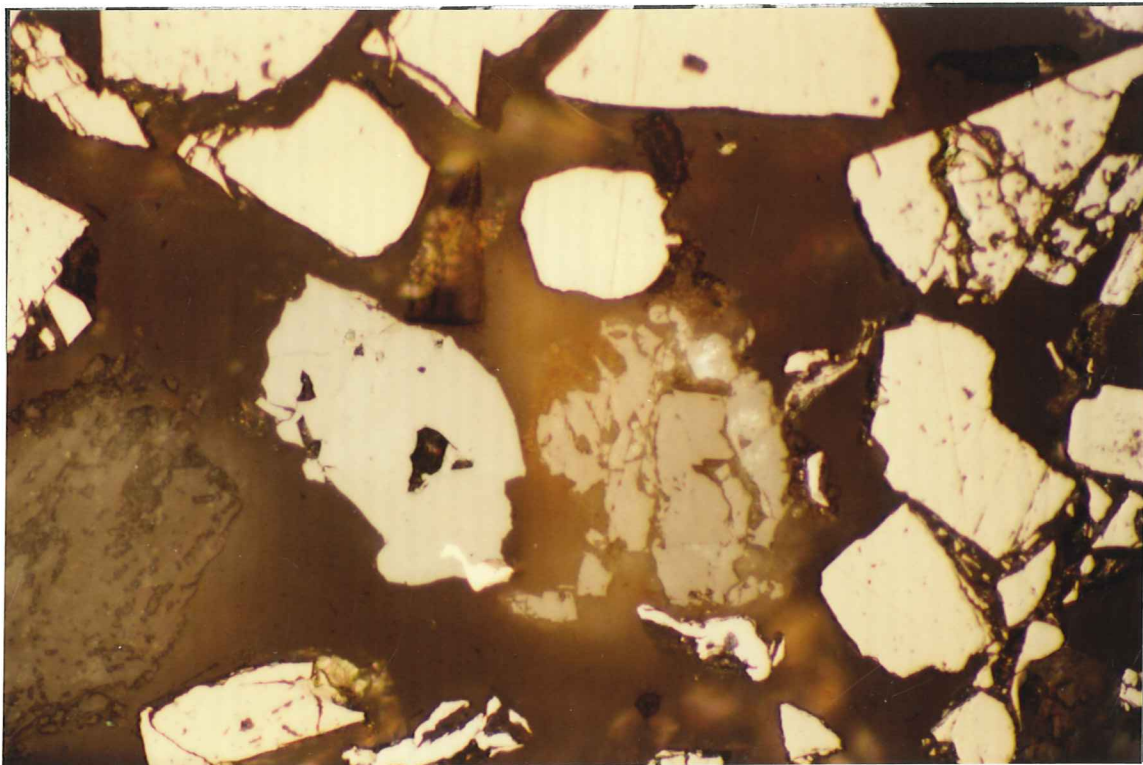


Zone 2 (Head). Polished section photomicrograph of pyrrargyrite fragment (upper center) with associated pyrite and marcasite. Plain light, X440.

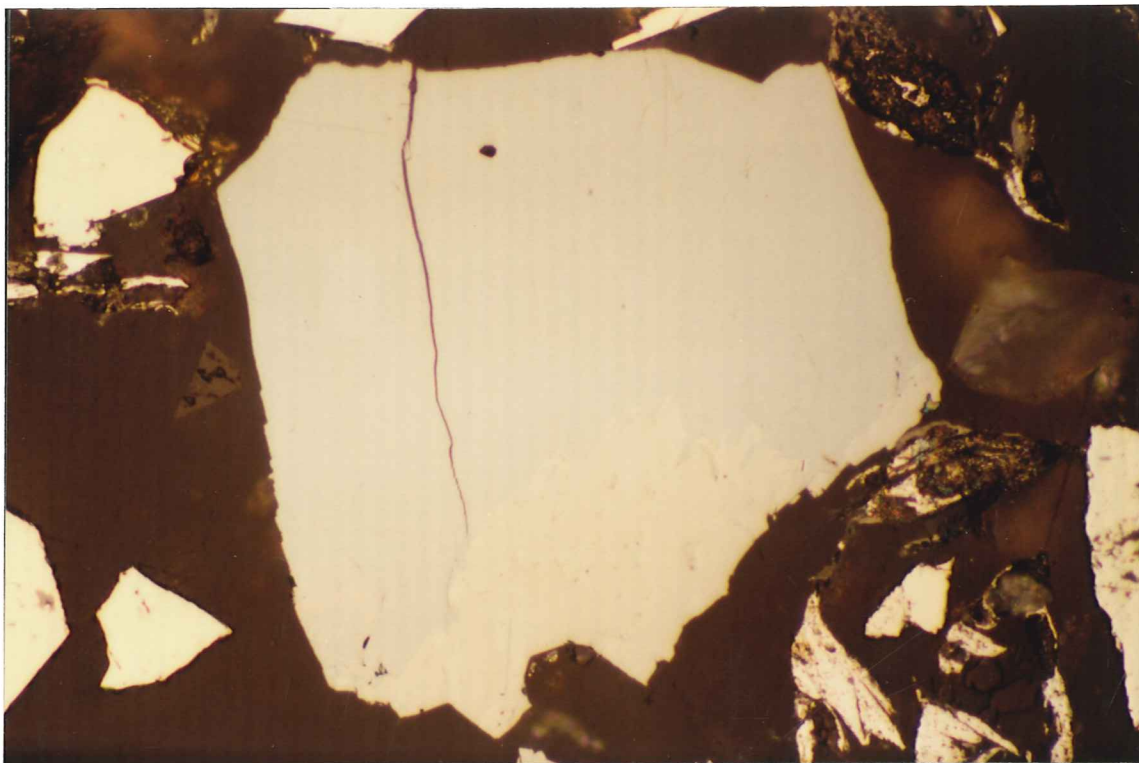




Zone 2 (Head). Polished section photomicrograph of miargyrite in relatively large composite with gangue and accompanied by pyrite and marcasite. Plain light, X440.

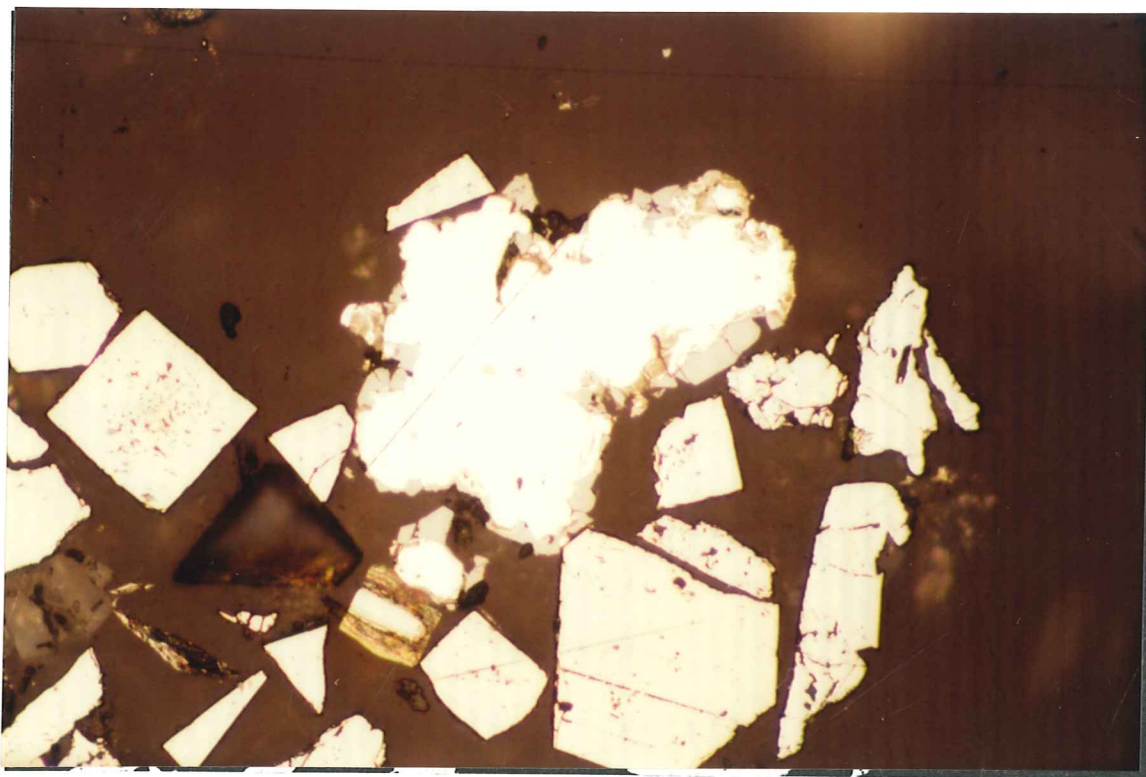


Zone 2 (Head). Polished section photomicrograph of pyrargyrite bordered by native silver (left center) and associated with sphalerite (right center), pyrite, and trash iron. Plain light, X440.

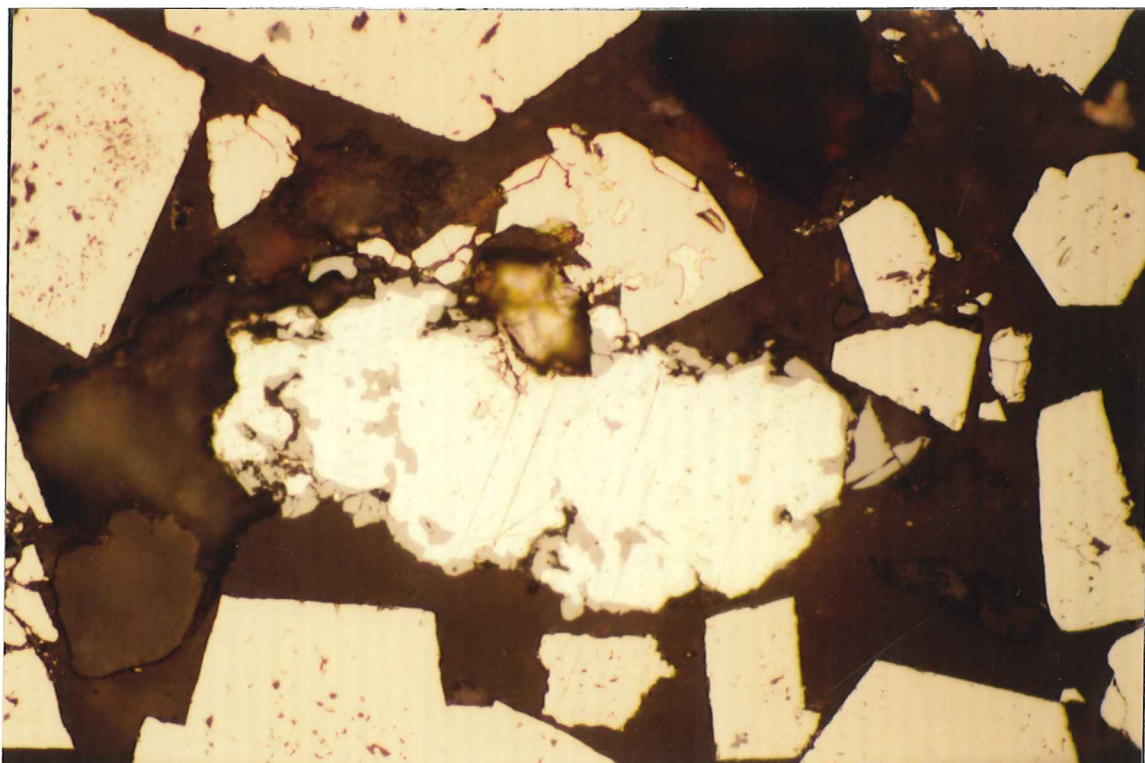


Zone 2 (Head). Polished section photomicrograph of miargyrite in relatively large fragment bordered at bottom by stephanite and polybasite. Also present are minor pyrite and trash iron. Plain light, X440.

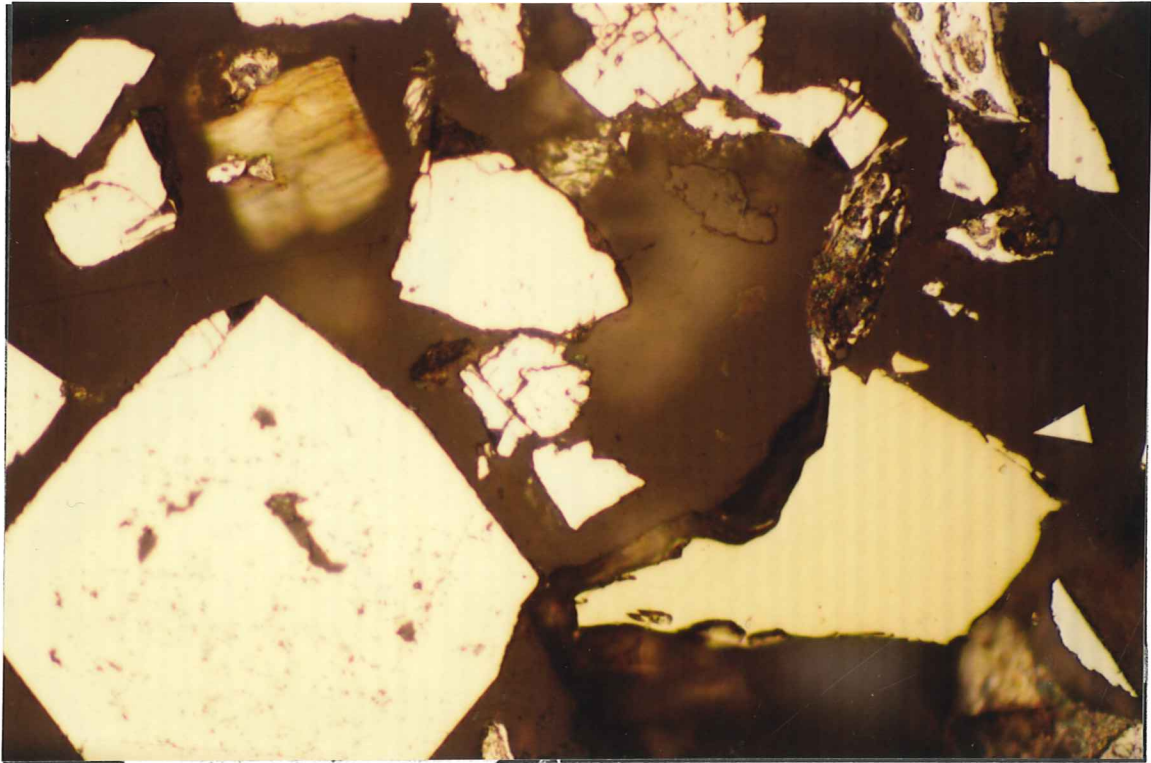




Zone 2 (Head). Polished section photomicrograph of native silver bordered in part by miargyrite and associated with pyrite and marcasite. Plain light, X440.

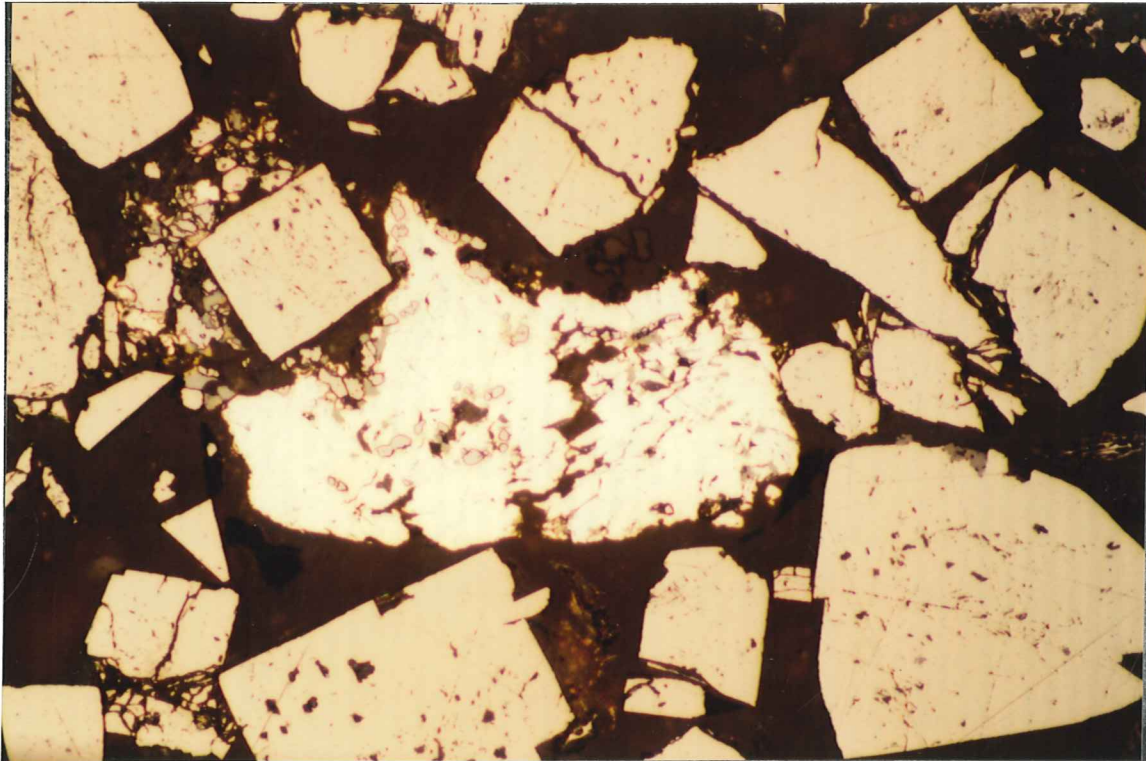


Zone 2 (Head). Polished section photomicrograph of native silver bordered by miargyrite and associated with pyrite that also encloses minor native silver (upper center). The latter may be a silver-rich electrum. Plain light, X440.

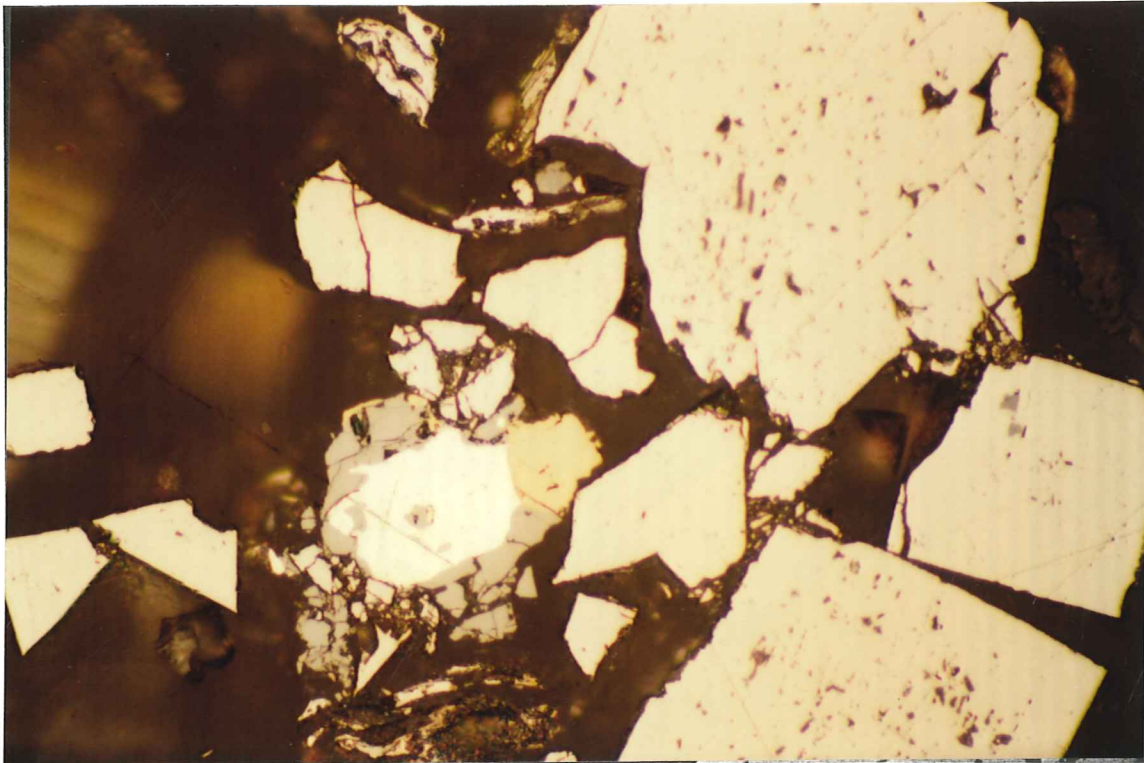


Zone 2 (Head). Polished section photomicrograph of chalcopyrite (lower right) accompanied by pyrite and trash iron. Plain light, X440.

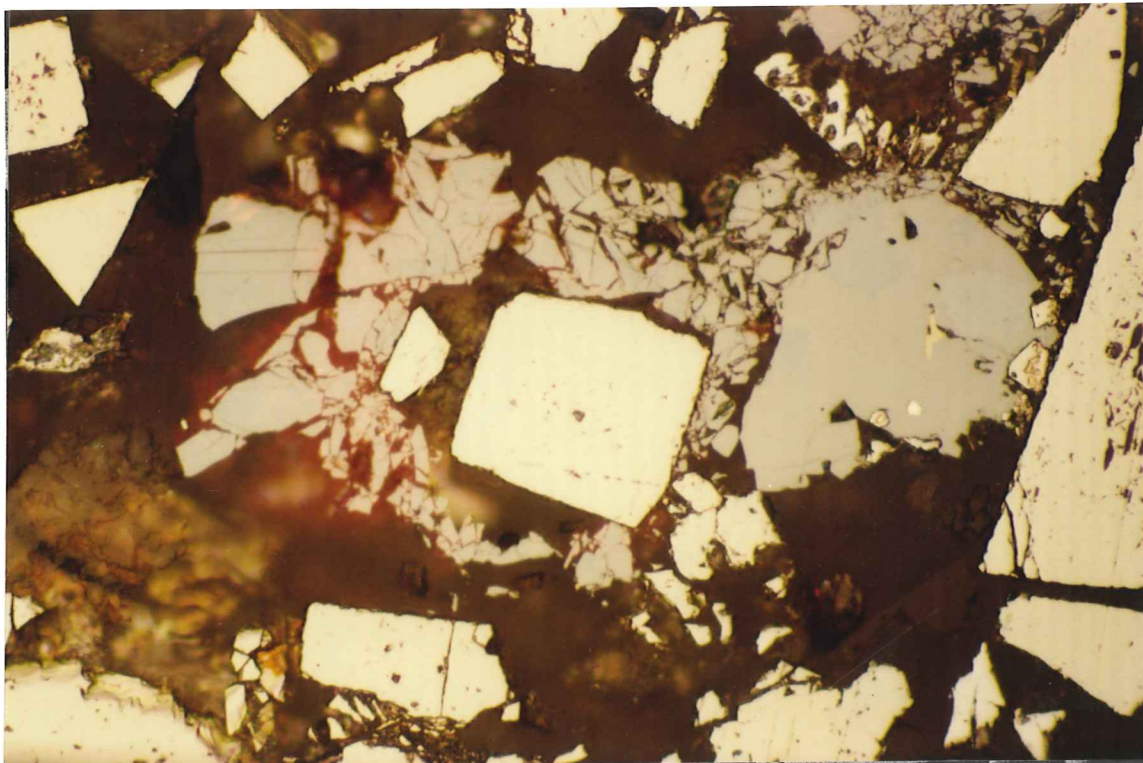




Zone 2 (Head). Polished section photomicrograph of native silver bordered by and enclosing minor polybasite and accompanied by fragments of pyrite and trash iron. Plain light, X220.

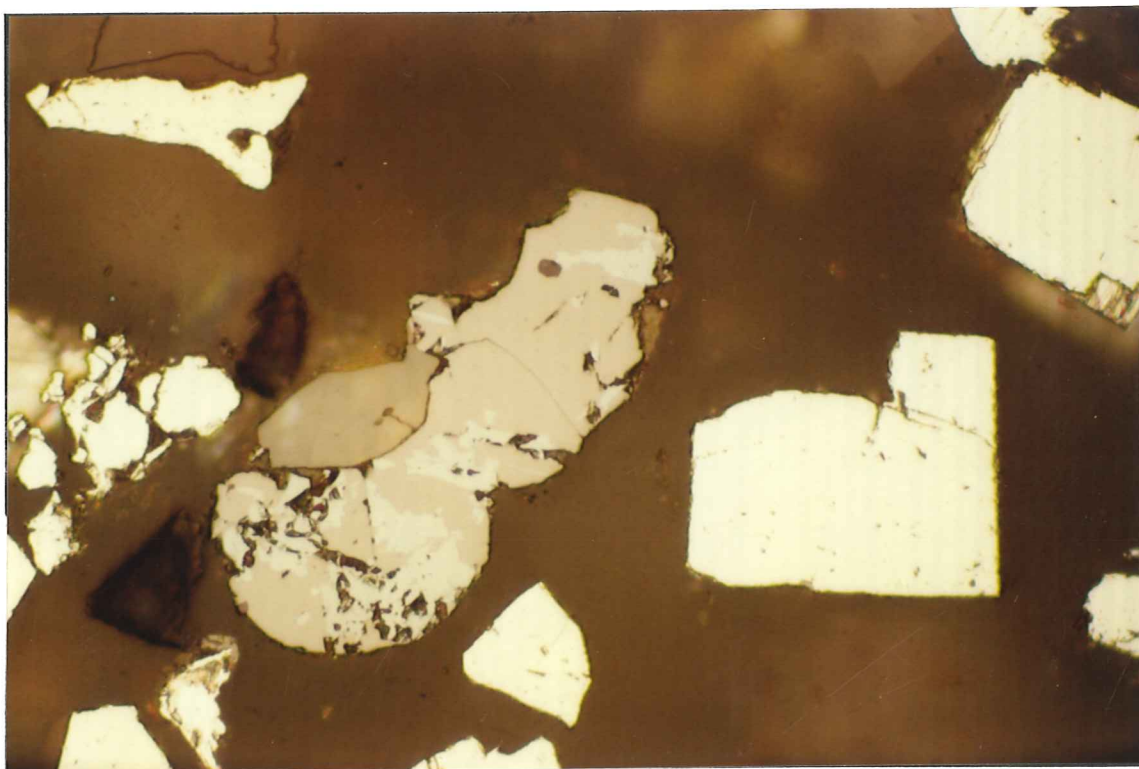


Zone 2 (Head). Polished section photomicrograph of native silver (lower center) bordered on right by chalcopyrite and on left by polybasite. Accompanied by pyrite. Plain light, X440.



Zone 2 (Head). Polished section photomicrograph of pyrrargyrite (left) and miargyrite (right) bordering and associated with pyrite. Plain light, X440.





Zone 2 (Head). Polished section photomicrograph of stephanite (pinkish) intergrown with pyrargyrite (blue) and associated with pyrite and trash iron. Plain light, X440.

Zone 2 (Gravity Rougher Concentrate). Liberated and composite native silver with minor liberated electrum plus a complex silver sulfosalt mineral suite in concentrate having dominant pyrite plus lesser amounts of marcasite, arsenopyrite, and sphalerite.

Native Silver - -1% - White metallic and with slight creamy tint, isotropic but does not show complete extinction because of polishing scratches, tarnishes rather quickly on exposure to air. Present as liberated fragments, as composites in which intergrown with silver sulfosalts, and as scarce and small inclusions in pyrite fragments. Liberation is better than in the head sample because of finer grind in this sample.

Electrum - -1% - Very pale yellowish color - indicating high silver content, isotropic but does not show complete extinction, low hardness and is well polished. Tarnishes - but not as quickly as for the native silver. Observed as single small liberated composite grain in which electrum is associated with acanthite.

Acanthite - -1% - Medium gray, weakly anisotropic but without distinctive polarization colors, very low hardness and with moderate perfection of polish. Observed in trace amount as composite grains with electrum and with pyrite. Develops light etching.

Pyrargyrite - -1% - Light grayish blue, anisotropic but with polarization colors masked by strong dark red internal reflections, low hardness and is well polished. Occurs alone as liberated fragments, as composites with associated native silver, miargyrite, and rarely with pyrite. Stronger internal reflections than for the other silver sulfosalts.

Miargyrite - -1% - Light grayish blue, anisotropic and with polarization colors of bluish gray to brown, rather poorly developed deep red internal reflections, low hardness and is well polished. Occurs as separate fragments and as composites in which bordered by pyrargyrite and native silver.

Polybasite - -1% - Light gray and with slightly greenish blue tint, moderately anisotropic and with polarization colors of greenish yellow

Zone 2 (Gravity Rougher Concentrate).

to blue to brownish, low hardness and is well polished. Present in minor amount as separate fragments and as composites with associated miargyrite. Very poorly developed deep red internal reflections.

Stephanite - -1% - Light gray with distinct pinkish violet tint, strongly anisotropic and with polarization colors of grayish green to violet, moderate hardness and is well polished. Occurs as scarce composite grains with pyrargyrite and with miargyrite.

Pyrite - 31% - Pale yellow, either isotropic or with weak anomalous anisotropism and very faint blue to brown polarization colors, hard and is well polished. Present mostly as cubic crystals and fragments - and in lesser amount as anhedral grains with marcasite and as scarce very fine grained aggregate-textured fragments. Contains minor amounts of encapsulated native silver and silver sulfosalt minerals.

Marcasite - 3% - Very pale yellow to almost white, weakly bireflectant, strongly anisotropic and with polarization colors of blue to green to violet, hard and is well polished. Occurs as anhedral aggregate-textured fragments - at times bordering and replacing pyrite.

Arsenopyrite - -1% - White and with very slight yellowish tint, strongly anisotropic and with polarization colors of blue to orange brown, hard and is well polished, often twinned. Present as anhedral to subhedral prismatic fragments.

Sphalerite - -1% - Medium gray, isotropic and with strong pale yellowish to brown internal reflections, moderate hardness and is well polished. Occurs as separate fragments and in trace amount as composites with or enclosed by the dominant pyrite.

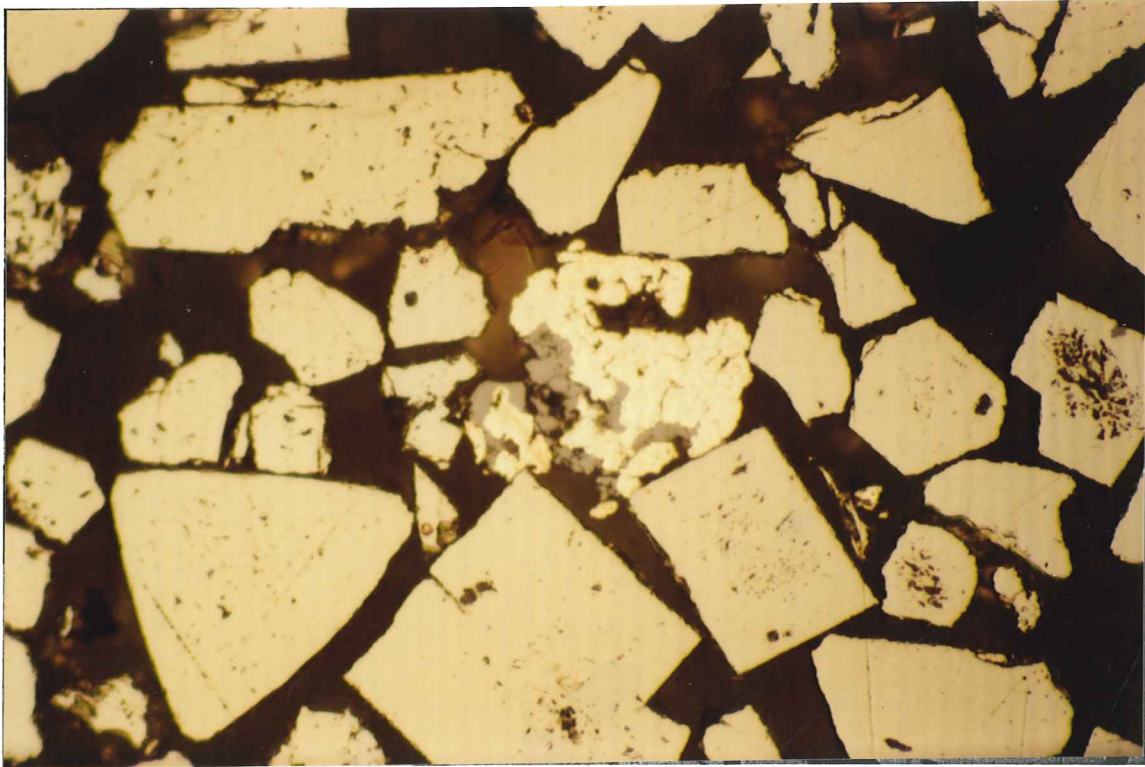
Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished, tarnishes quickly. Added as a contaminant during sample preparation.



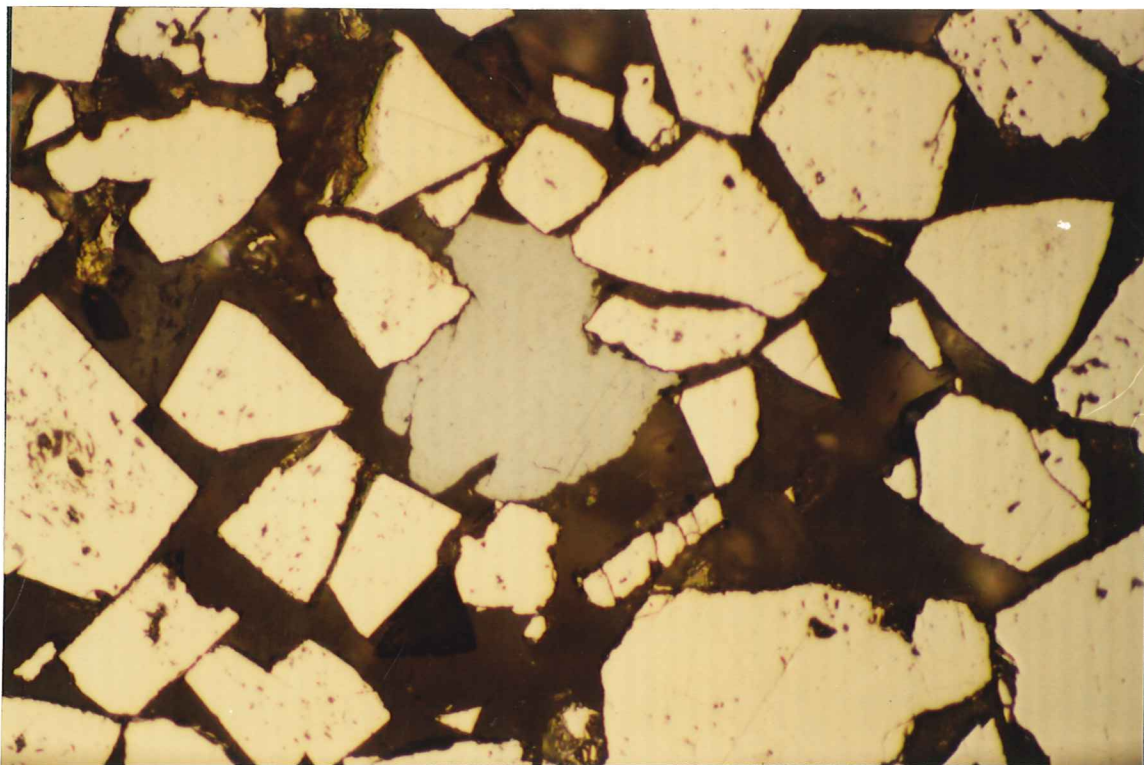
Zone 2 (Gravity Rougher Concentrate).

Non-metallic gangue - 65% - Comprised mostly of host silicates.

\*Note: Two polished sections were prepared and examined - one of the sample "as received" and one of a panned concentrate prepared therefrom.

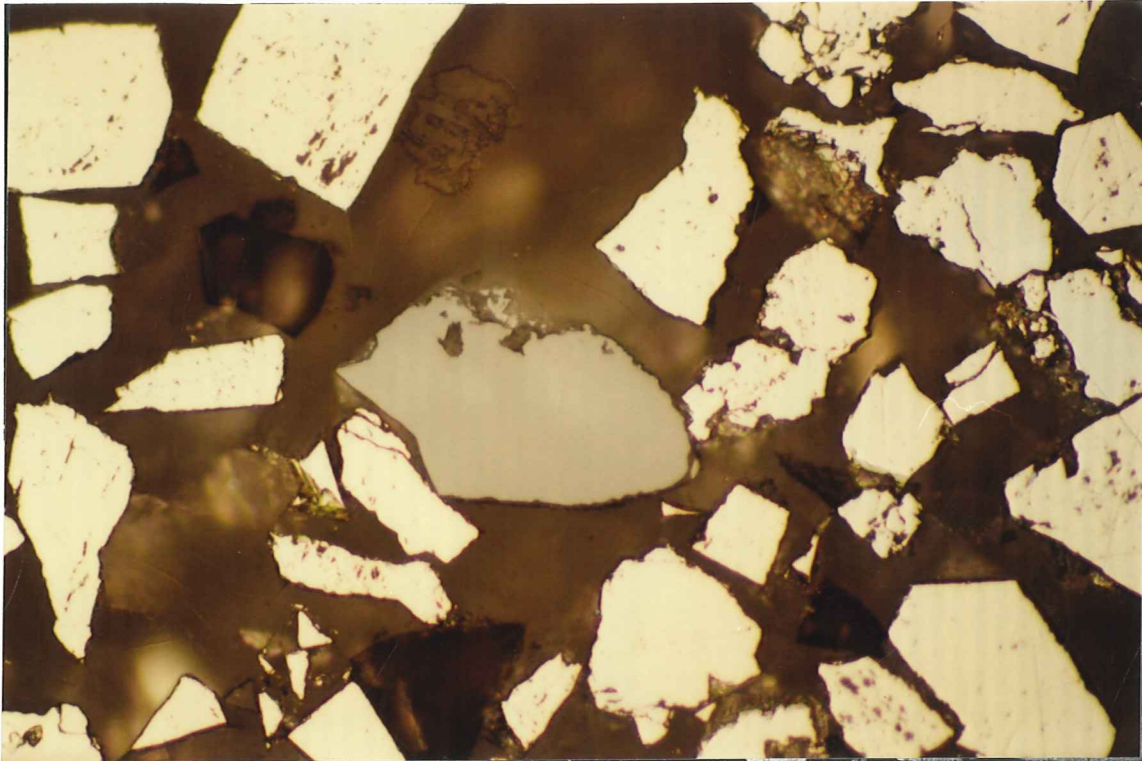


Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of native silver bordered in part by polybasite (right center) and associated with pyrite fragments. Plain light, X440.

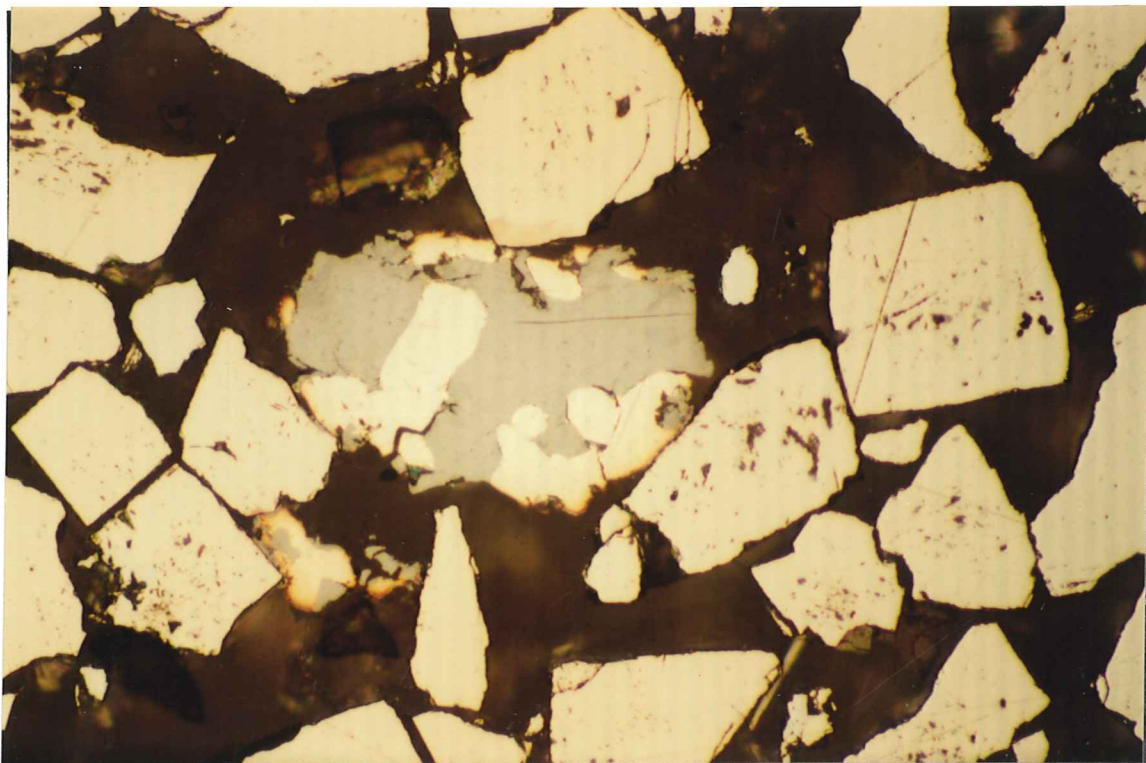


Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of miargyrite (center) associated with pyrite. Plain light, X440.

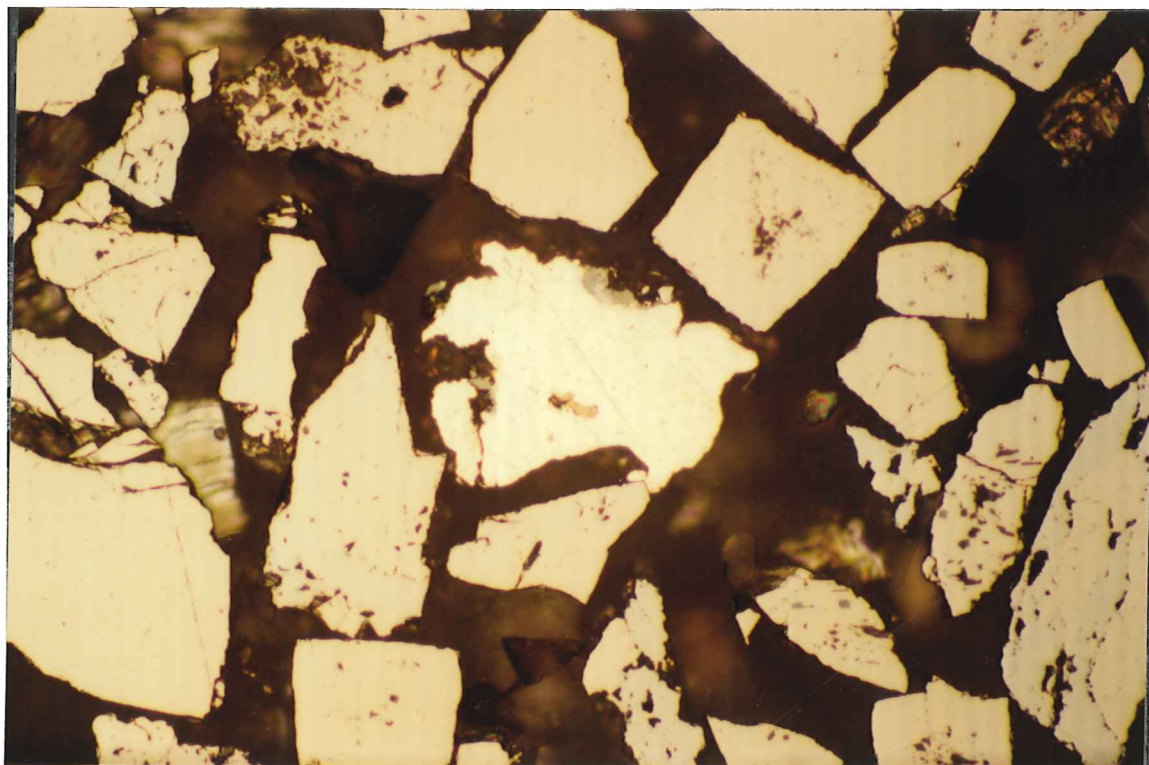




Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of sphalerite (center) with marcasite and pyrite fragments. Plain light, X440.

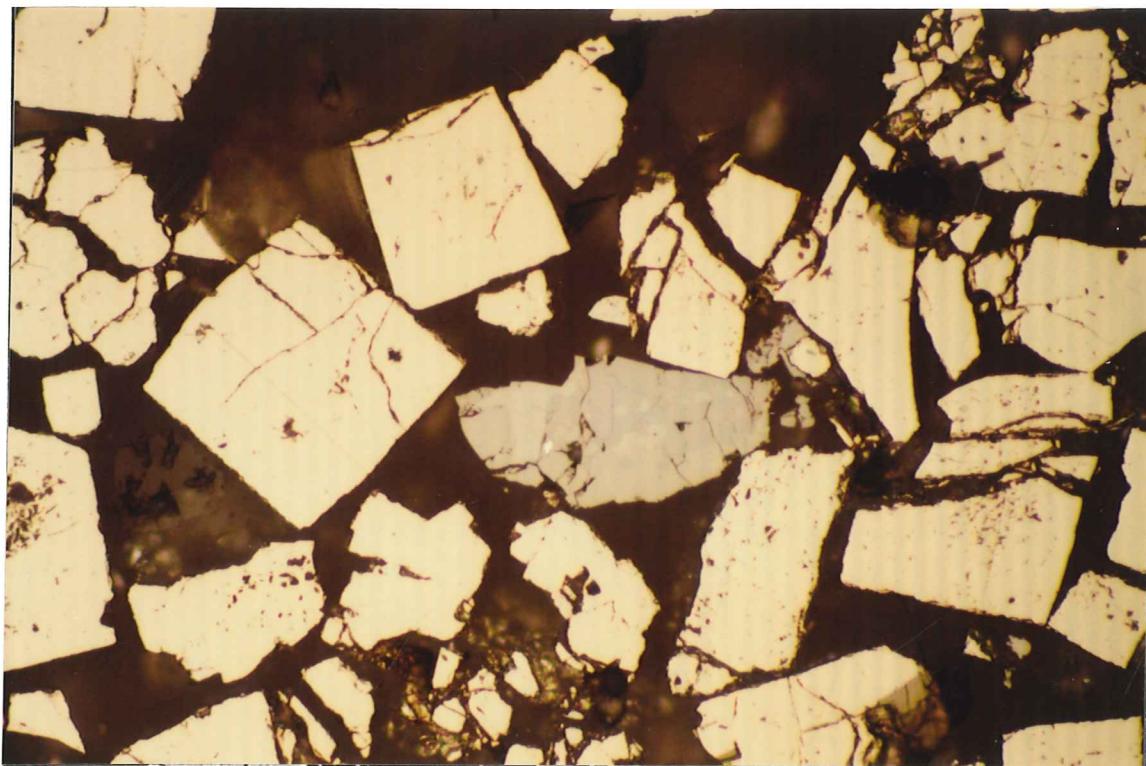


Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of native silver (slightly tarnished) intergrown with miargyrite (center) and associated with pyrite. Plain light, X440.

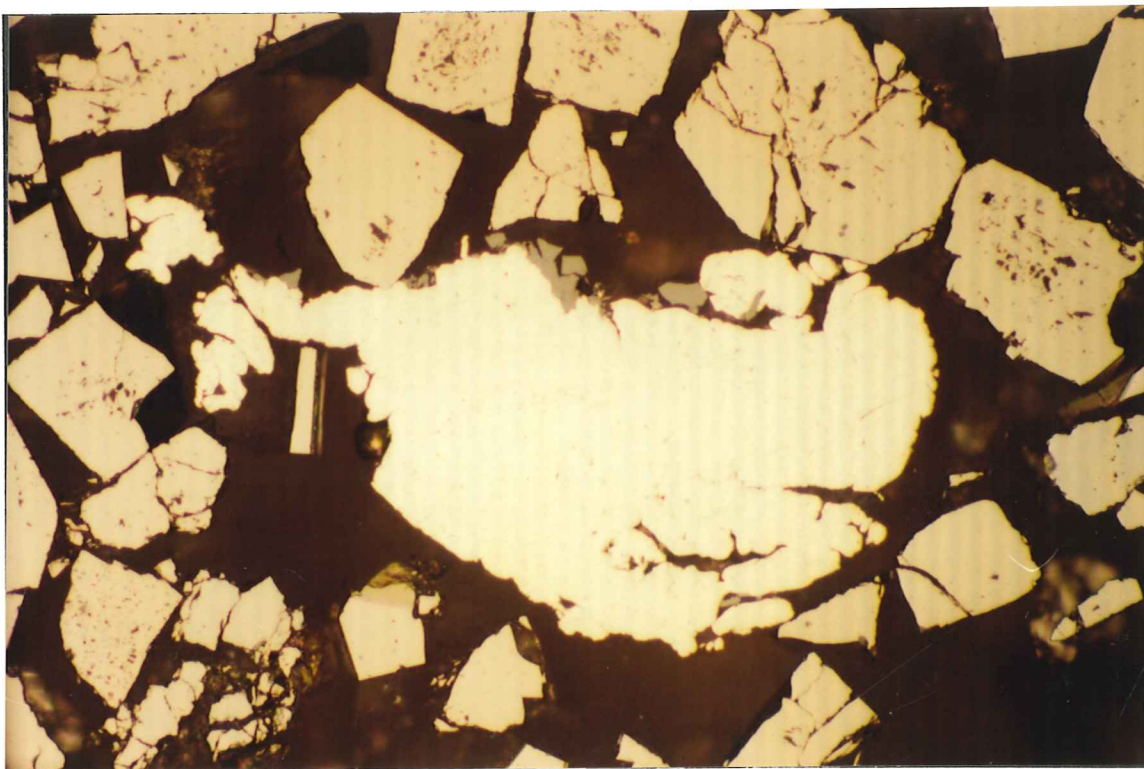


Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of native silver bordered at top by minor polybasite and accompanied by pyrite and marcasite. Plain light, X440.

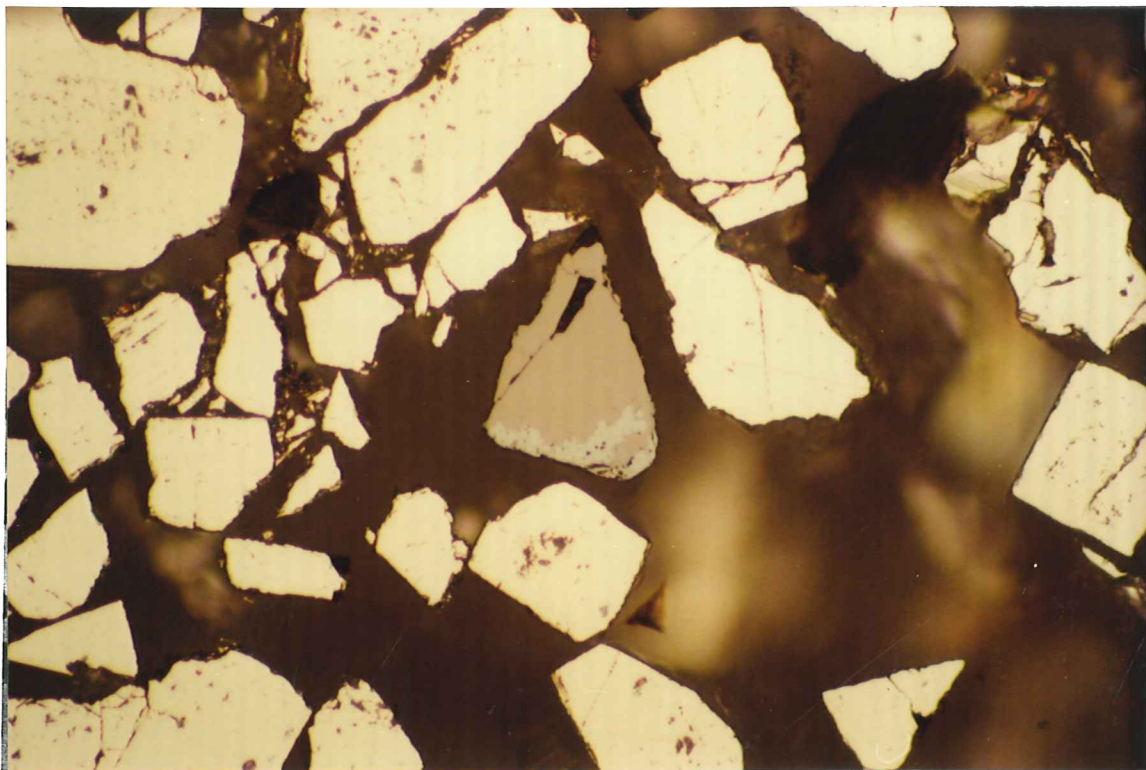




Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of pyrrhargyrite (center) bordered by minor native silver and associated with pyrite. Plain light, X440.

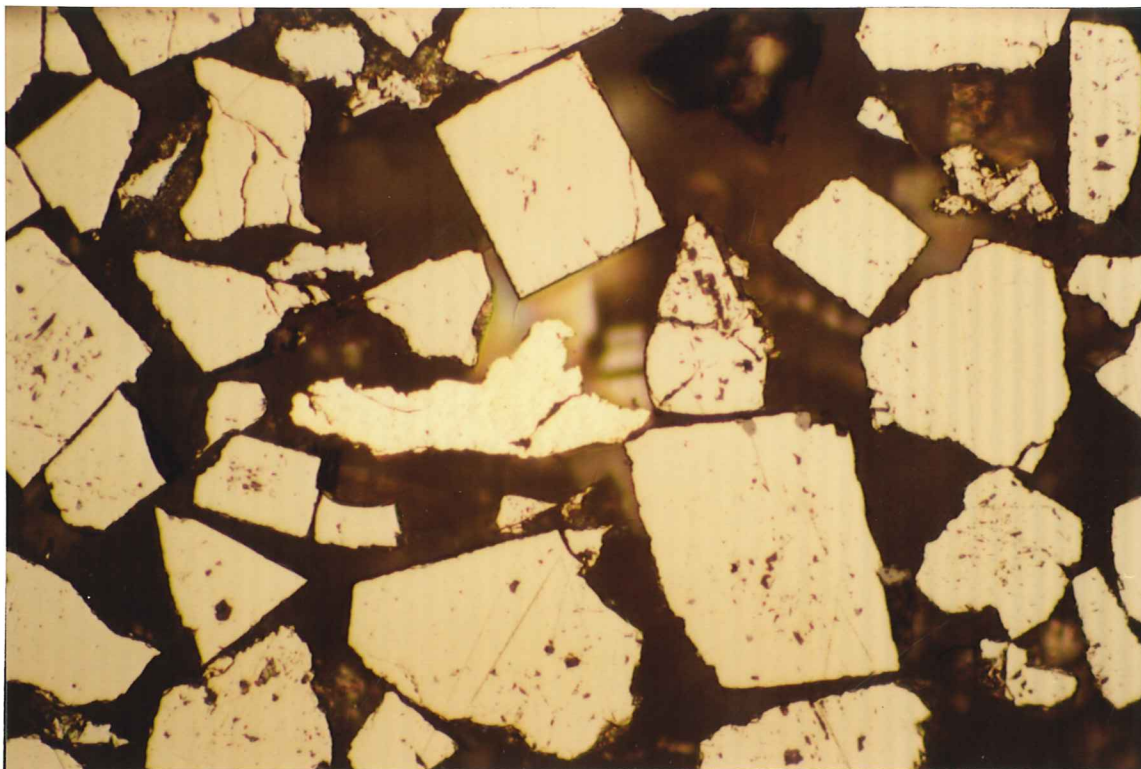


Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of large native silver particle bordered by minor polybasite and accompanied by pyrite. Plain light, X440.

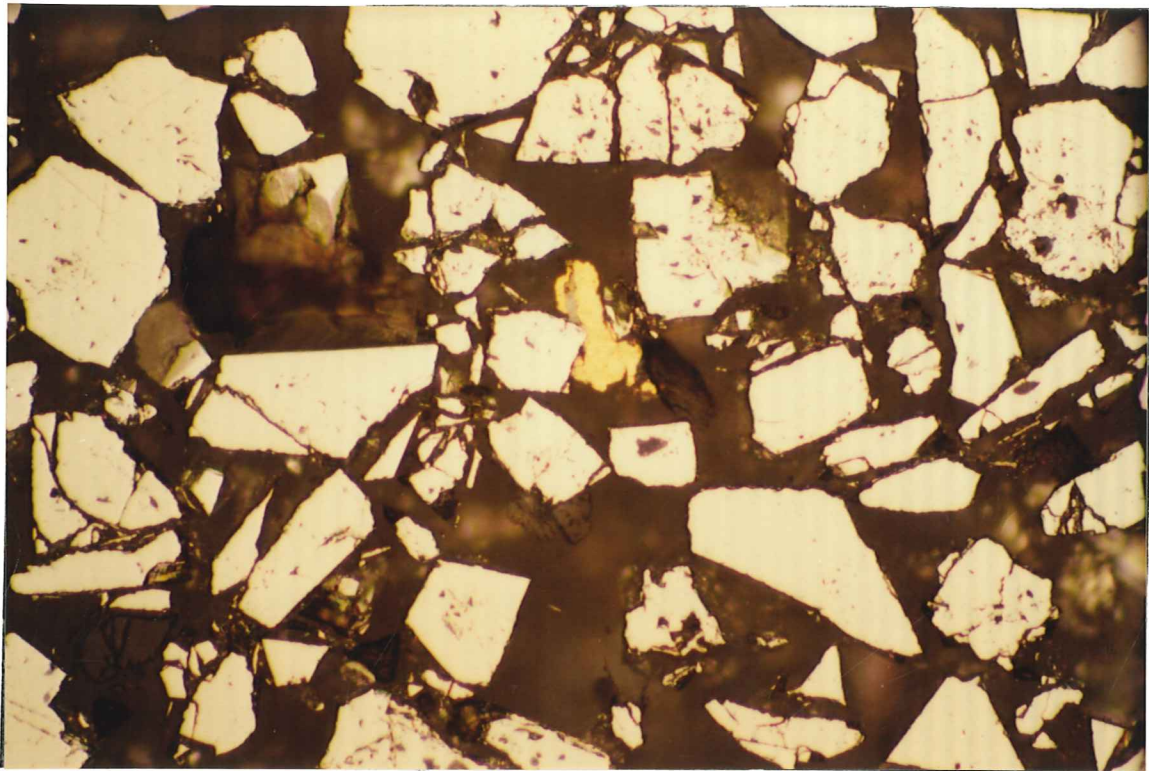


Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of stephanite (pinkish) with minor pyrargyrite (bluish) and associated with pyrite. Plain light, X440.

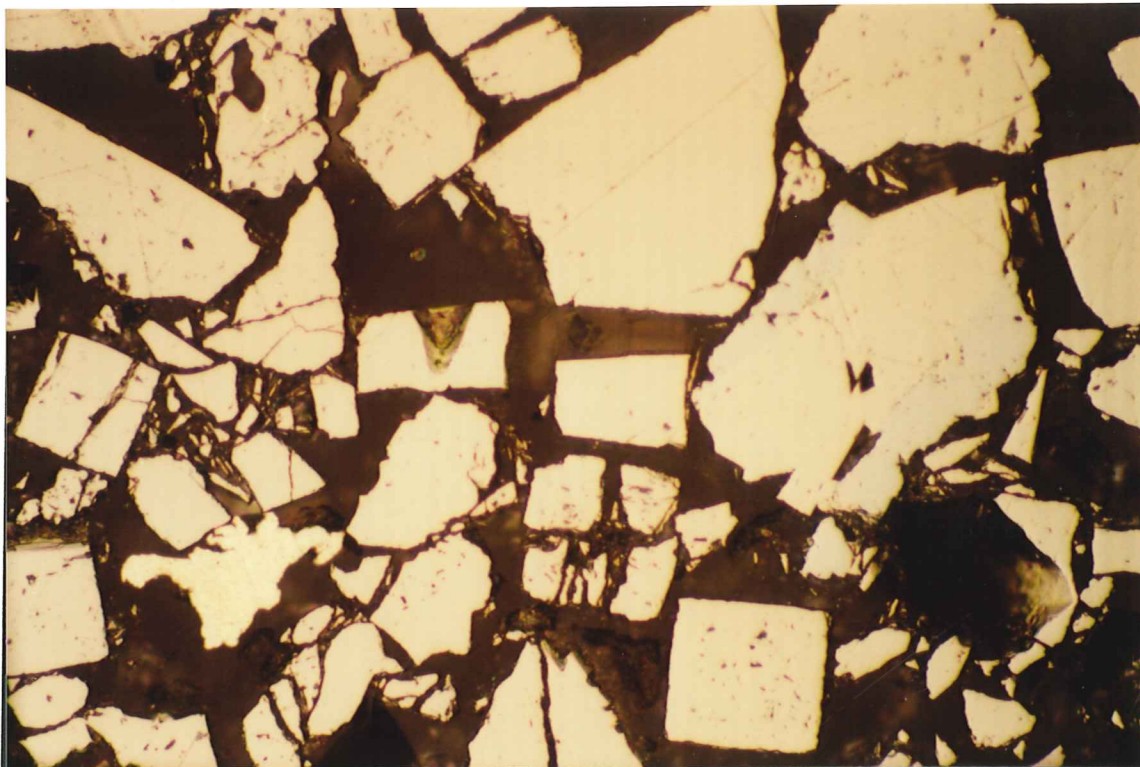




Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of native silver (left center) with associated pyrite and marcasite. Plain light, X440.



Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of electrum with minor associated acanthite (center) associated with pyrite and marcasite. Plain light, X440.



Zone 2 (Gravity Rougher Concentrate). Polished section photomicrograph of arsenopyrite (right center) with native silver (lower left) and pyrite. Plain light, X440.



Zone 2 (Head, Leach Residue). Liberated, locked, and composite pyrrargyrite and miargyrite with locked native silver and acanthite, and a sulfide suite of dominant pyrite plus marcasite and lesser amounts of arsenopyrite, sphalerite, and chalcopyrite

Native Silver - -1% - White metallic and with slight creamy tint, isotropic but does not show complete extinction, low hardness and is well polished, tarnishes quickly. Trace amount is present as small locked grains with acanthite in pyrite host fragment.

Acanthite - -1% - Medium gray and with slight greenish tint, weakly anisotropic but without distinctive polarization colors, very low hardness and is moderately well polished, shows light etching. Observed alone and with associated native silver as locked or encapsulated grains in pyrite host fragment.

Pyrrargyrite - -1% - Light grayish blue, anisotropic but with polarization colors masked by strong dark red internal reflections, low hardness and is well polished. Present in polished surface as liberated fragments, as scarce composites in which bordered by miargyrite and as small and irregularly shaped inclusions in pyrite host grains.

Miargyrite - -1% - Light bluish gray, anisotropic and with polarization colors of bluish gray to brown, low hardness and is well polished. Occurs as scarce liberated fragments and as composites in which bordered by pyrrargyrite. Has lighter color and shows fewer red internal reflections than for pyrrargyrite.

Pyrite - 5% - Pale yellow, either isotropic or with weak anomalous anisotropism and faint blue to brown polarization colors, hard and is well polished. Present most often as cubic crystals and fragments - at times with silicate inclusions. Also as anhedral grains and as very fine grained aggregate-textured fragments. Contains scarce inclusions of sphalerite and pyrrargyrite.

Marcasite - 1% - Very pale yellow to almost white, weakly bireflectant, strongly anisotropic and with polarization colors of blue to green to violet, hard and is well polished.

Zone 2 (Head, Leach Residue).

Occurs as subhedral prismatic aggregates and as anhedral fragments. At times borders earlier pyrite.

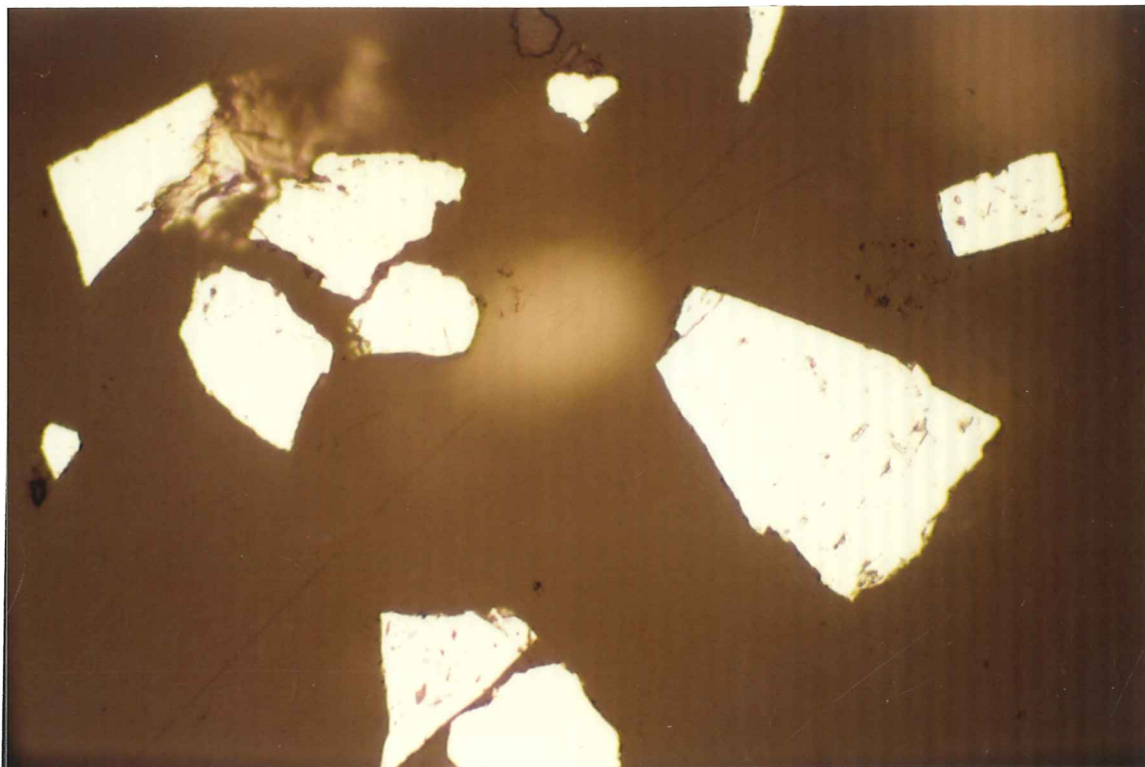
Arsenopyrite - -1% - White and with faint creamy tint in some orientations, weakly bireflectant, strongly anisotropic and with polarization colors of blue to orange brown, hard and is well polished. Occurs as fragments of subhedral prismatic crystals - and was not seen in contact with other opaques.

Sphalerite - -1% - Medium gray, isotropic and with strong white to pale yellowish internal reflections, moderate hardness and is well polished. Observed in polished surface as liberated fragments, as scarce and small anhedral inclusions in pyrite, and as a single composite grain in which enclosing chalcopyrite.

Chalcopyrite - -1% - Bright yellow, weakly anisotropic and with faint blue to green polarization colors, moderate hardness and is well polished. Occurs as separate fragments and in minor amount as irregularly shaped inclusions in sphalerite.

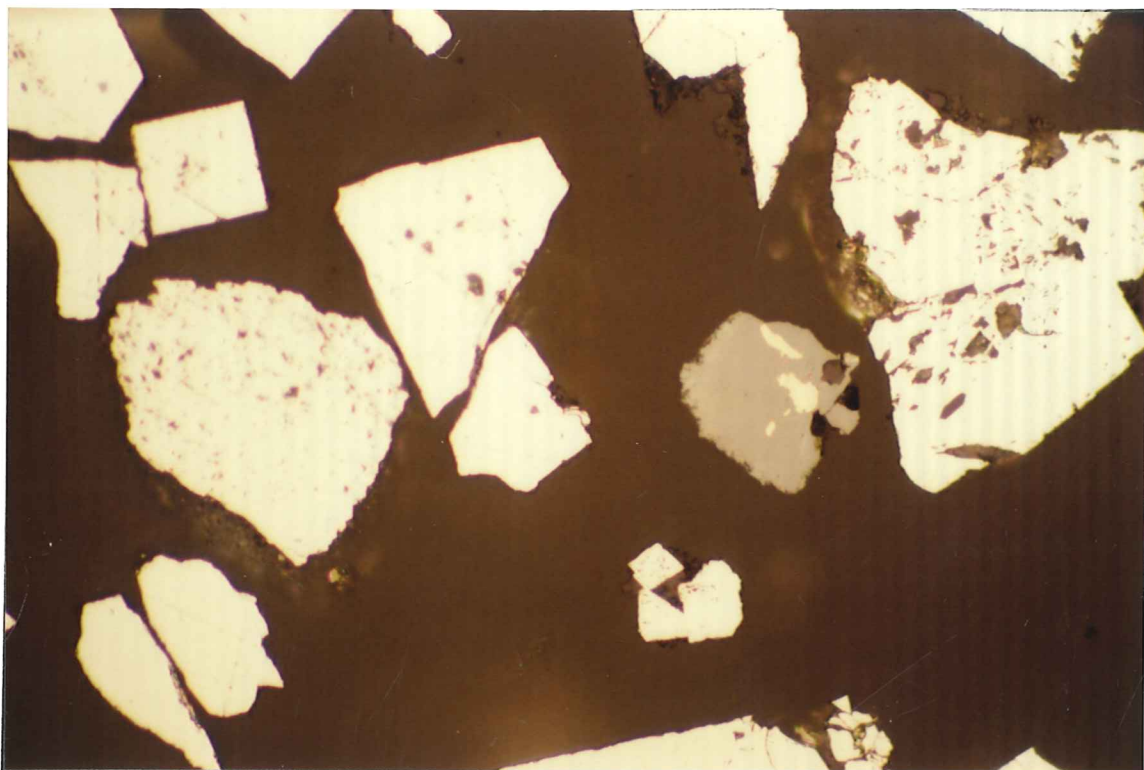
Non-metallic gangue - 94% - Comprised largely of host silicates.

\*Note: Two polished sections were prepared and examined - one of the sample "as received" and one of a panned concentrate prepared therefrom.

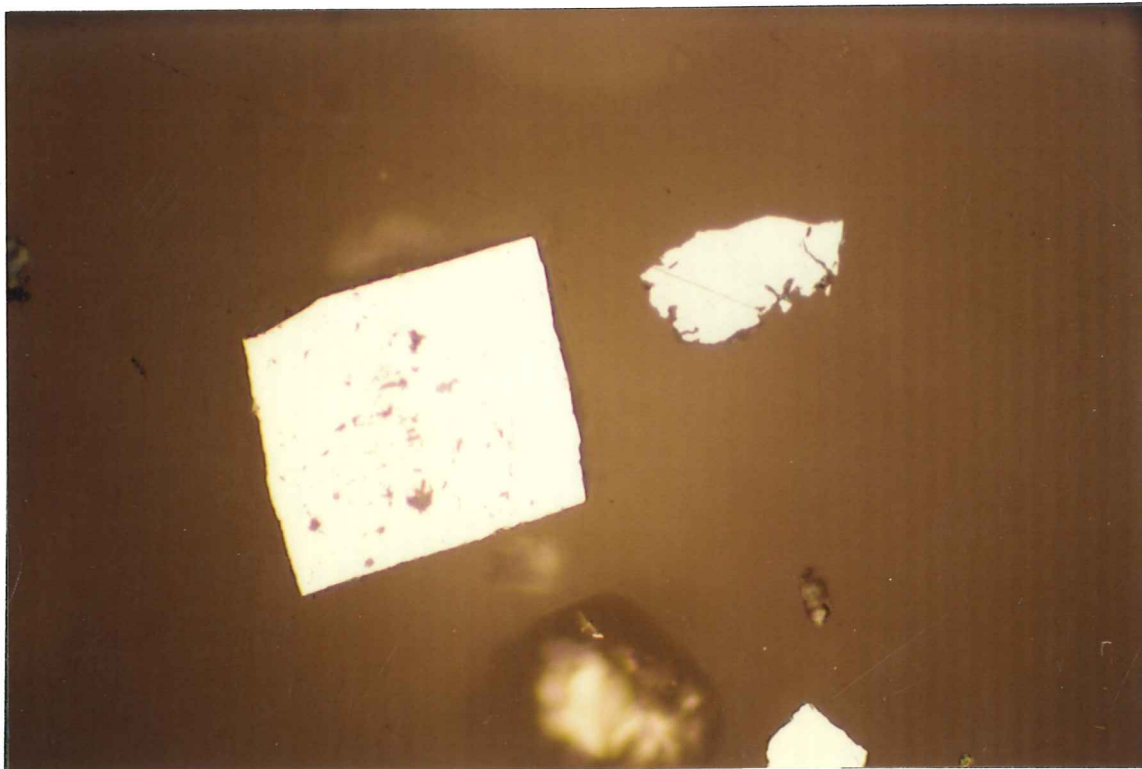


Zone 2 (Head, Leach Residue). Polished section photomicrograph of arsenopyrite fragment (right) with smaller pyrite grains. Plain light, X440.

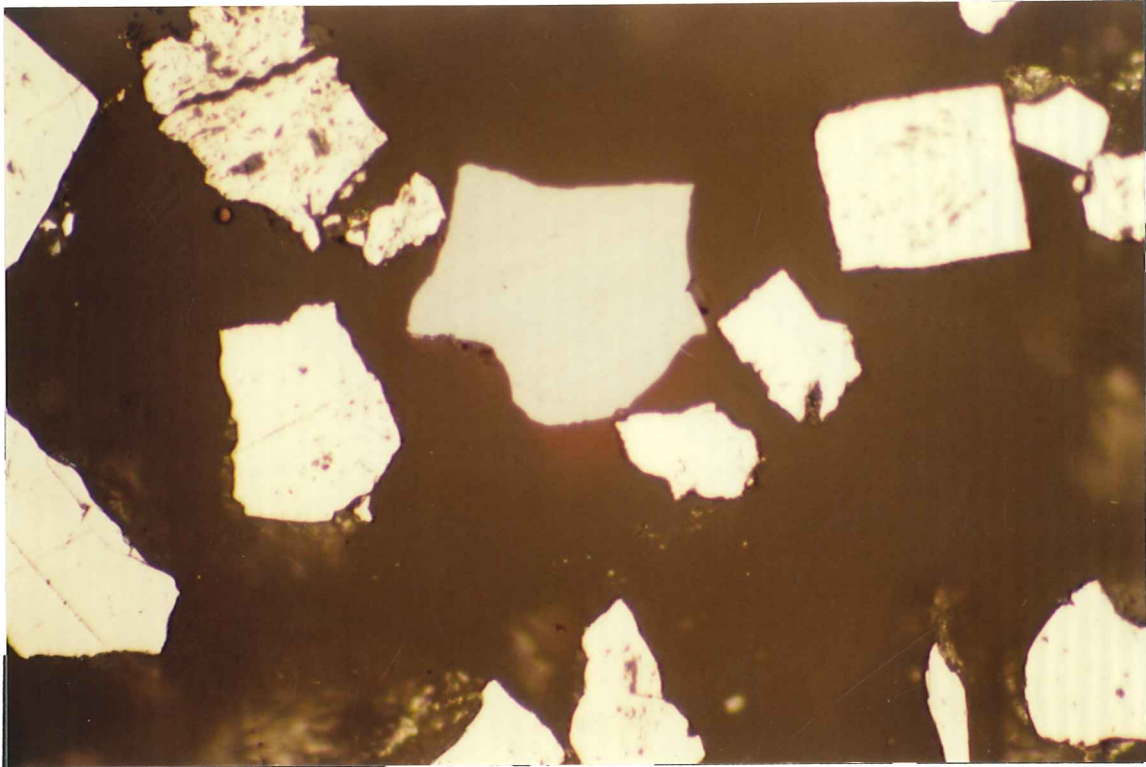




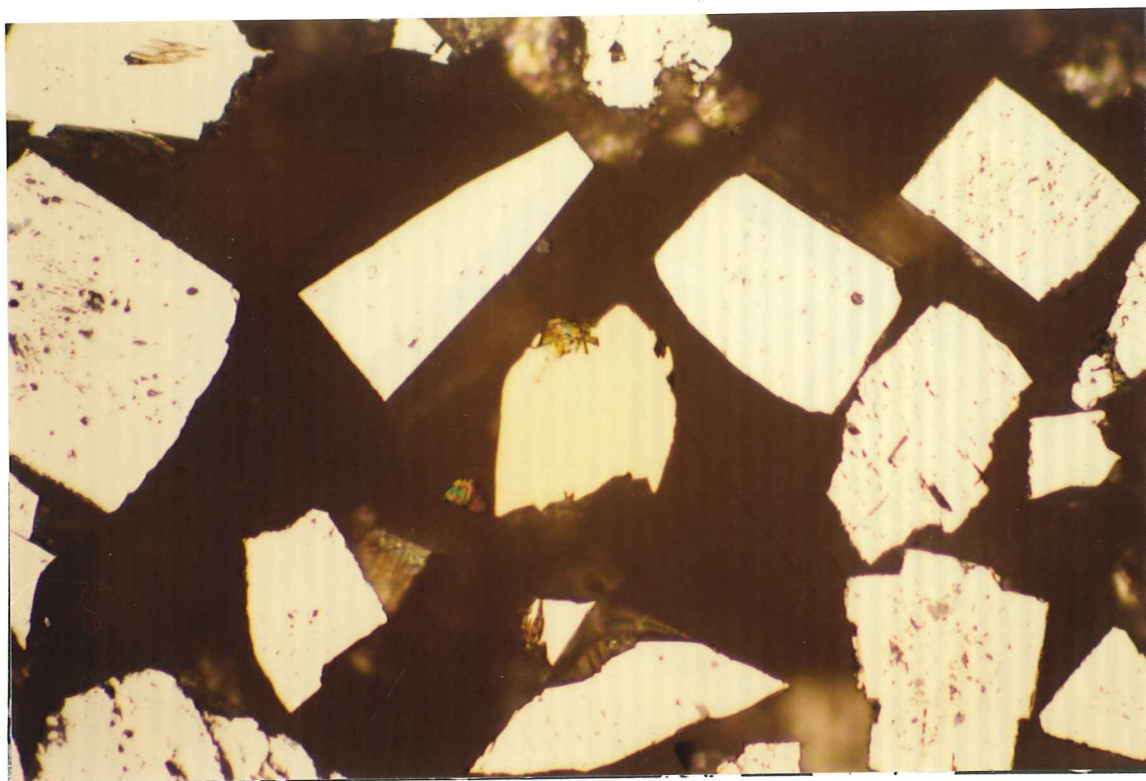
Zone 2 (Head, Leach Residue). Polished section photomicrograph of chalcopyrite enclosed by sphalerite (right center) and accompanied by pyrite and marcasite. Plain light, X440.



Zone 2 (Head, Leach Residue). Polished section photomicrograph of miargyrite (right center) with pyrite cube. Plain light, X440.

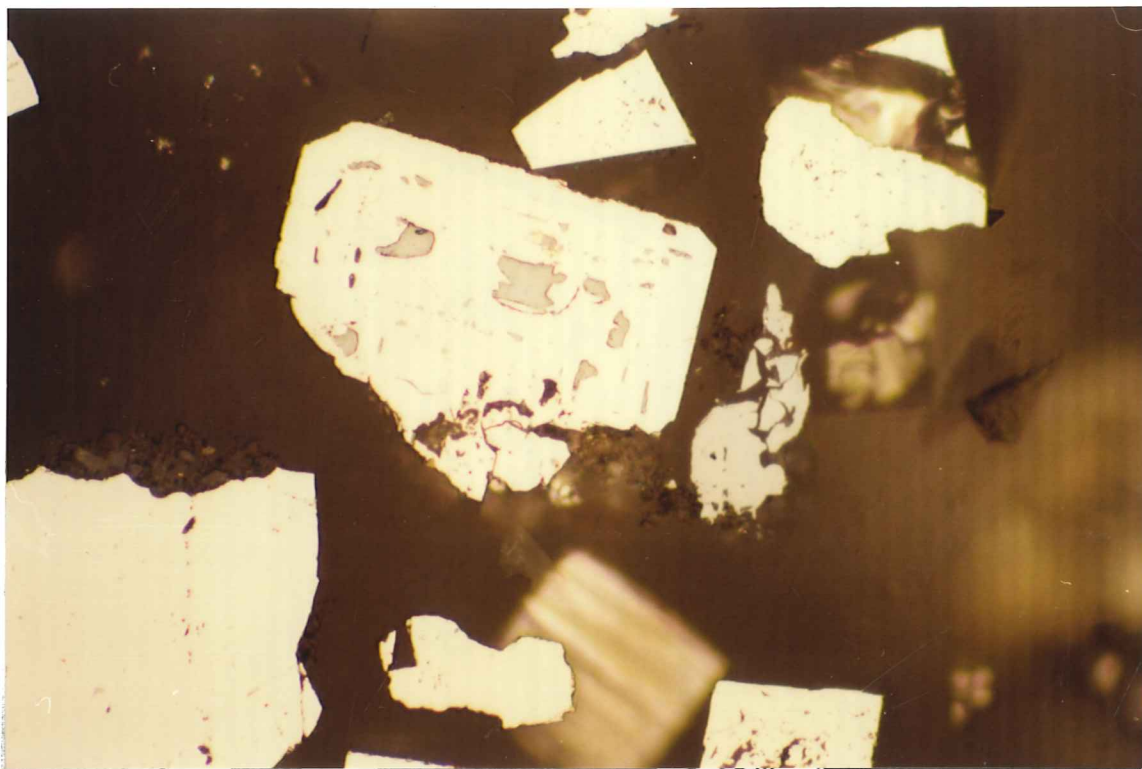


Zone 2 (Head, Leach Residue). Polished section photomicrograph of pyrrhargyrite (upper center) accompanied by pyrite. Plain light, X440.

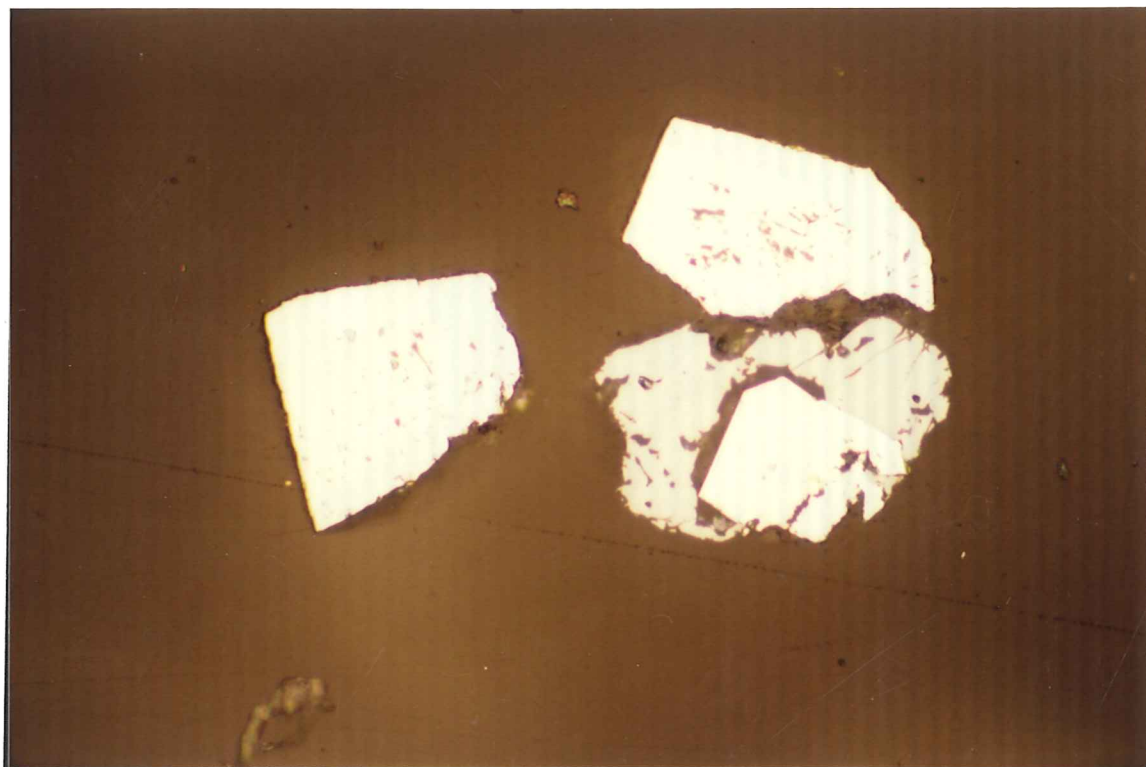


Zone 2 (Head, Leach Residue). Polished section photomicrograph of liberated chalcopyrite (center) with associated pyrite. Plain light, X440.





Zone 2 (Head, Leach Residue). Polished section photomicrograph of acanthite with minor native silver enclosed by pyrite (left) and with associated miargyrite (right) and pyrite fragments. Plain light, X440.



Zone 2 (Head, Leach Residue). Polished section photomicrograph of miargyrite partially surrounding pyrite (lower center) and accompanied by separate pyrite fragments. Plain light, X440.

Zone 2 (Gravity Rougher Concentrate, Leach, Residue). Locked native silver with liberated silver sulfosalt suite of pyrargyrite-miargyrite-polybasite and with sulfide suite that includes dominant pyrite plus lesser amounts of marcasite-arsenopyrite-sphalerite-chalcopyrite-galena.

Native silver - -1% - White metallic and with creamy tint, isotropic but does not show complete extinction, low hardness and is well polished, tarnishes quickly. Observed as single small locked or encapsulated particle in polybasite host fragment.

Pyrargyrite - -1% - Light grayish blue, anisotropic but with polarization colors masked by strong dark red internal reflections, low hardness and is well polished. Present as scarce separate fragments and as composites in which associated with miargyrite.

Miargyrite - -1% - Light bluish gray, moderately anisotropic and with polarization colors of bluish gray to brown, poorly developed red internal reflections, low hardness and is well polished. Scarce separate fragments and as composites in which bordered by pyrargyrite.

Polybasite - -1% - Light gray with slight bluish green tint, moderate anisotropism and with polarization colors of greenish to blue to brown, low hardness and is well polished. Present as separate fragments - one of which contains a small native silver inclusion. Not seen in contact with other silver sulfosalts.

Pyrite - 30% - Pale yellow, either isotropic or with weak anomalous anisotropism and faint blue to brown polarization colors, hard and is well polished. Occurs as euhedral cubic crystals and fragments, as anhedral grains that at times form composites with marcasite, and as scarce very fine grained aggregate-textured fragments.

Marcasite - 2% - Very pale yellow, weakly birefractant, strongly anisotropic and with blue to green to violet polarization colors, hard and is well polished. Occurs as aggregate-textured fragments - at times bordering and corroding earlier pyrite.

Arsenopyrite - -1% - White and with faint creamy tint in some orientations, weakly birefractant,



Zone 2 (Gravity Rougher Concentrate, leach, Residue).

strongly anisotropic and with blue to orange brown polarization colors, hard and is well polished. Scarce separate fragments - and not seen in contact with other sulfides.

Sphalerite - -1% - Medium gray, isotropic and with strong very pale yellowish to orange internal reflections, moderate hardness and is well polished. Occurs in small amount as separate fragments, as composites in which bordered by chalcopyrite, and as scarce and small locked inclusions in pyrite.

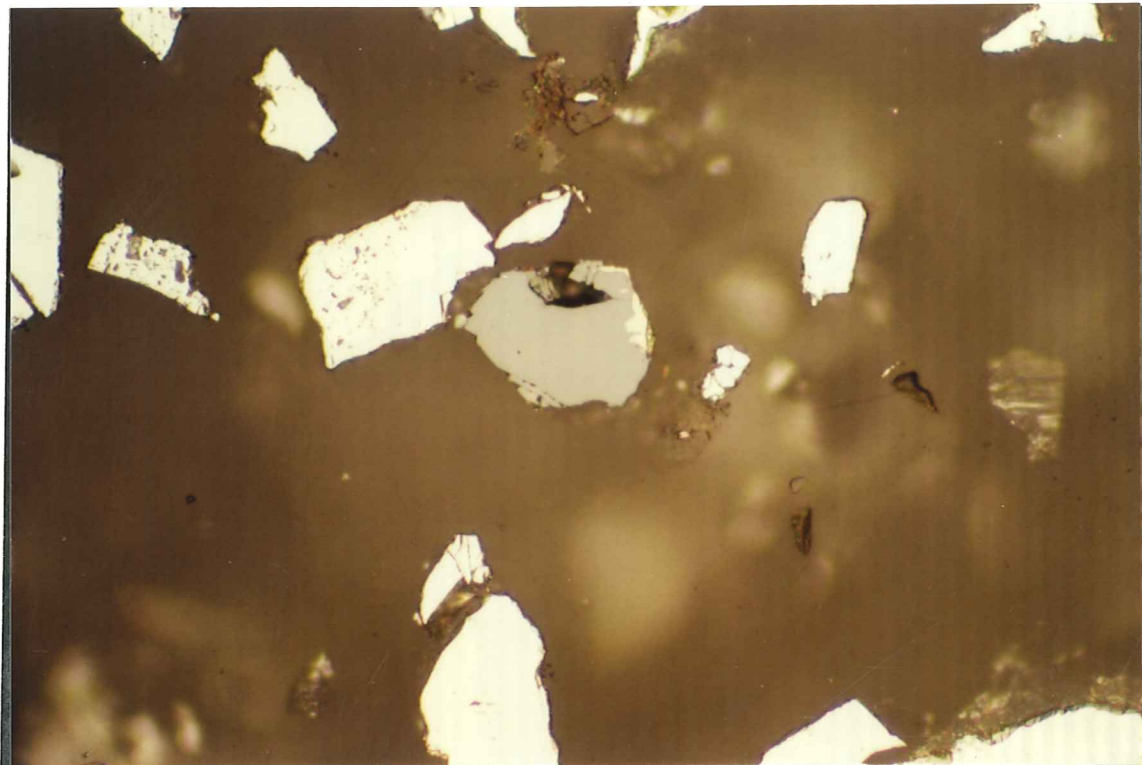
Chalcopyrite - -1% - Bright yellow, weakly anisotropic and with faint blue to green polarization colors, moderate hardness and is well polished. Present as rare separate fragments and as composites with sphalerite.

Galena - -1% - Light grayish white, isotropic and with poorly shown cubic cleavage, low hardness and is well polished. Seen in polished surface as a single liberated fragment.

Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished. Scarce fragments were added as a contaminant during sample preparation.

Non-metallic gangue - 67% - Comprised dominantly of host silicates.

\*Note: Two polished sections were prepared and examined - one of the concentrate "as received" and one of a panned concentrate prepared therefrom.

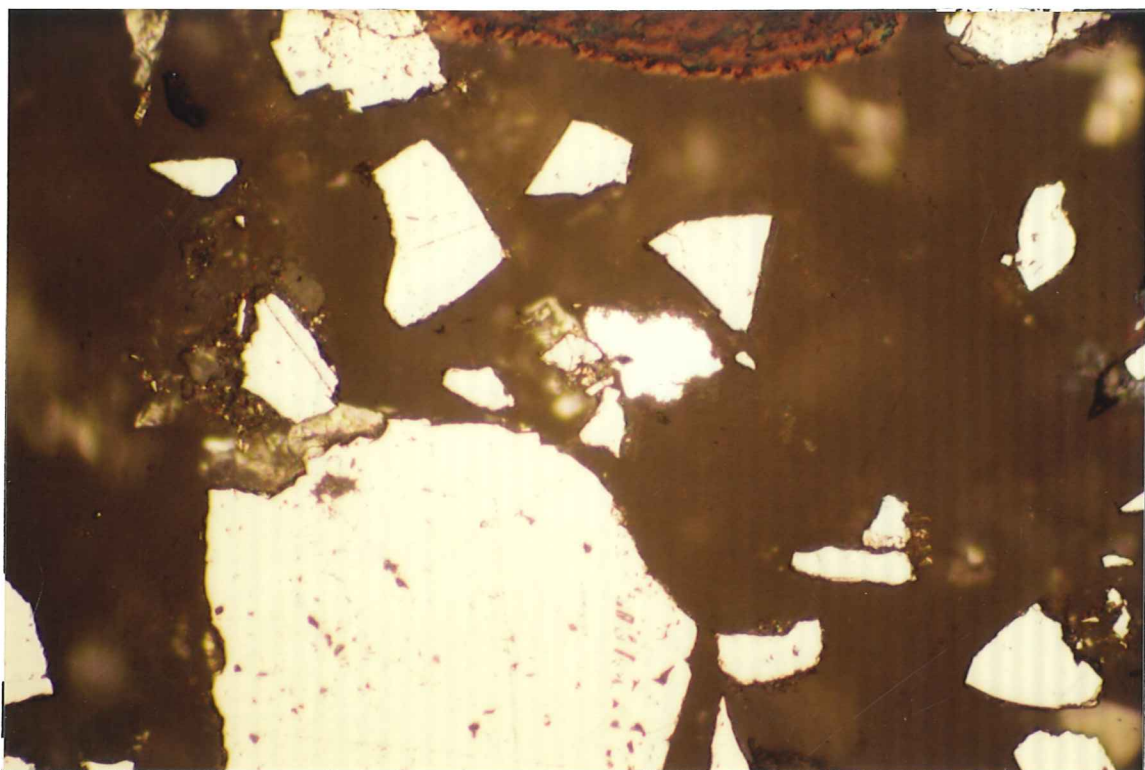


Zone 2 (Gravity Rougher Concentrate, Leach Residue).  
Polished section photomicrograph of sphalerite bordered in  
part by chalcopyrite (center) and associated with pyrite and  
marcasite. Plain light, X440.

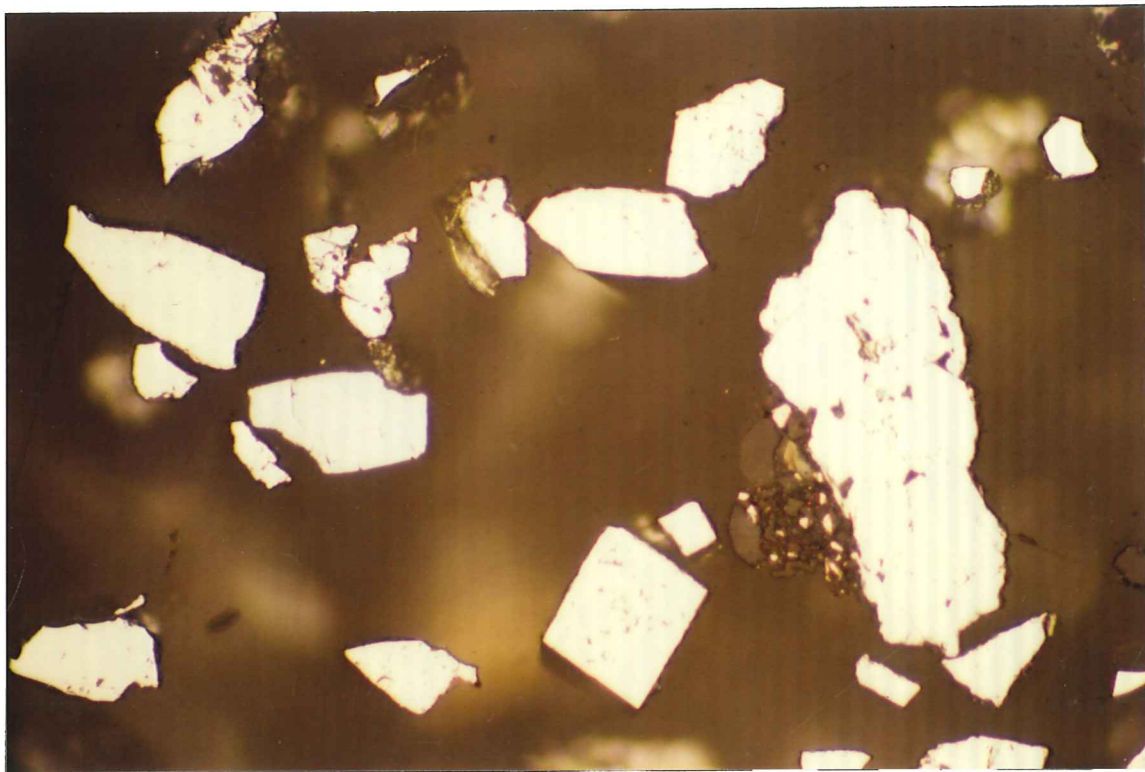


Zone 2 (Gravity Rougher Concentrate, Leach Residue).  
Polished section photomicrograph of miargyrite (lower left)  
with arsenopyrite (right) and pyrite. Plain light, X440.

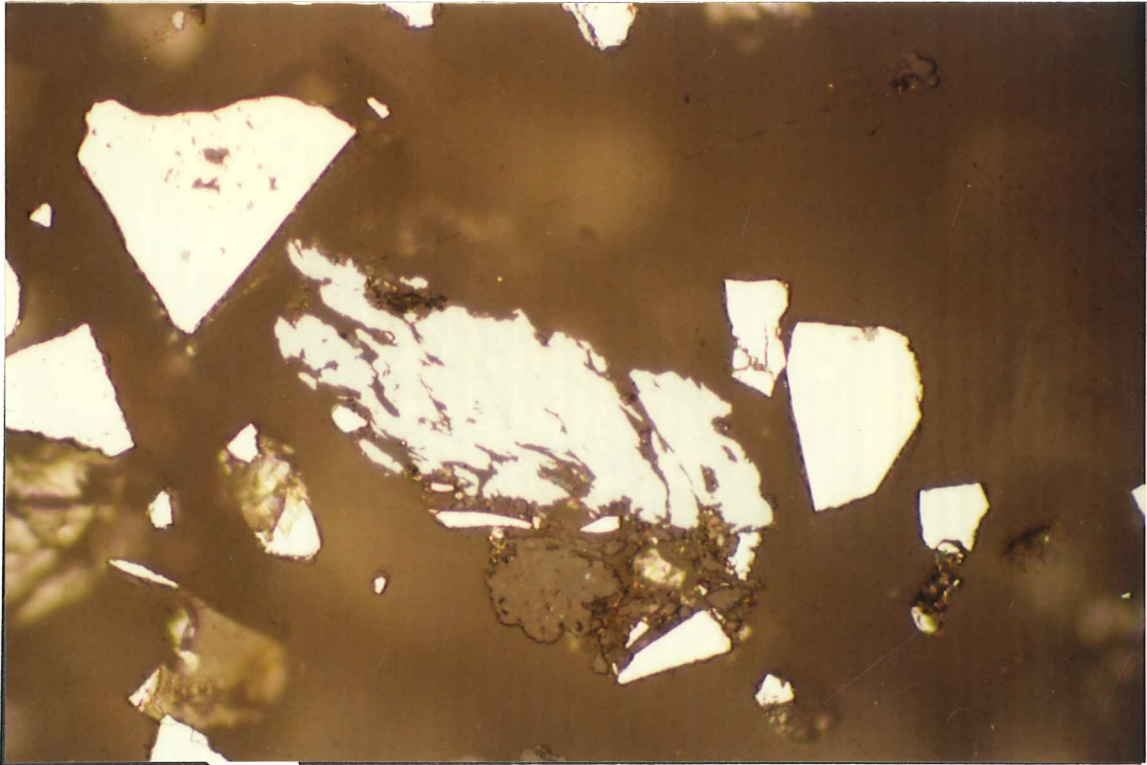




Zone 2 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of liberated native silver particle (center) associated with pyrite fragments. Plain light, X440.

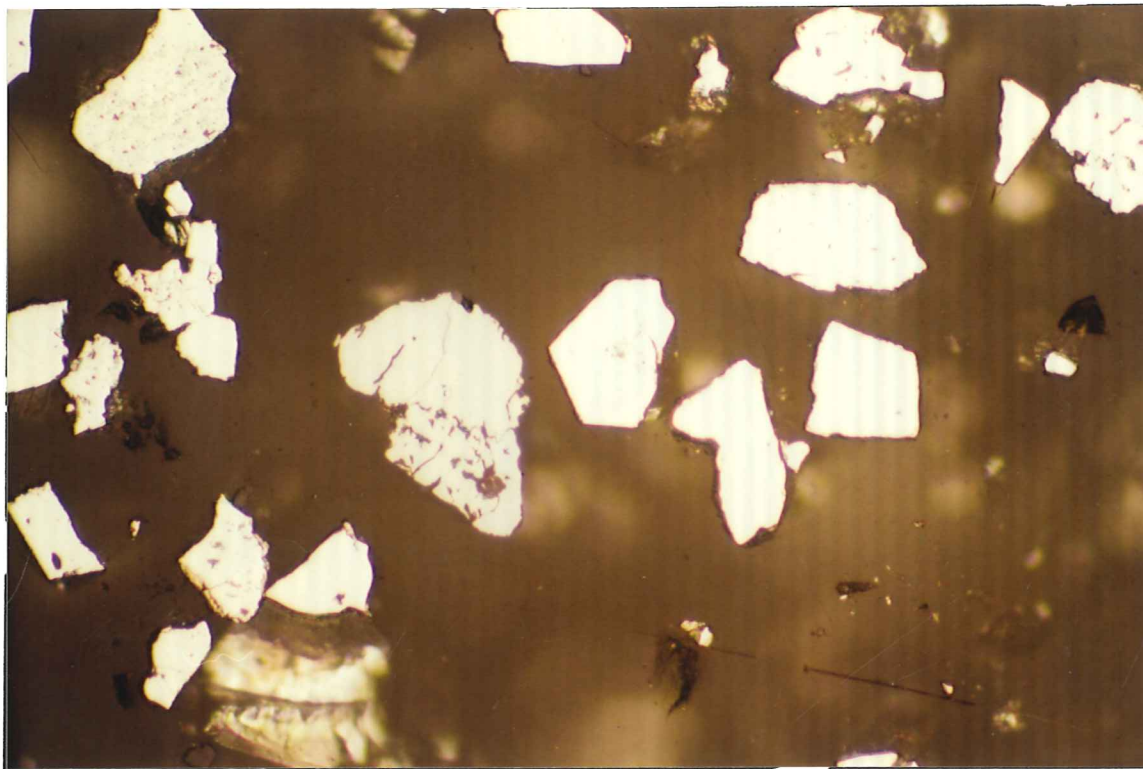


Zone 2 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of liberated galena fragment (left center) with associated pyrite and marcasite. Plain light, X440.



Zone 2 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of large polybasite fragment accompanied by pyrite and marcasite. Plain light, X440.





Zone 2 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of pyrrargyrite in composite with miargyrite (left center) and associated with pyrite and marcasite. Plain light, X440.

Zone 6 (Head). Liberated electrum with silver mineral suite that includes minor pyrrhotite and freibergite in sulfide assemblage with dominant pyrite and marcasite plus lesser amounts of arsenopyrite-sphalerite-chalcopyrite-pyrrhotite\*

Electrum - -1% - Pale golden yellow - indicating high silver content, isotropic but does not show complete extinction because of polishing scratches, low hardness and is well polished, tends to tarnish relatively slowly. Present in polished surface as three liberated particles - 46, 50, and 190 microns in maximum dimension.

Pyrrhotite - -1% - Light grayish blue, anisotropic but with polarization colors masked by strong deep red internal reflections, low hardness and is well polished, brittle. Observed as single small liberated fragment - not seen in contact with other minerals.

Freibergite - -1% - Light gray with bluish tint, isotropic, moderate hardness and is well polished. Occurs as scarce composite fragments in which bordered by chalcopyrite. Silver-rich composition is suggested by associations.

Pyrite - 4% - Pale yellow, either isotropic or with weak anomalous anisotropism and faint blue to brownish polarization colors, hard and is well polished. Present mostly as subhedral cubic and pyritohedral crystals and fragments - and as anhedral grains and aggregates. These often contain microscopic inclusions of silicate gangue. Also as scarce very fine grained aggregate-textured fragments.

Marcasite - 1% - Pale yellow to almost white, weakly birefractant, strongly anisotropic and with polarization colors of blue to green to violet, hard and is well polished. Present as subhedral prismatic to anhedral aggregate-textured fragments - at times bordering and corroding pyrite.

Arsenopyrite - -1% - White and with faint creamy tint, weakly birefractant, strongly anisotropic and with polarization colors of blue to orange brown, hard and is well polished. Subhedral prismatic to anhedral grains and aggregates, often twinned. Rarely bordered by pyrite.

Zone 6 (Head).

Sphalerite - -1% - Medium gray, isotropic and with strong yellowish to brown internal reflections, moderate hardness and is well polished. Occurs as separate fragments, as inclusions in pyrite, and as scarce composites with chalcopyrite. Some also contains micron-sized inclusions of chalcopyrite.

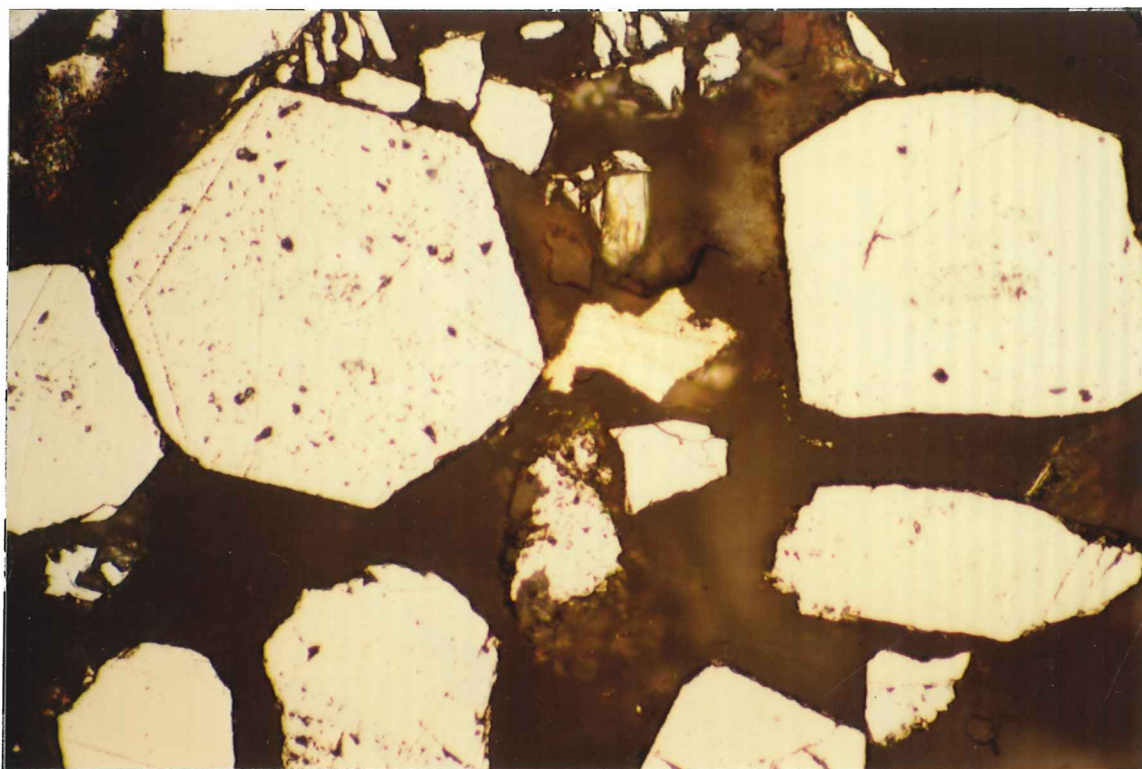
Chalcopyrite - -1% - Bright yellow, weakly anisotropic and with polarization colors of faint blue to green, moderate hardness and is well polished. Present as separate fragments, as composites in which bordered by tetrahedrite and sphalerite, and as micron-sized inclusions in sphalerite.

Pyrrhotite - -1% - Pale creamy brown, weakly bireflectant, strongly anisotropic and with polarization colors of greenish yellow to reddish brown, moderate hardness and is well polished. Scarce separate fragments and as small inclusions in both pyrite and marcasite host grains.

Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished. Occurs as curved to irregularly shaped fragments added as a contaminant during sample preparation.

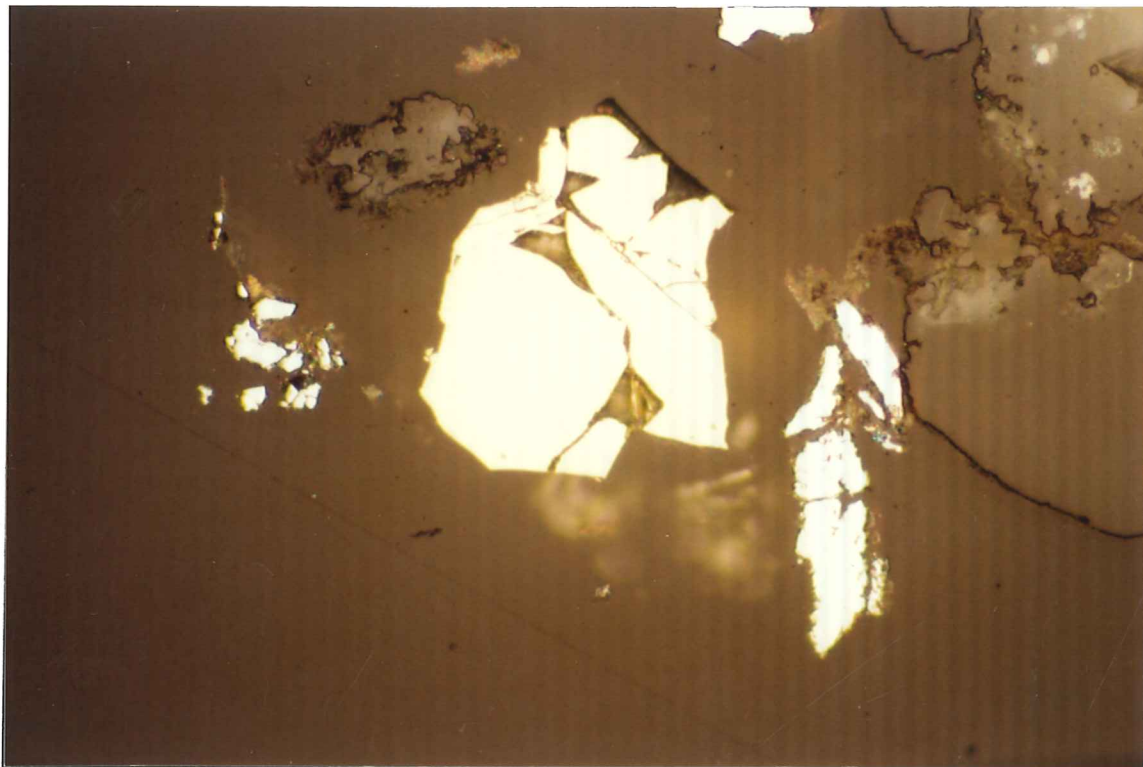
Non-metallic gangue - 95% - Comprised largely of host silicates.

\*Note: Two polished sections were prepared and examined - one of the "as received" sample ground to -70 mesh and one of a panned concentrate prepared therefrom.

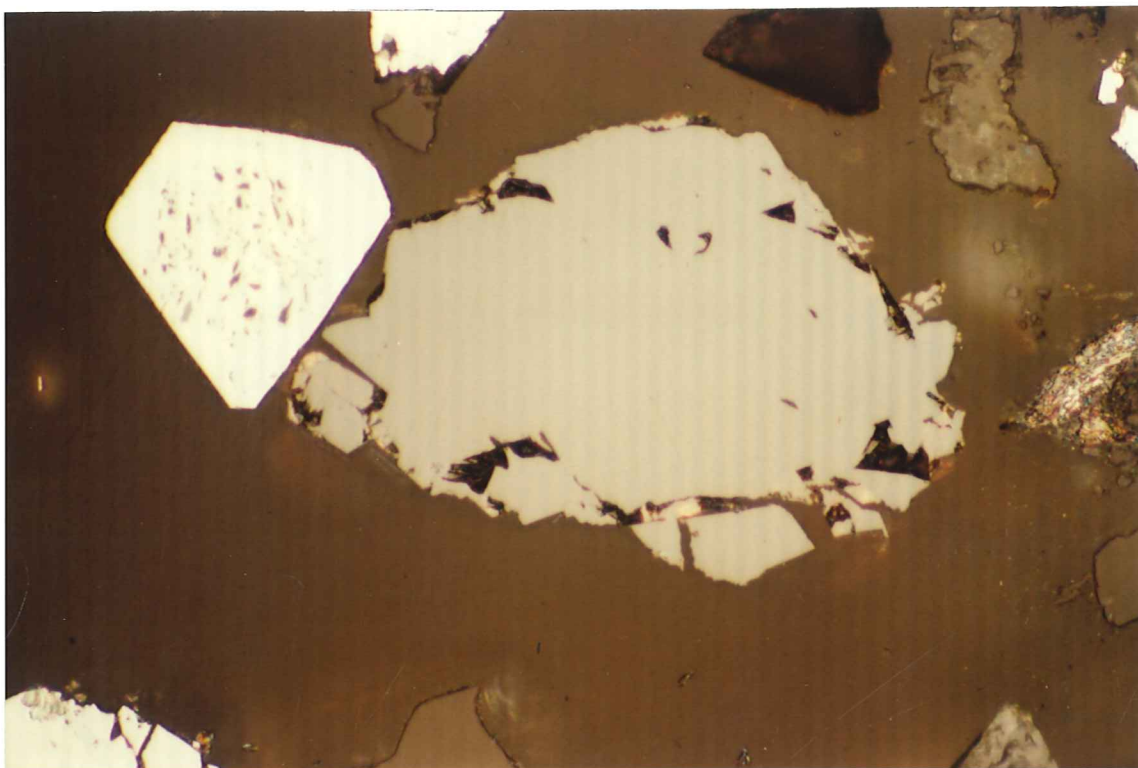


Zone 6 (Head). Polished section photomicrograph of liberated electrum particle (center) with associated pyrite and marcasite fragments. Plain light, X440.

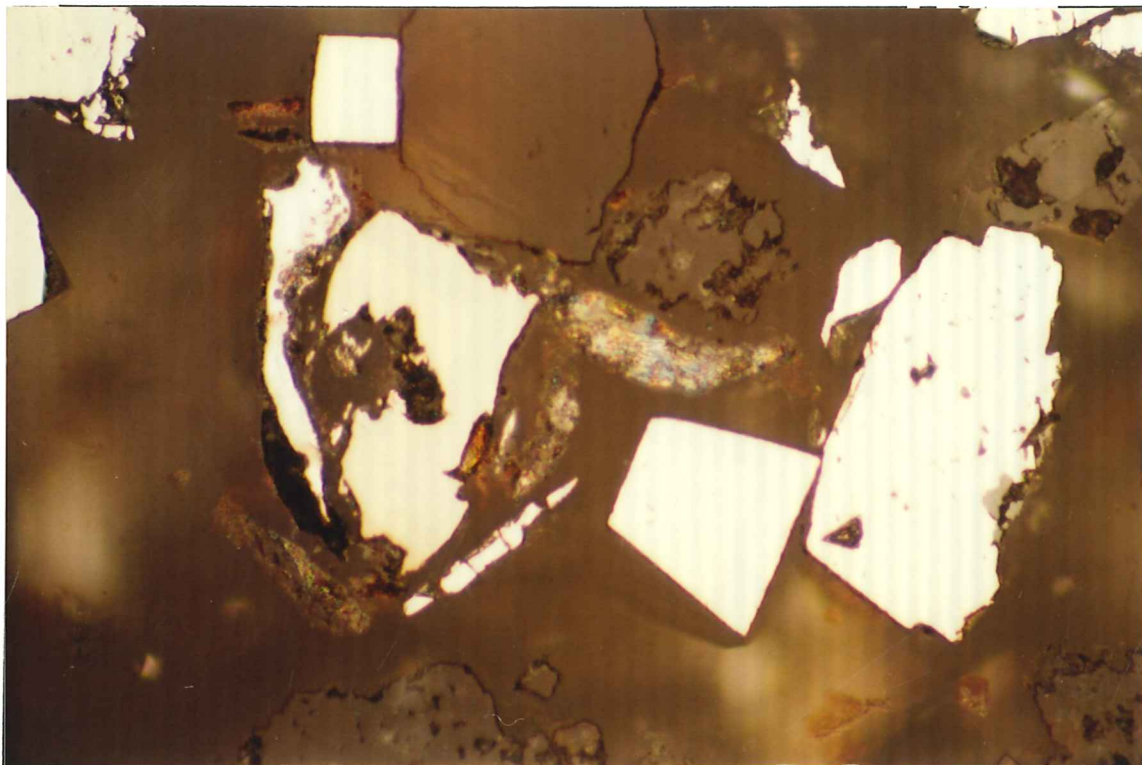




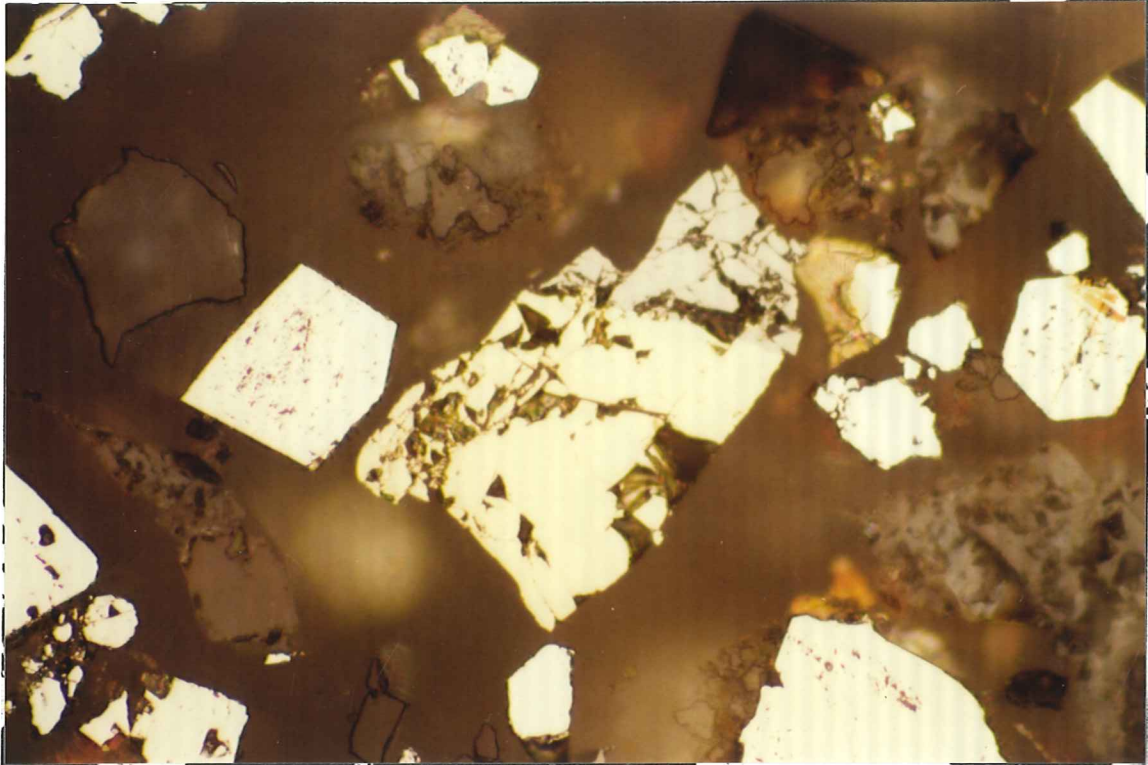
Zone 6 (Head). Polished section photomicrograph of liberated chalcopyrite (center) associated with marcasite and pyrite. Plain light, X440.



Zone 6 (Head). Polished section photomicrograph of sphalerite in relatively large fragment associated with pyrite and gangue. Plain light, X440.

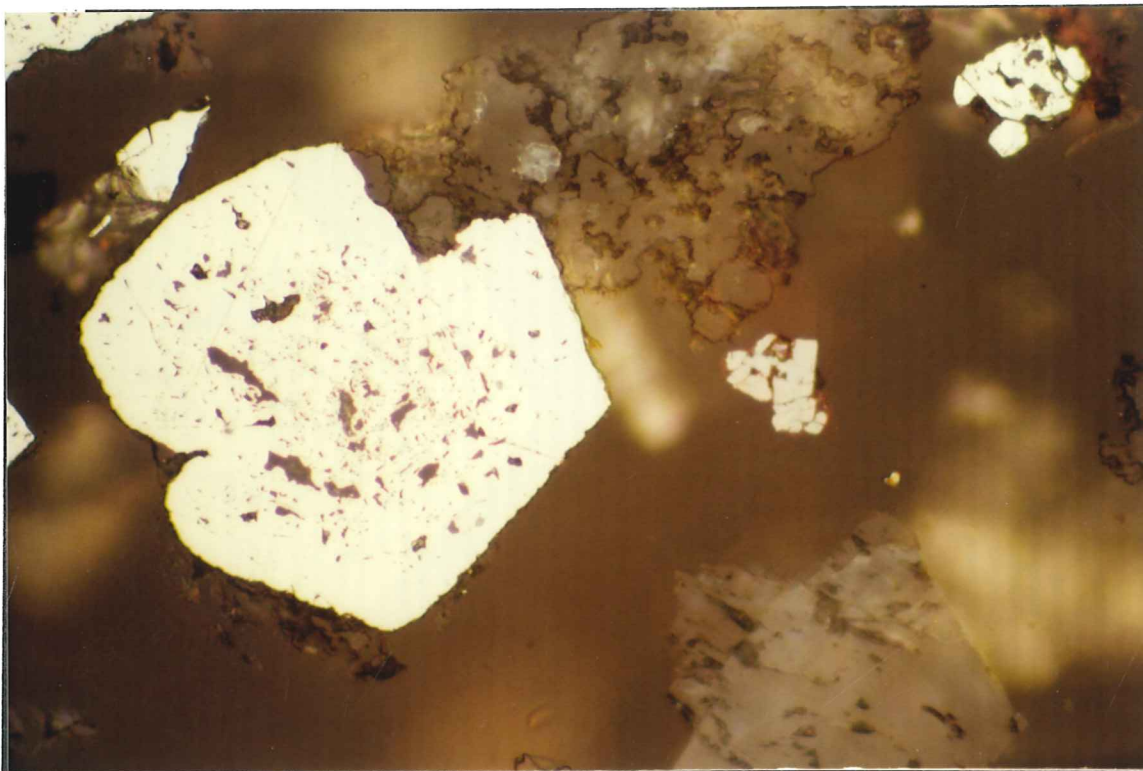


Zone 6 (Head). Polished section photomicrograph of pyrrhotite fragment (left center) bordered by trash iron and with associated pyrite and arsenopyrite fragments. Plain light, X440.

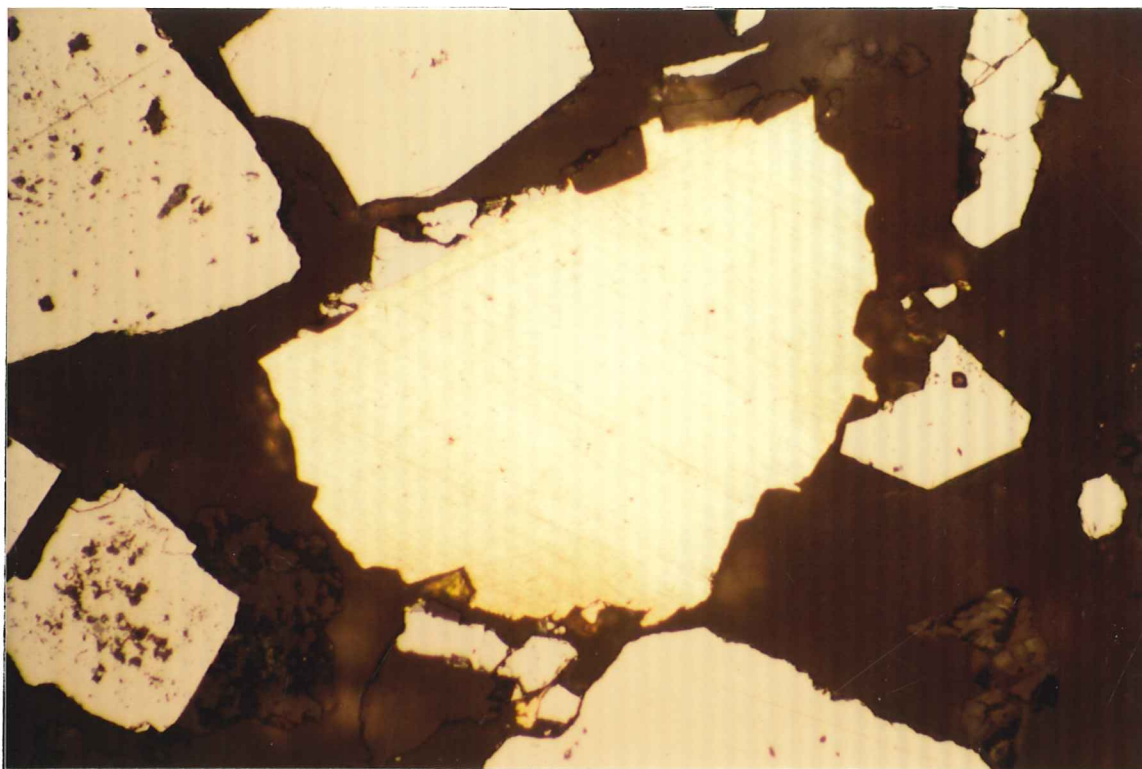


Zone 6 (Head). Polished section photomicrograph of chalcopyrite (center) bordered by freibergite and with associated pyrite and gangue. Plain light, X440.3

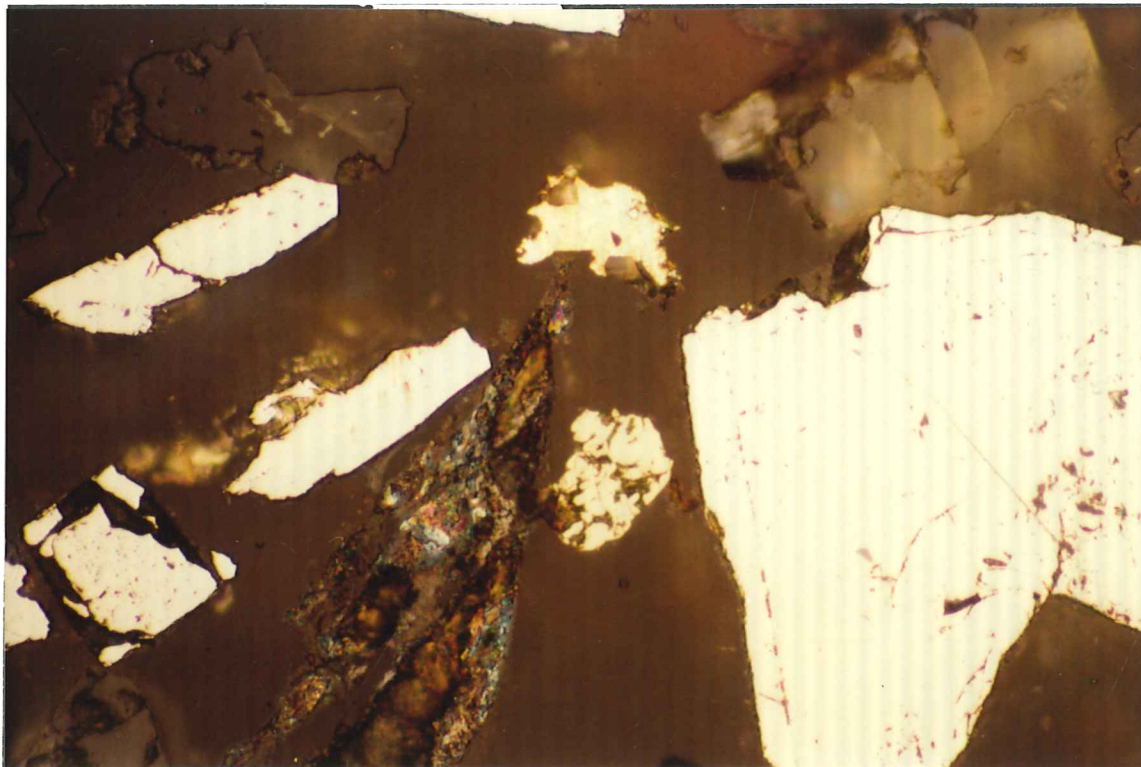




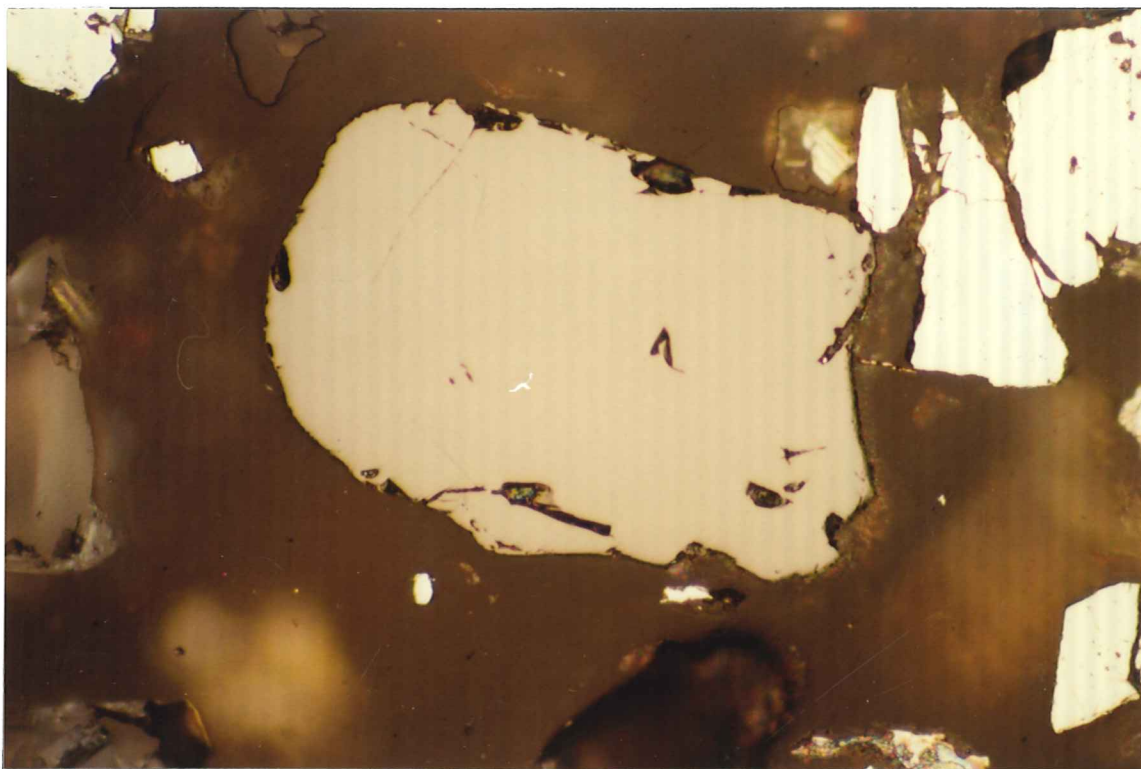
Zone 6 (Head). Polished section photomicrograph of small pyrargyrite fragment (center) with silicate gangue and pyrite fragments. Plain light, X440.



Zone 6 (Head). Polished section photomicrograph of large liberated electrum particle accompanied by pyrite. Plain light, X440.



Zone 6 (Head). Polished section photomicrograph showing liberated electrum particles (upper and lower center) with associated pyrite, marcassite, and gangue. Plain light, X440.



Zone 6 (Head). Polished section photomicrograph of large magnetite fragment associated with pyrite. Plain light, X440.



Zone 6 (Gravity Rougher Concentrate). Liberated and locked electrum particles in concentrate with dominant pyrite plus lesser amounts of marcasite-arsenopyrite-pyrrhotite-chalcopyrite-sphalerite-galena\*

Electrum - -1% - Pale golden yellow - suggesting relatively high silver content, isotropic but does not show complete extinction because of polishing scratches, low hardness and is rather well polished. Present in polished surface as 5 liberated particles (86, 102, 105, 110, and 114 microns) - two of which are bordered in part by fractured pyrite. Also present as 7 locked particles (3, 3, 4, 5, 7, 7, and 55 microns) enclosed by marcasite and pyrite and associated with inclusions of chalcopyrite and freibergite.

Pyrite - 31% - Pale yellow, either isotropic or with weak anomalous anisotropism and faint blue to purplish brown polarization colors, hard and is well polished. Present mostly as sub-to euhedral cubic and pyritohedral crystals and fragments, as anhedral grains that are at times associated with marcasite, and as very fine grained aggregate-textured fragments. Crystals at times contain abundant silicate inclusions - and enclose minor amounts of pyrrhotite, sphalerite, galena, and chalcopyrite.

Marcasite - 3% - Very pale yellow to almost white,, weakly bireflectant, strongly anisotropic and with polarization colors of blue to green to violet, hard and is well polished. Subhedral prismatic to anhedral aggregates in large fragments that at times form composites with pyrite. Encloses minor pyrrhotite, chalcopyrite, and electrum.

Arsenopyrite - 1% - White and with faint creamy tint, weakly bireflectant, strongly anisotropic and with polarization colors of blue to orange brown, hard and is well polished. Fragments of subhedral prisms and anhedral aggregates. Observed only in contact with pyrite.

Pyrrhotite - -1% - Pale creamy brown, weakly bireflectant, strongly anisotropic and with polarization colors of greenish yellow to reddish brown, moderate hardness and is well polished.

Zone 6 (Gravity Rougher Concentrate).

Present as scarce liberated fragments and as small anhedral grains locked or encapsulated by pyrite and marcasite.

Chalcopyrite - -1% - Bright yellow, weakly anisotropic and with faint blue to green polarization colors, moderate hardness and is well polished. Occurs in minor amount as small liberated fragments and either enclosed by or at the margins of pyrite fragments. In one instance is associated in space with locked electrum particle.

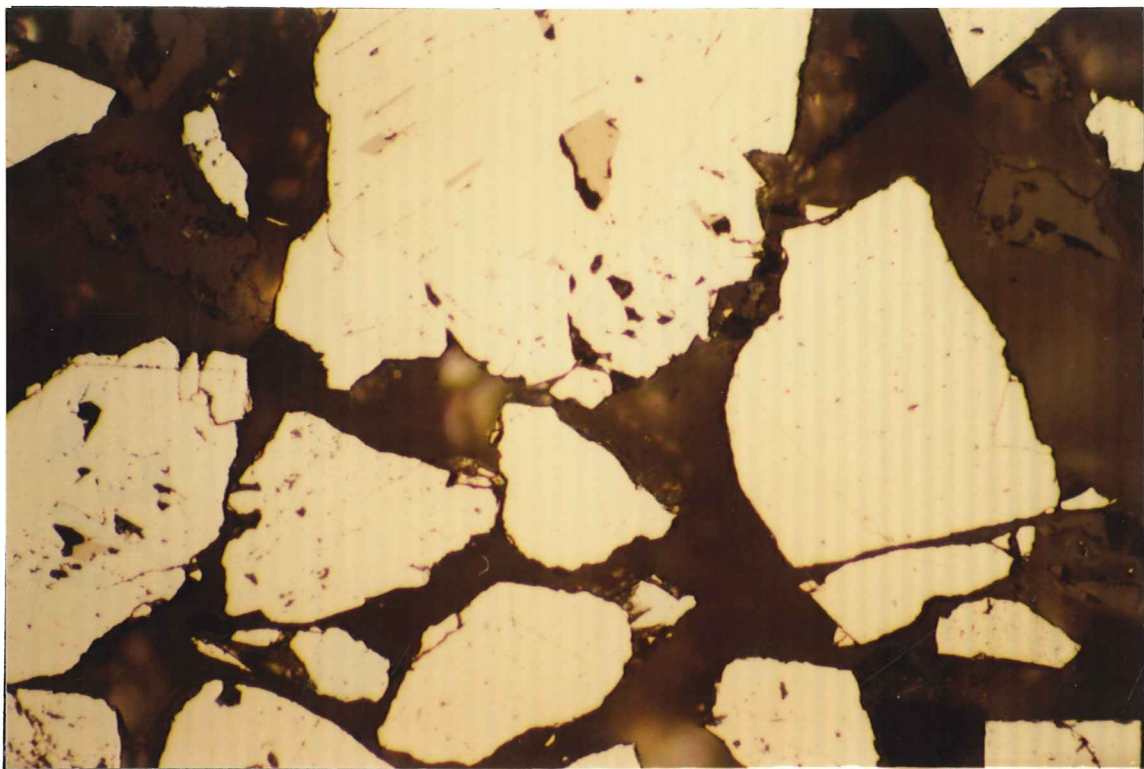
Freibergite - -1% - Light gray with greenish blue tint, isotropic, moderate hardness and is well polished. Present in trace amount as locked grains in marcasite-pyrite host where associated in space with locked electrum.

Sphalerite - -1% - Medium gray, isotropic and with strong yellowish to brown internal reflections, moderate hardness and is well polished. Present as rare liberated fragments and as small equant to anhedral inclusions in pyrite host grains.

Galena - -1% - Light gray, isotropic and with poorly shown cubic cleavage, low hardness and is moderately well polished. Observed in trace amount as small and irregularly shaped inclusions in pyrite.

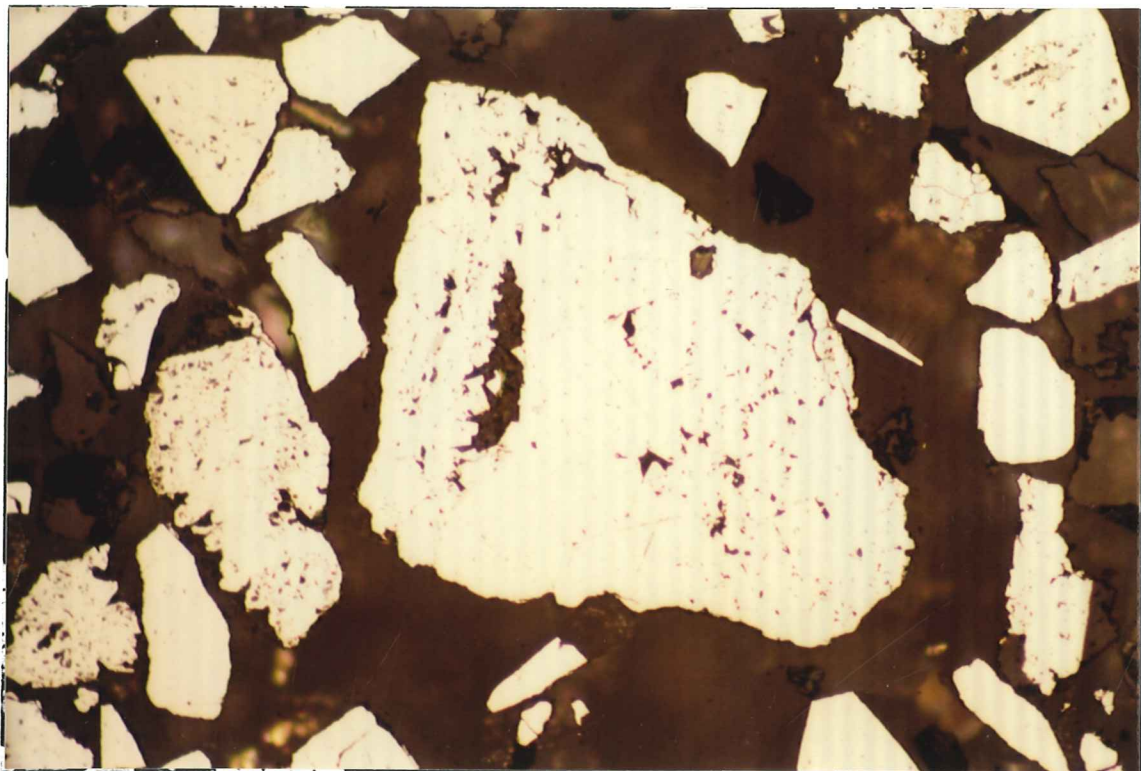
Non-metallic gangue - 65% - Comprised dominantly of host silicates.

\*Note: Two polished sections were prepared and examined - one of the concentrate sample "as received" and one of a panned concentrate prepared therefrom.



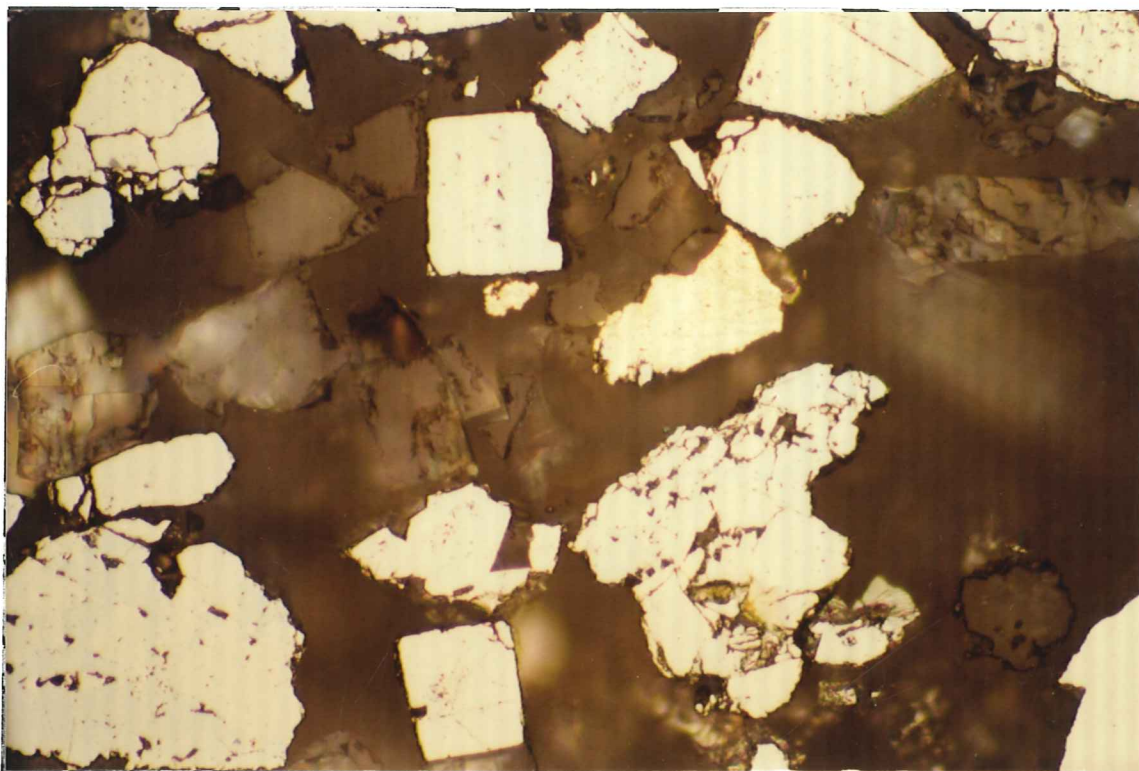
Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of pyrrhotite inclusion in pyrite (upper center) and associated with other pyrite fragments. Plain light, X440.



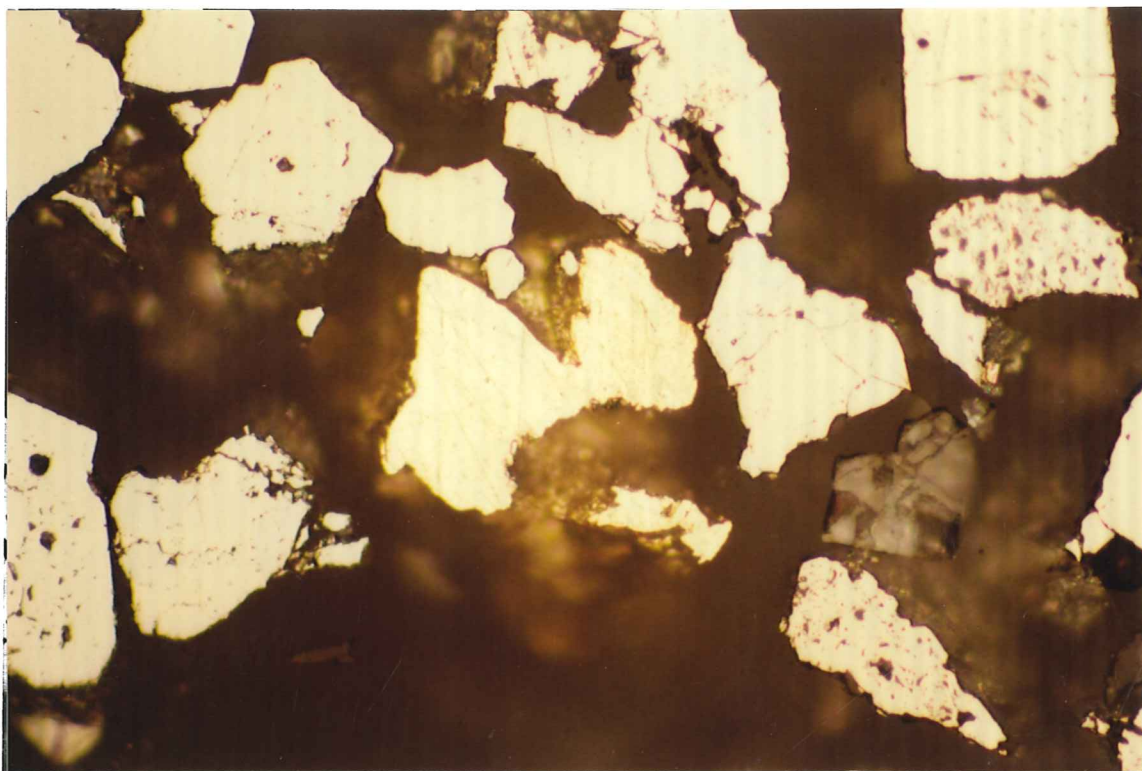


Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of marcasite bordering and corroding pyrite (center) and associated with small pyrite fragments. Plain light, X220.

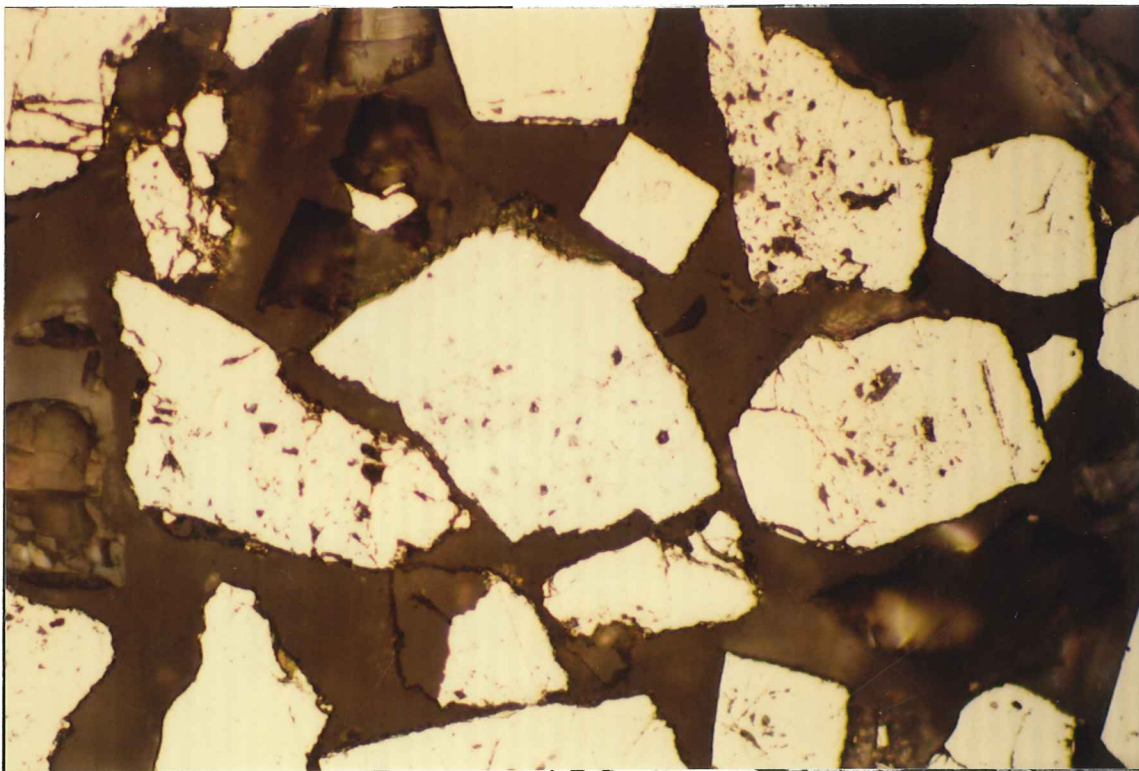




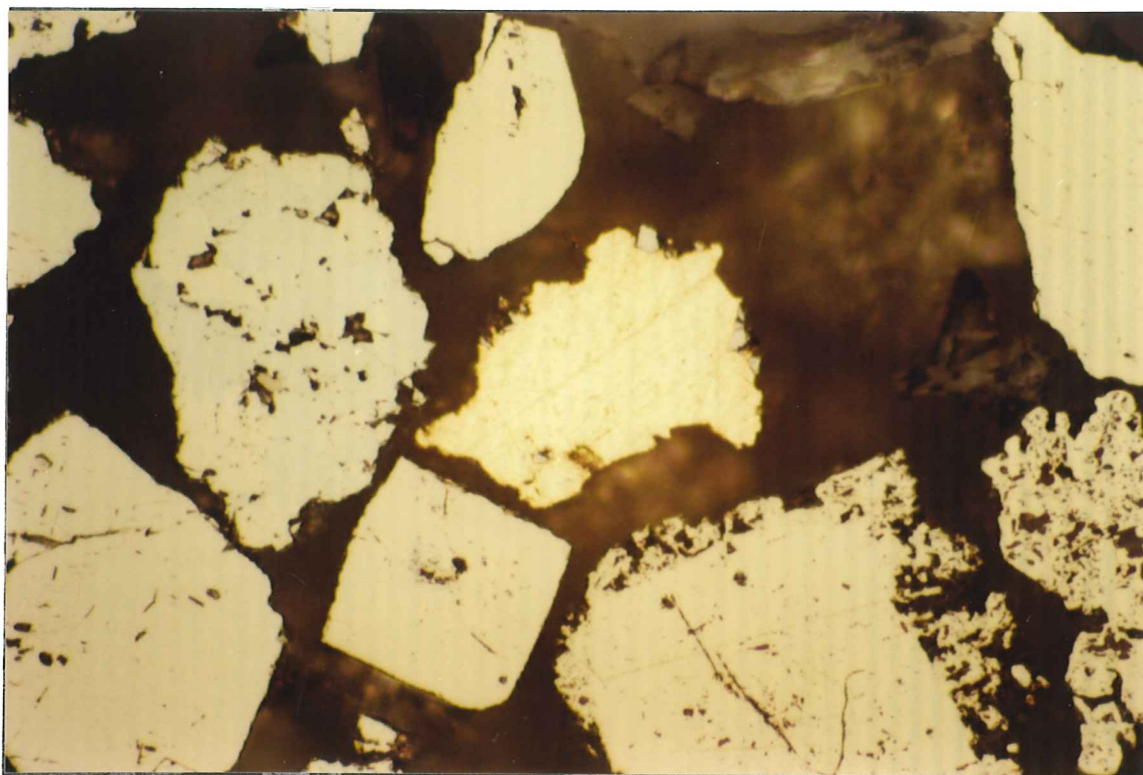
Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of liberated electrum particle with associated pyrite, marcasite, and gangue. Plain light, X440.



Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of liberated electrum particle (continuous beneath polished surface) with associated pyrite, marcasite, and silicate gangue. Plain light, X440.

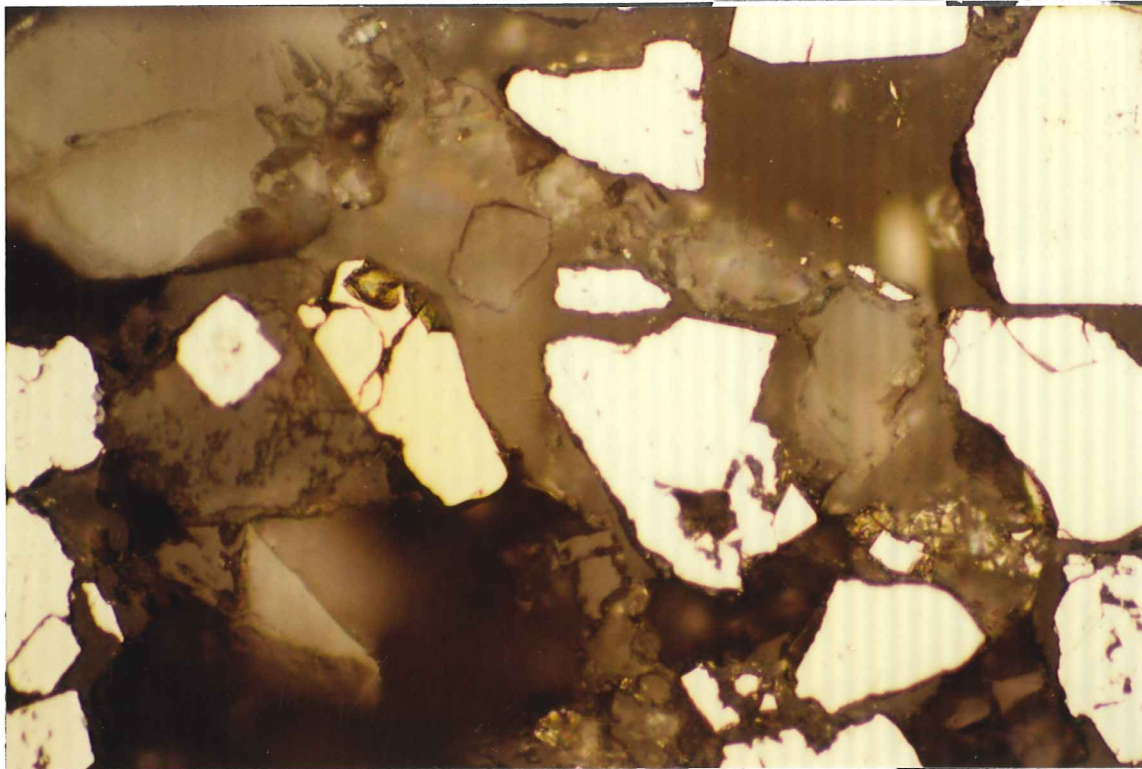


Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of arsenopyrite (center) associated with pyrite and marcasite. Plain light, X440.

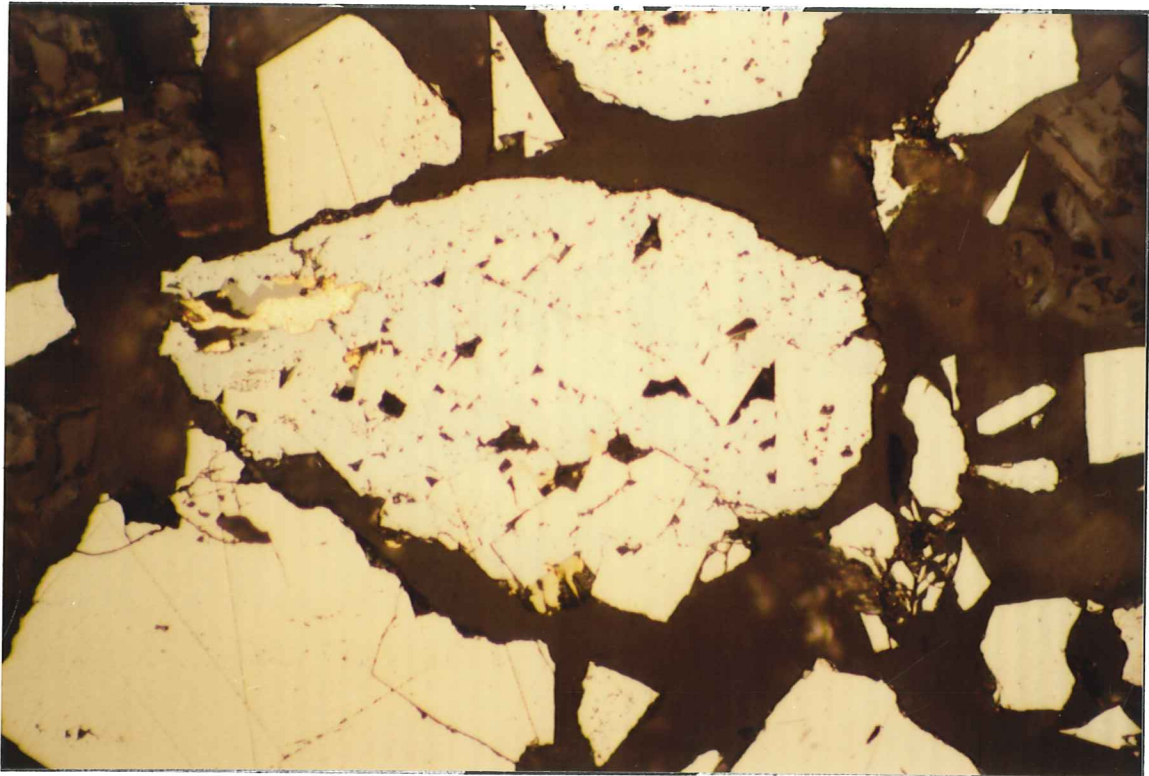


Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of electrum particle bordered by minor pyrite and associated with pyrite and marcasite. Plain light, X440.





Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of liberated electrum particle accompanied by pyrite and gangue. Plain light, X440.



Zone 6 (Gravity Rougher Concentrate). Polished section photomicrograph of locked or encapsulated electrum particles associated with minor freibergite and chalcopyrite in pyrite host grain. Plain light, X440.

Zone 6 (Head, Leach Residue). Single very small locked native silver particle in polybasite composite with pyrite-marcasite. Sulfide suite contains dominant pyrite with lesser amounts of marcasite-pyrrhotite-arsenopyrite-chalcopyrite-sphalerite-galena\*

Native silver - -1% - White with faint yellowish tint in polished surface, isotropic but does not show complete extinction, low hardness and is moderately well polished, tarnishes on exposure to air. Observed as single very small (7 microns) locked particle in polybasite host grain that is bordered by pyrite and marcasite.

Polybasite - -1% - Light gray with slightly greenish blue tint, moderately anisotropic and with polarization colors of greenish gray to bluish to brown, low hardness and is well polished. Observed as single corroded particle that is bordered in part by marcasite and pyrite and that encapsulates or locks small native silver particle as described above.

Pyrite - 4% - Pale yellow, either isotropic or with weak anomalous anisotropism and very faint blue to brown polarization colors, hard and is well polished. Present as separate euhedral cubic crystals and fragments, as anhedral grains and aggregates that are at times bordered by marcasite, and as scarce very fine grained aggregate-textured fragments. Some of crystals are bordered by chalcopyrite, sphalerite, and electrum - and others enclose sphalerite and galena.

Marcasite - 1% - Very pale yellow to almost white, weakly bireflectant, strongly anisotropic and with polarization colors of blue to green to violet, present as separate aggregate-textured fragments and at times in composites where bordering and corroding pyrite.

Pyrrhotite - -1% - Pale creamy brown, weakly bireflectant, strongly anisotropic and with polarization colors of greenish yellow to reddish brown, moderate hardness and is well polished. Occurs as scarce separate fragments and as small anhedral inclusions in both pyrite and marcasite.



Zone 6 (Head, Leach Residue).

Arsenopyrite - -1% - White and with slight creamy tint in some orientations, weakly birefractant, strongly anisotropic and with polarization colors of blue to orange brown, hard and is well polished. Present as broken subhedral fragments and as anhedral aggregate-textured fragments. Rarely in contact with pyrite.

Chalcopyrite - -1% - Bright yellow, weakly anisotropic and with faint blue to green polarization colors, moderate hardness and is well polished, brittle. Present as scarce liberated fragments and as composites in which associated with pyrite.

Sphalerite - -1% - Medium gray, isotropic and with strong yellow to brown internal reflections, moderate hardness and is well polished. Rare separate fragments and as small equant inclusions in a few pyrite fragments.

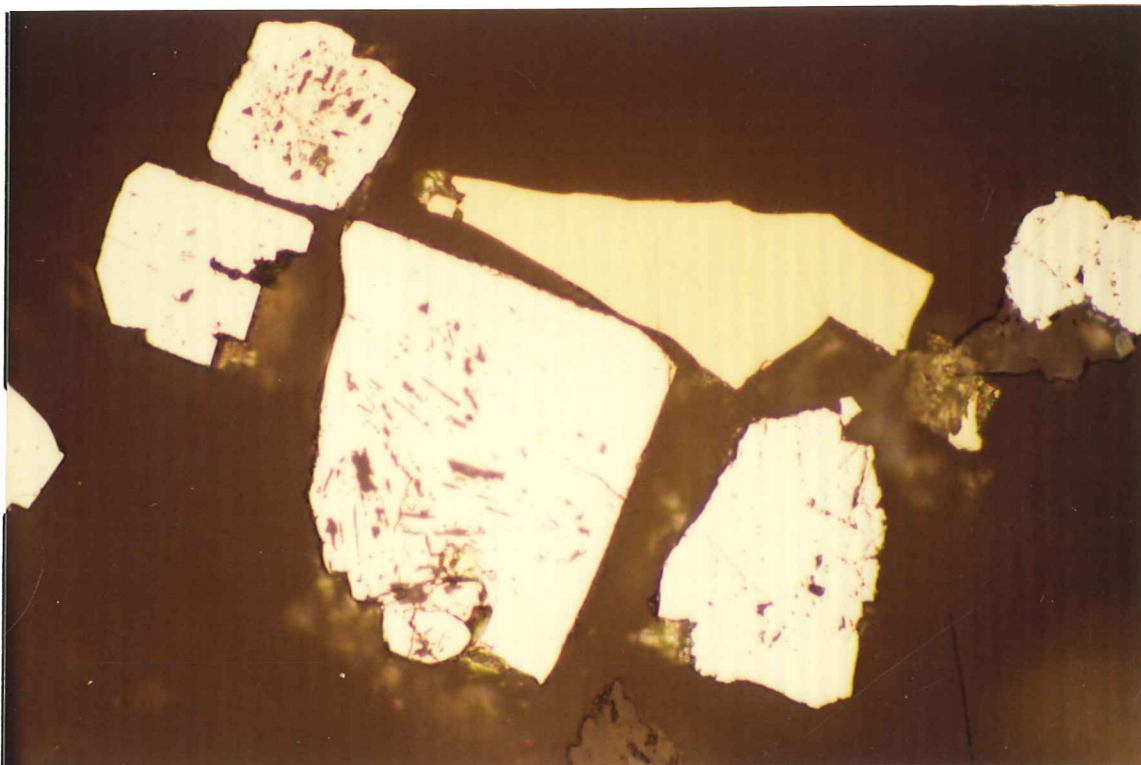
Galena - -1% - Light gray, isotropic, low hardness and is moderately well polished. Occurs in trace amount as small and irregularly shaped inclusions locked in pyrite.

Carbon - -1% - Slightly brownish gray, isotropic, well developed cellular texture, low hardness and is well polished. Occurs as a remnant from leach process.

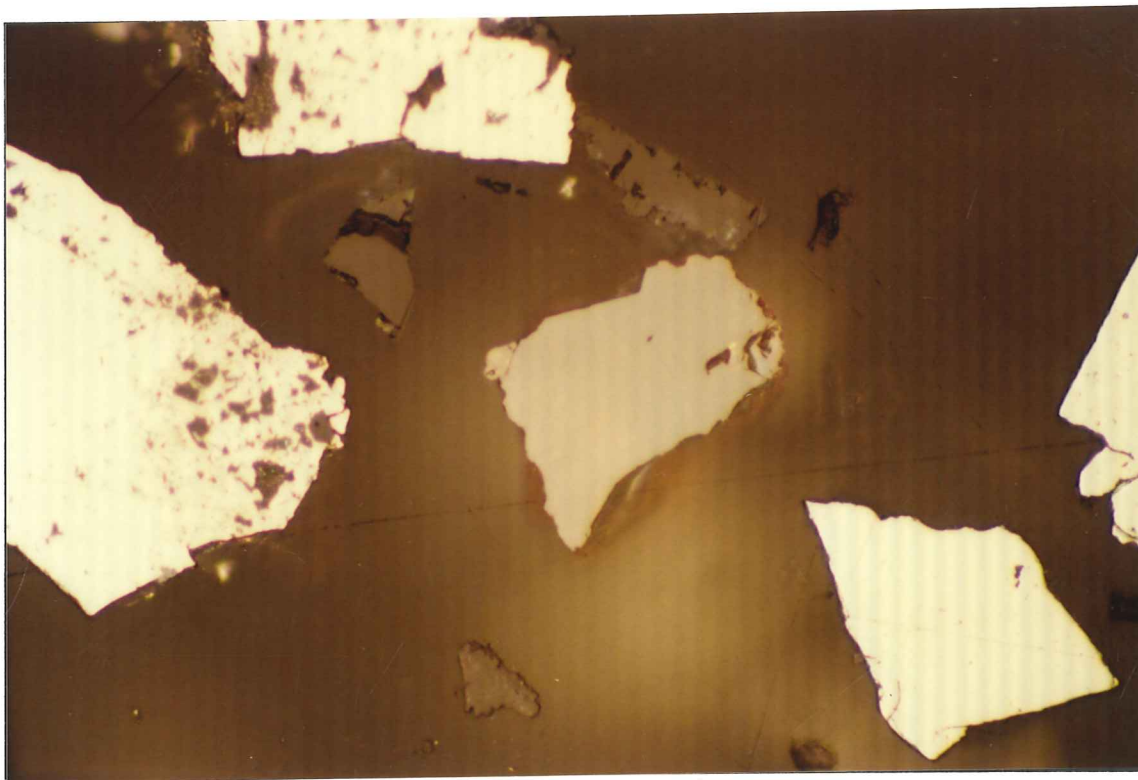
Non-metallic gangue - 95% - Comprised very largely of host silicates.

\*Note: Two polished sections were prepared and examined - one of the sample "as received" and one of a panned concentrate prepared therefrom.

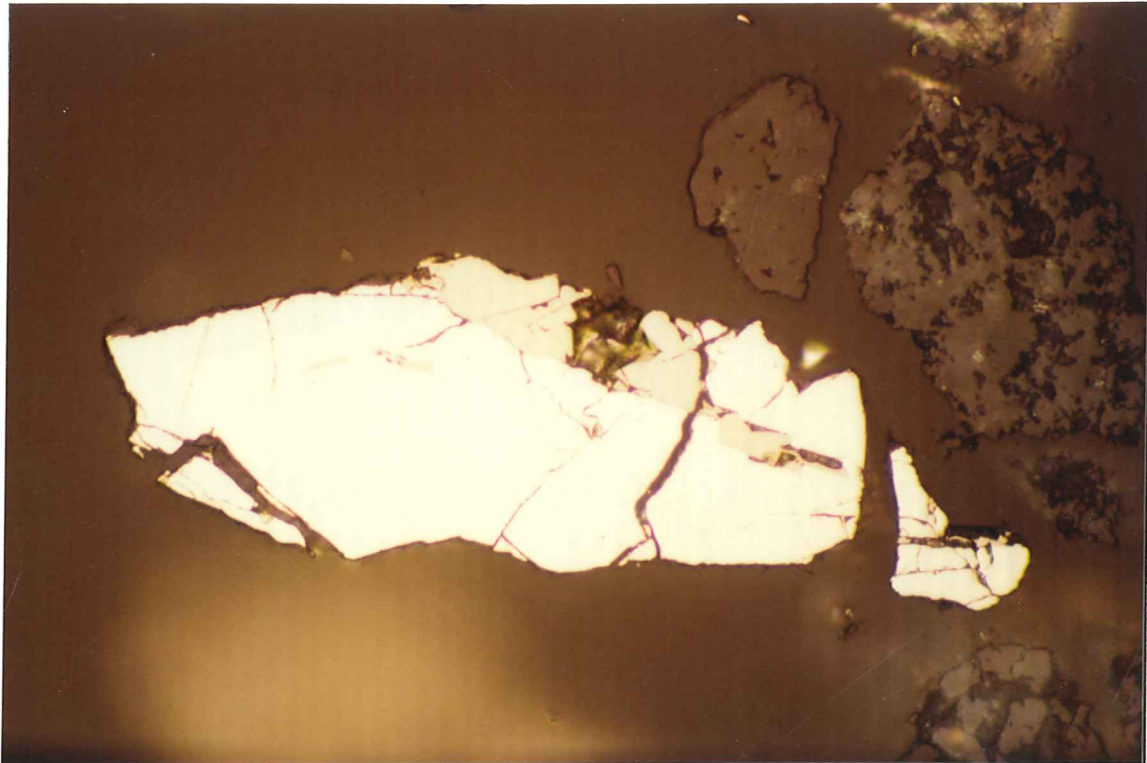




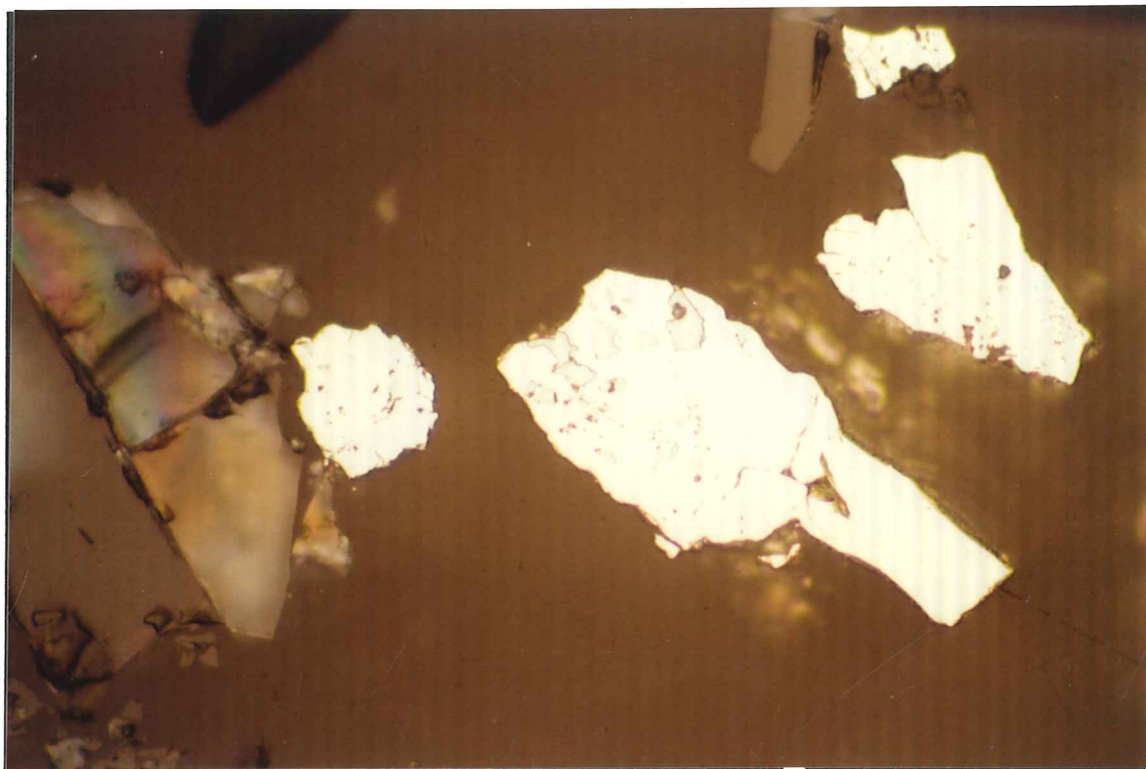
Zone 6 (Head, Leach Residue). Polished section photomicrograph of chalcopyrite associated with pyrite and minor marcasite. Plain light, X440.



Zone 6 (Head, Leach Residue). Polished section photomicrograph of sphalerite fragment associated with pyrite. Plain light, X440.

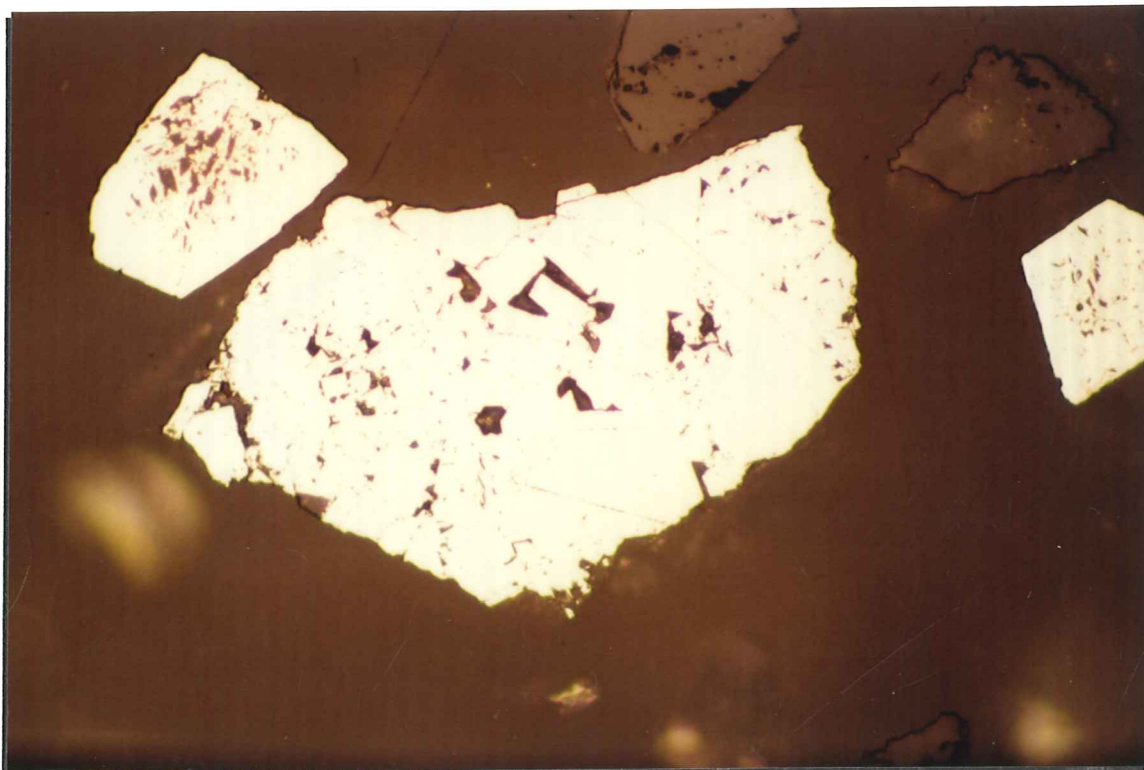


Zone 6 (Head, Leach Residue). Polished section photomicrograph of pyrrhotite in composite with pyrite. Associated with silicate gangue. Plain light, X440.

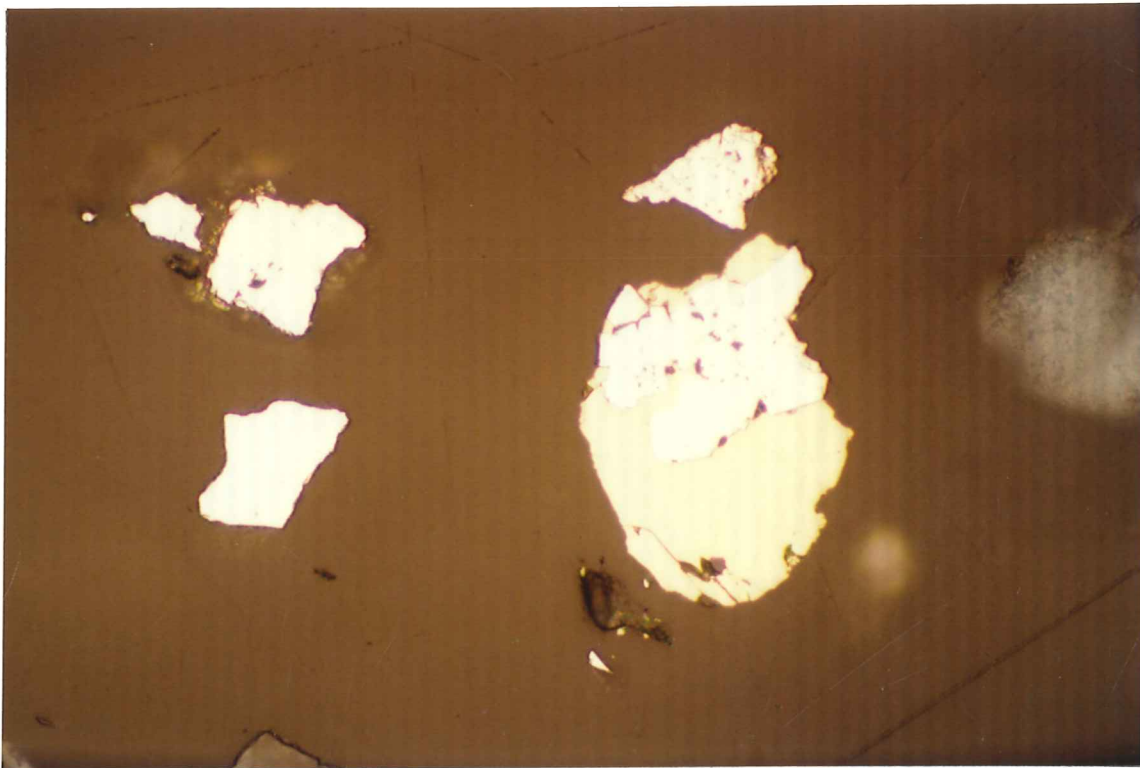


Zone 6 (Head, Leach Residue). Polished section photomicrograph of galena locked by pyrite (center) and associated with separate pyrite and gangue fragments. Plain light, X440.





Zone 6 (Head, Leach Residue). Polished section photomicrograph of marcasite bordering pyrite (center). Plain light, X440.



Zone 6 (Head, Leach Residue). Polished section photomicrograph of chalcopyrite-pyrite composite associated with separate pyrite fragments. Plain light, X440.

Zone 6 (Gravity Rougher Concentrate, Leach Residue). Single very small locked native silver particle in arsenopyrite and with minor amounts of associated miargyrite-polybasite-stephanite in sulfide suite containing dominant pyrite plus lesser amounts of marcasite-pyrrhotite-arsenopyrite-chalcopyrite-sphalerite-galena.

Native silver - -1% - White and with faint yellow or creamy tint, isotropic but does not show complete extinction, low hardness and is well polished. Present in polished surface as single very small (3 microns) locked particle in arsenopyrite fragment. Is too small for good determination of optical constants - and may contain some gold in solid solution.

Miargyrite - -1% - Light grayish blue, anisotropic but with polarization colors masked by strong deep red internal reflections, low hardness and is well polished. Occurs as scarce and small separate fragments and as composites with bordering polybasite and stephanite.

Polybasite - -1% - Light gray and with slight greenish blue tint, moderately anisotropic and with polarization colors of greenish gray to brown, low hardness and is well polished. Present in minor amount as composites bordered by miargyrite and by pyrite.

Stephanite - -1% - Light gray and with distinct pinkish violet tint, strongly anisotropic and with polarization colors of grayish green to violet, moderate hardness and is well polished. Observed in trace amount as small composites in which bordered by miargyrite.

Pyrite - 32% - Pale yellow, either isotropic or with weak anomalous anisotropism and faint blue to brown polarization colors, hard and is well polished. Occurs most often as cubic to pyritohedral crystals and fragments - a few of which enclose sphalerite and galena. Also as anhedral aggregates with marcasite and as scarce very fine grained aggregate-textured fragments.

Marcasite - 2% - Very pale yellow to almost white, weakly bireflectant, strongly anisotropic and with

Zone 6 (Gravity Rougher Concentrate, leach Residue).

polarization colors of blue to green to violet, hard and is well polished. Present as very fine grained prismatic aggregates and as anhedral aggregates bordering and corroding pyrite.

Arsenopyrite - -1% - White and with slight creamy tint in some orientations, weakly bireflectant, strongly anisotropic and with polarization colors of blue to orange brown, hard and is well polished. Subhedral prismatic to anhedral fragments. In one instance encloses small native silver particle.

Pyrrhotite - -1% - Pale creamy brown, weakly bireflectant, strongly anisotropic and with polarization colors of pale greenish yellow to dark reddish brown, moderate hardness and is well polished. Occurs in small amount as composites bordering pyrite and as small inclusions in both pyrite and marcasite.

Chalcopyrite - -1% - Bright yellow, weakly anisotropic and with pale blue to green polarization colors, moderate hardness and is well polished. Scarce and small separate fragments and as composites with pyrite.

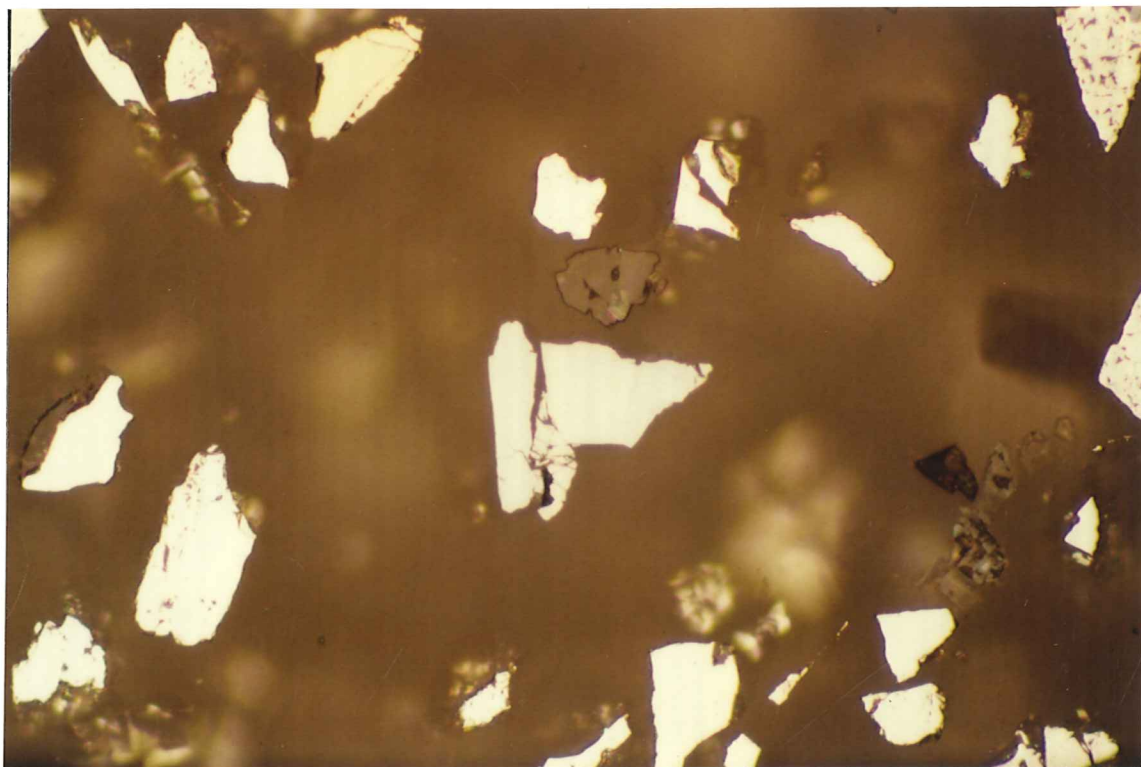
Sphalerite - -1% - Medium gray, isotropic and with strong pale yellowish to orange brown internal reflections, moderate hardness and is well polished. Scarce separate fragments and as inclusions in some of cubic pyrite crystals.

Galena - -1% - Light gray, isotropic and showing poor to moderate development of cubic cleavage, low hardness and is well polished. Occurs in polished surface as scarce liberated fragments and as rare anhedral inclusions in pyrite or bordering pyrite.

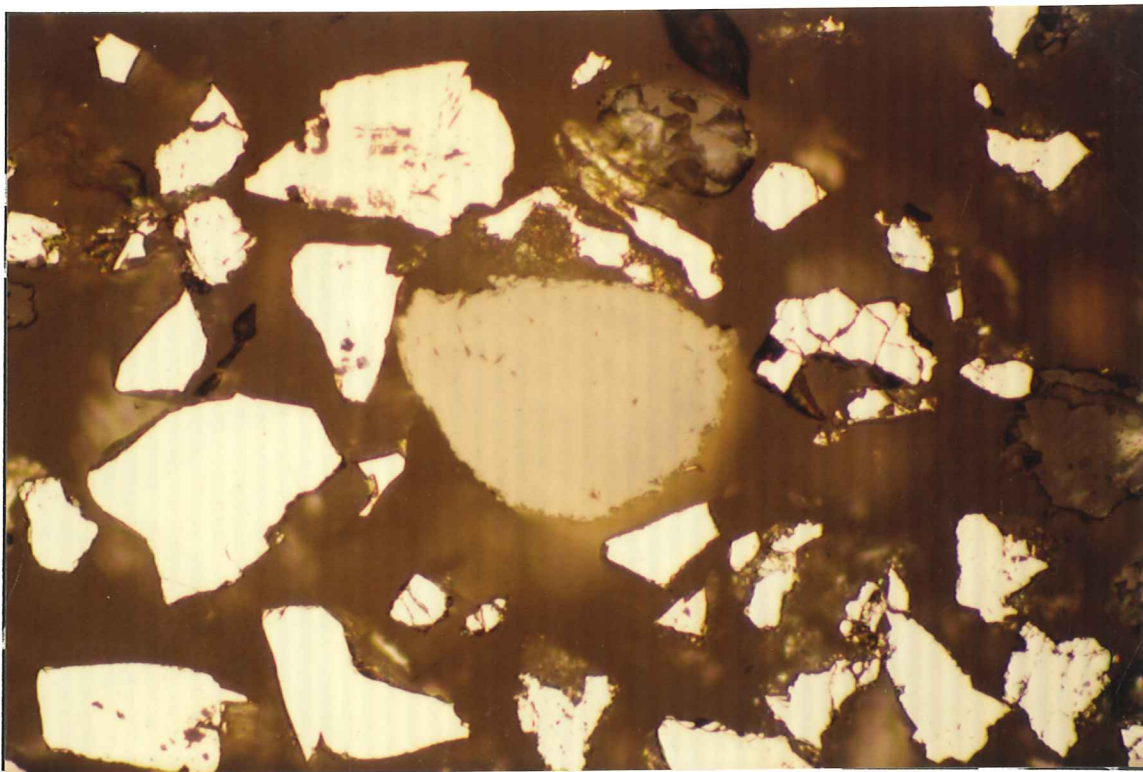
Non-metallic gangue - 65% - Comprised very dominantly of host silicates.

\*Note: Two polished sections were prepared and examined - one of the sample "as received" and one of a panned concentrate prepared therefrom.

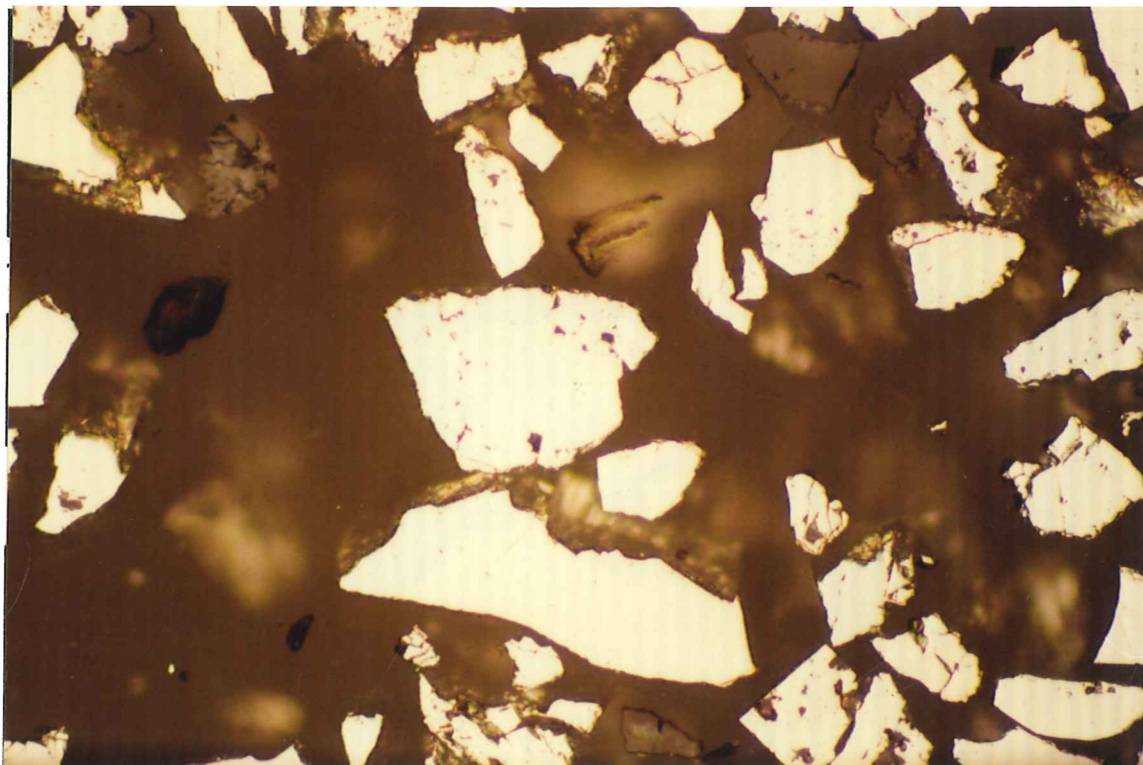




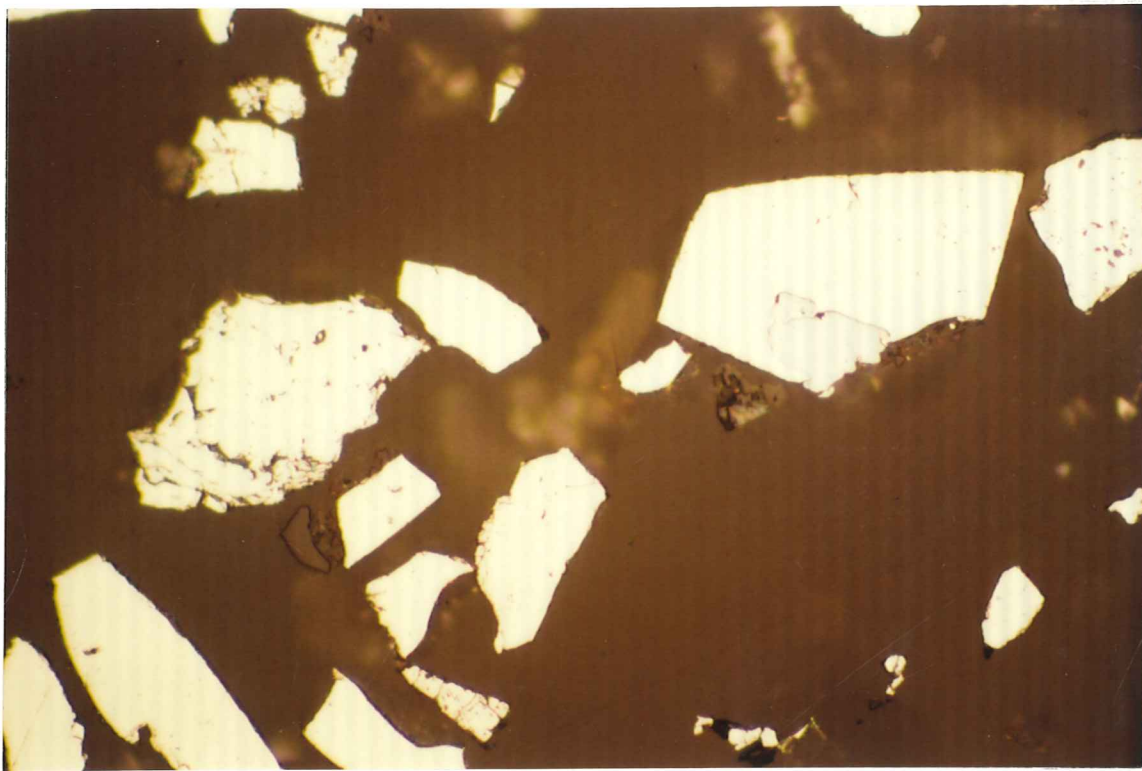
Zone 6 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of miargyrite-polybasite composite (center) accompanied by fragments of pyrite and chalcopyrite (upper left). Plain light, X440.



Zone 6 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of sphalerite with associated pyrite and marcasite. Plain light, X440.

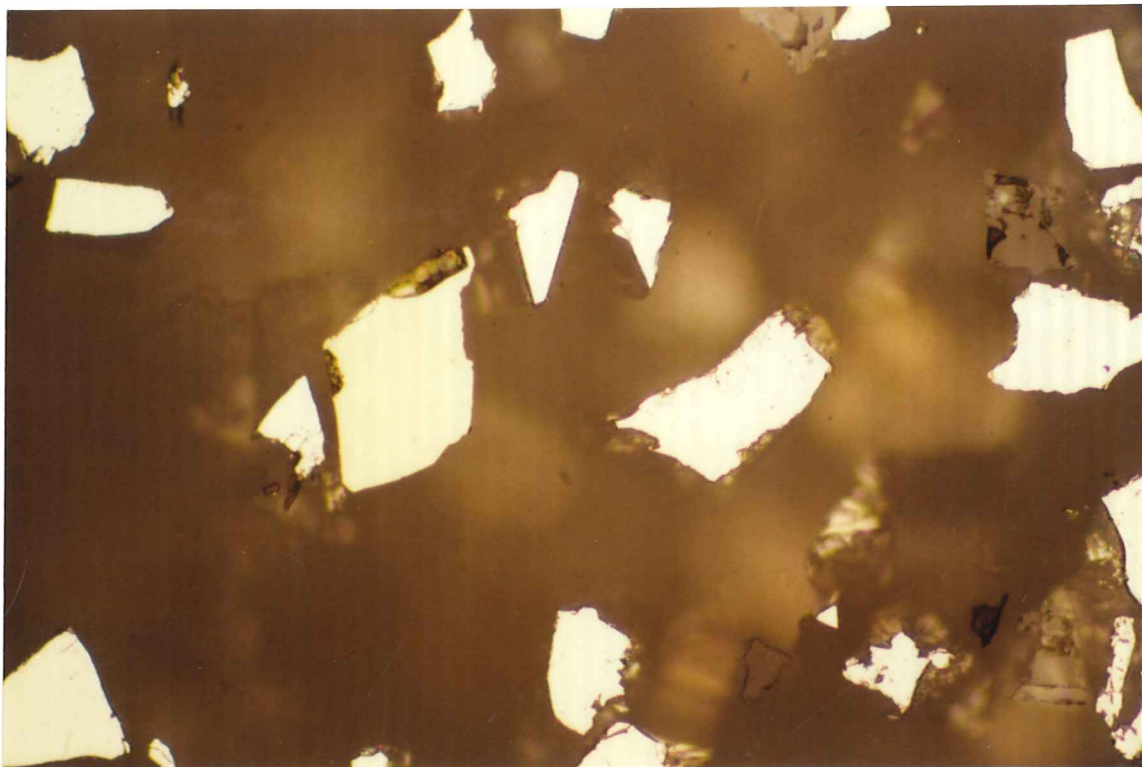


Zone 6 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of two micron sized native gold particle enclosed by arsenopyrite (center) associated with pyrite. Plain light, X440.



Zone 6 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of galena composite with pyrite (upper right) and associated with separate pyrite and marcasite fragments. Plain light, X440.





Zone 6 (Gr. Ro. Conc., Leach Residue). Polished section photomicrograph of chalcopyrite (left) associated with pyrite fragments. Plain light, X440.