

Mining District File Summary Sheet

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DIST_NO	4010
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AUTHOR	Clark J; Allen K
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QUAD_NAME	Sulphur 7.5
P_M_C_NAME (mine, claim & company names)	Rosebud Mine; Rosebud Mining Co LLC; Applied Petrographics
COMMODITY If not obvious	gold; silver
NOTES	petrographic report; geology; photographs mineral list 14p.

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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PETROGRAPHY OF A HIGH-GRADE VEIN SAMPLE FROM
THE ROSEBUD MINE, NEVADA (Sample 24-4532)

By

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APPLIED PETROGRAPHICS
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12 August 1999

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INTRODUCTION

A petrographic study of high-grade vein sample number 24-4532 was undertaken in order to identify ore and gangue minerals. Sample number 24-4532 is the highest grade sample collected from the Rosebud ore body. It assays 126.945 ounces per ton gold and 1186.78 ounces per ton silver. The sample was examined using standard reflected light and transmitted light petrographic techniques, as well as under cathodoluminescence. Mineral identification in this study is based on optical petrographic techniques. In some cases it may be advisable to confirm petrographic identification using quantitative or semi-quantitative analytical techniques, such as electron microprobe or SEM/EDAX.

ORE MICROSCOPY

The polished thin section from sample 24-4532 contains approximately 35 - 40% opaque mineral phases. The opaque mineral phases identified and approximate abundance estimates are:

- Pyrite (20 - 25%)
- Marcasite (5 - 7%)
- Silver sulphosalt (Sb-rich pearceite; antimonpearceite) (5 - 7%)
- Electrum (5%)
- Chalcopyrite (2 - 3%)
- Acanthite (< 1%)

The primary gangue mineral in the vein is calcite, and there appears to be more than one calcite variety (see section on Cathodoluminescence). Host rock alteration minerals are dominantly clay (kaolin?), along with minor fine-grained sericite and quartz. The mineralogy and textural features are documented in photomicrographs that comprise Figures 1 - 6.

Pyrite

Pyrite is the most abundant of the ore mineral assemblage (Figure 1). It occurs as coarse aggregates of sub- to anhedral crystals. The pyritic aggregates reach dimensions of 10mm X 5mm in size, with individual crystal to \pm 4mm diameter. Fine marcasite intergrowths are commonly found within the pyrite crystals. Pyrite occurs also as fine-grained, cubic, rectangular, or trapezoidal crystals, generally < 1mm diameter. These finer grained crystals are also found in aggregates filling skeletal marcasite crystals.

Marcasite

Marcasite is the second most abundant phase in the ore mineral assemblage (Figures 1 and 2). It occurs primarily as eu- to subhedral, elongate, lath-shaped skeletal crystals with long dimensions reaching more than 6mm and aspect ratios of from 2:1 to > 12:1. The skeletal crystals occur both individually and in aggregates. The aggregates of skeletal marcasite crystals occur in matted clusters with a moderate to strong preferred orientation, and as partly radiating clusters. The skeletal crystals are characterized by narrow margins and patchy to elongate interior zones of marcasite. Much of the interior void space is filled by aggregates of fine-grained (0.0Xmm diameter) euhedral pyrite crystals. Locally, significant intracrystalline void space (between the fine-grained pyrite crystals) is filled with a late-crystallizing silver sulphosalt (identified tentatively as Sb-rich pearceite or antimonpearceite), electrum, or

chalcopyrite (Figure 3). Marcasite occurs also as coarse aggregates of subhedral crystals with aggregate and individual crystal dimensions similar to the aforementioned coarse pyrite aggregates. Patches of intergrown pyrite are present locally.

Electrum

Electrum is probably the most important ore mineral. It is present throughout the slide in the following occurrence modes:

- discrete irregular grains (Figure 1).
- filling intercrystalline spaces between fine pyrite/marcasite crystals that occupy the void spaces in skeletal marcasite crystals (Figure 1).
- inclusions in grains of pyrite, marcasite, and chalcopyrite (Figure 4).
- less commonly as narrow, irregular margins between pyrite/marcasite and chalcopyrite crystals (Figure 4).
- as irregular, semi-continuous, essentially poikilitic crystals partially locked against scattered pyrite crystals and partly to completely enclosing irregular blebs of Ag sulphosalt (antimonpearceite?). Some of these blebs are in mottled intergrowth with chalcopyrite (Figure 4).
- as irregular grains with inclusions of chalcopyrite (Figure 1).

The electrum is characterized by very high reflectance and a bright yellowish white color in RL (reflected light). It tarnishes easily, sometimes within several hours after light polishing has removed the tarnish.

Chalcopyrite

Chalcopyrite is common in this sample, but its abundance is subordinate to pyrite, marcasite, electrum, and Ag sulphosalt minerals. It has a pale yellow color under RL, similar to that described for native gold with a significant silver content. This phase was identified originally as native gold, but the mineral has weak, though distinct, anisotropy (Figure 2), and its reflectance is significantly less than that of electrum. The chalcopyrite occurs as:

- discrete, irregular to subhedral cubic grains to > 1mm diameter. Locally these grains nucleate on or encompass earlier crystallizing pyrite or pyrite/marcasite intergrowths.
- partial locked overgrowths on skeletal marcasite/pyrite crystals (Figure 2). Narrow, discontinuous zones of electrum or antimonpearceite (?) sometimes intervene between the chalcopyrite and marcasite.
- irregular blebs and inclusions in electrum and antimonpearceite (Figure 4).
- amoeboid or mottled intergrowth with antimonpearceite and/or electrum (Figures 1 and 4).
- filling intercrystalline spaces between fine pyrite and/or marcasite crystals that fill the skeletal marcasite crystals (Figure 3).

Silver sulphosalt minerals

The most abundant silver-bearing phase is a silver sulphosalt mineral identified tentatively as antimonpearceite. In RL the mineral is grey with a very weak greenish blue tint that becomes more pronounced when it is intergrown with the chalcopyrite. Anisotropism is weak with colors under X-nicols of bluish-grey and brown. No internal reflections were observed, leading to the identification of the phase as antimonpearceite, the only member of the pearceite-antimonpearceite/arsenpolybasite-polybasite solid solution series that lacks internal reflections. One grain was observed under X-nicols to have an isotropic core and an anisotropic rim, although no reflectance difference was noted without the nicols crossed. Occurrence modes include:

- discrete, irregular to subround grains generally less than 0.3mm length or diameter. Locally these grains may have tiny inclusions of chalcopyrite. These discrete grains may be concentrated locally in patches that appear almost as "pseudomymekitic" intergrowths with gangue matrix carbonate (Figure 1).
- late patches that fill intercrystalline void space between fine pyrite and marcasite crystals that themselves fill the skeletal marcasite crystals (Figure 3).
- irregular grains with amoeboid or mottled intergrowths with chalcopyrite (Figures 1 and 4).
- complex intergrowths with electrum, chalcopyrite, and acanthite. The electrum is commonly present as a more or less "poikilitic" host (Figure 4).
- in partial locking texture with larger pyrite or marcasite crystals, sometimes intervening as a discontinuous, thin rim between the pyrite/marcasite and electrum or chalcopyrite (Figure 3).

Acanthite

Acanthite is very much subordinate to silver sulphosalt minerals (antimonpearceite?). Its reflectance is similar, but the polishing hardness is considerably less, and the acanthite tends to have a high concentration of polishing scratches (Figure 3). Acanthite occurs primarily as very fine grains with antimonpearceite in intercrystalline voids between fine pyrite/marcasite crystals that fill the skeletal marcasite crystals.

CATHODOLUMINESCENCE (CL)

Calcite is the primary non-opaque vein-filling gangue mineral. Examination of sample 24-4532 under cathodoluminescence indicates that there are at least two episodes of calcite deposition. Relationships between the calcite varieties are complex locally. There appears to be an early, perhaps pre-ore mineral deposition, phase of non-luminescent calcite (Figures 5 and 6). The lack of CL response is probably due to a significant content of substitutional Fe²⁺ in the

calcite lattice, as Fe^{2+} tends to quench luminescence. A second phase of calcite has bright orange luminescence, attributable to Mn^{2+} activation. The brightly luminescent calcite sometimes displays compositional zonation in bands of different luminescence intensity (Figure 6). This second phase of calcite is the one most intimately associated with the ore minerals (Figure 5).

PARAGENESES

Pyrite and marcasite were the first opaque phases to crystallize. Chalcopyrite and the silver sulphosalt phase (antimonpearceite?) are essentially co-crystalline and were deposited following pyrite-marcasite deposition. Acanthite may also have been deposited at this time. Electrum appears to be the last ore mineral in the depositional sequence.

Coarse, non-luminescent calcite appears to be the first vein mineral in the depositional sequence and appears to be pre- or early syn-ore mineral deposition. The brightly luminescent calcite was deposited with, or closely following, deposition of the ore mineral phases.

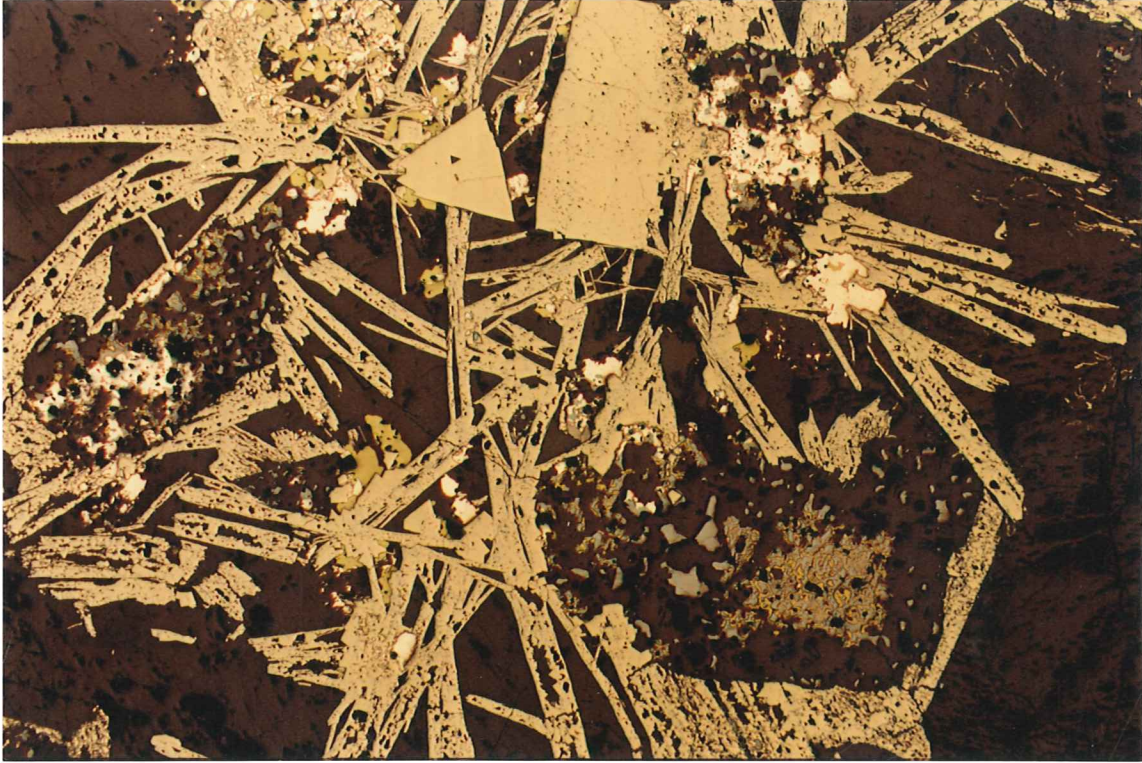


Figure 1. An overview of the ore mineral assemblage in vein sample 24-4532. This photomicrograph shows the dominant composite skeletal crystals of pyrite-marcasite (yellowish creme color and moderately high reflectance. The silver sulphosalt phase (antimonpearceite?) has moderate reflectance and a grey color with a greenish blue tint. Electrum has a bright yellowish white color and a very high reflectance. The chalcopyrite is yellow to pale yellow in color and has a moderately high reflectance. (RL; 1 cm on the photo = 0.441mm)

Figure 2a. Elongate composite skeletal marcasite-pyrite crystals. The marcasite rims exhibit a slightly whiter color than the pyrite. Note also euhedral pyrite crystals. Chalcopyrite is the yellow mineral in locked overgrowth texture with marcasite-pyrite in the upper right quadrant of the photograph. Electrum is the late-crystallizing phase with bright yellowish white reflectance. The largest electrum grains are near the left edge of the photo. (RL; 1 cm on the photo = 0.044mm).
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Figure 2b. Same view and scale as Figure 2a in reflected light with nicols crossed (RLX). Note the bluish grey color of anisotropy of the marcasite in the skeletal composite marcasite-pyrite crystals, and the weak, but distinct, yellow-brown to greenish brown colors of anisotropy in the chalcopyrite.
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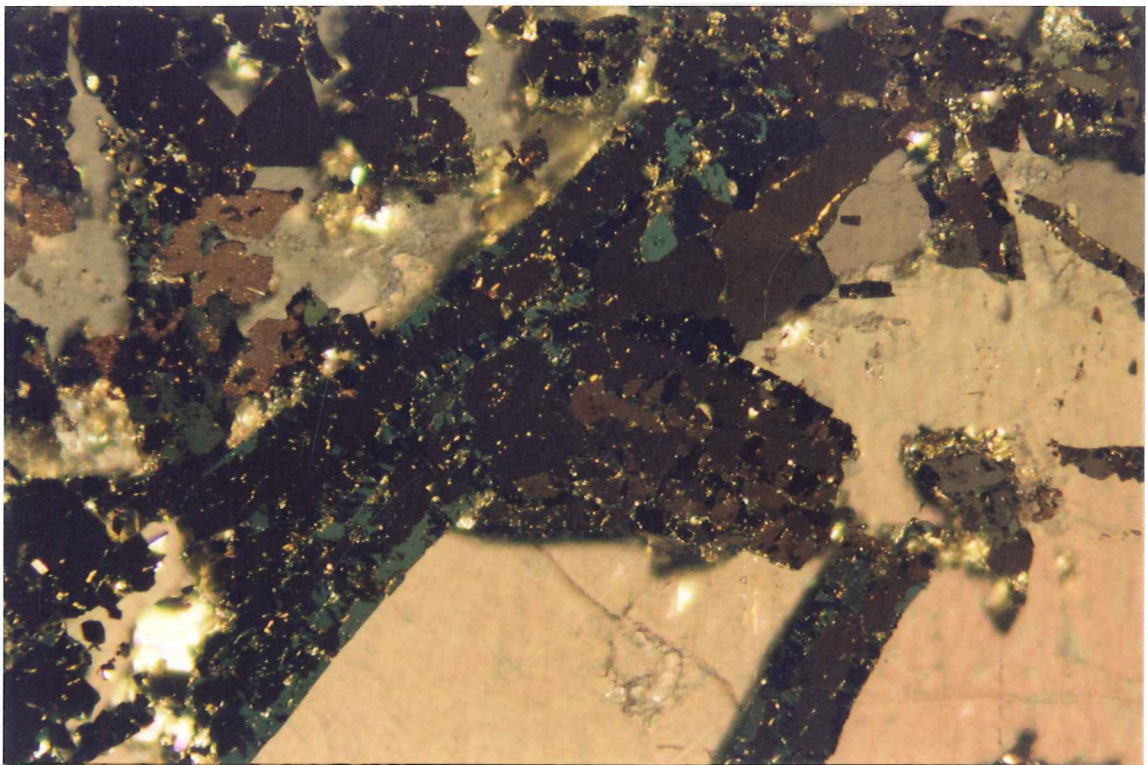
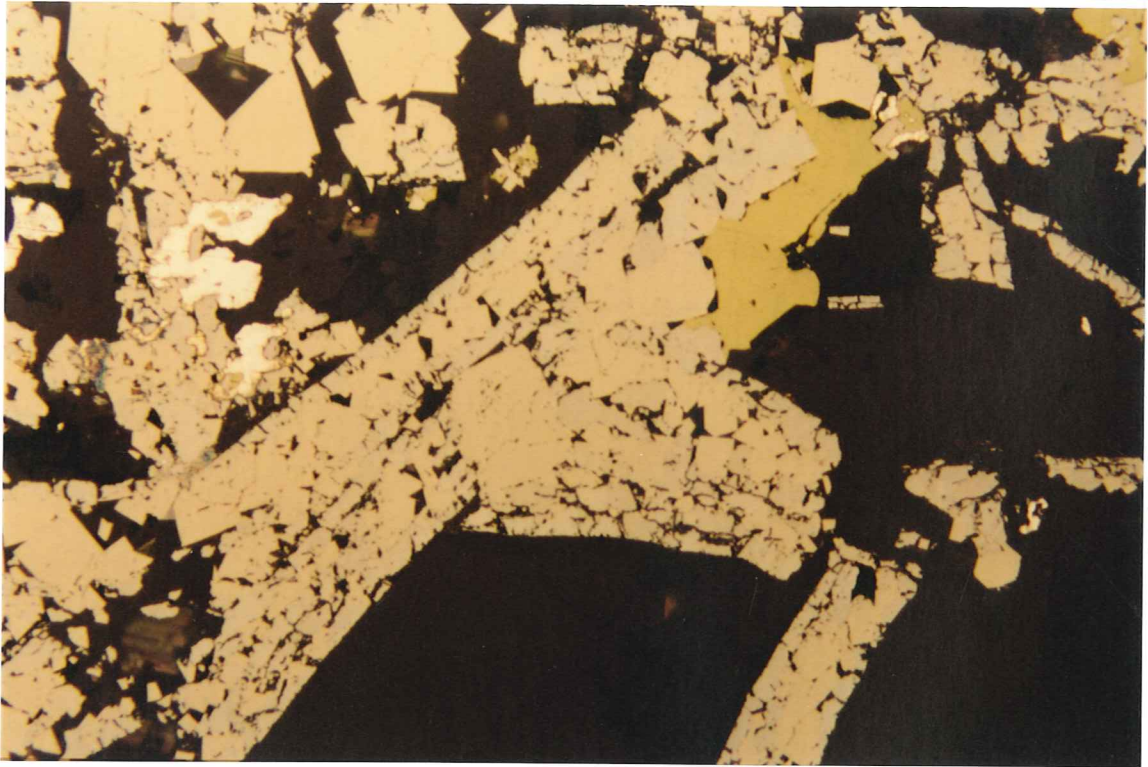


Figure 3. Skeletal marcasite-pyrite crystals with included silver sulphosalt phase (antimonpearceite?) and acanthite (grey color and abundant polishing scratches). Chalcopyrite infill in the central and upper left parts of the photomicrograph. (RL; 1 cm on the slide = 0.018mm).
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Figure 4. Late-crystallizing electrum "poikilitically" enclosing silver sulphosalt phase (antimonpearceite?), chalcopyrite, and pyrite. Intergrowths of Ag sulphosalt and chalcopyrite, and aggregates of composite pyrite-marcasite crystals. (RL; 1 cm on the photo = 0.088mm).
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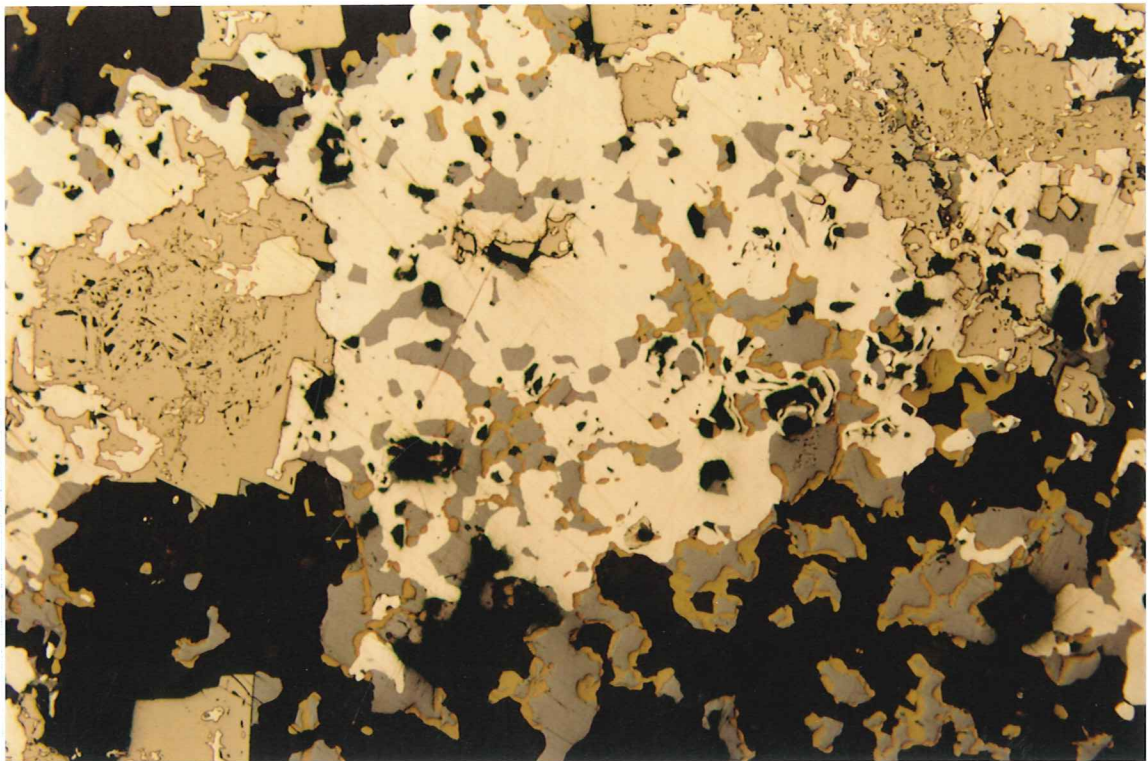
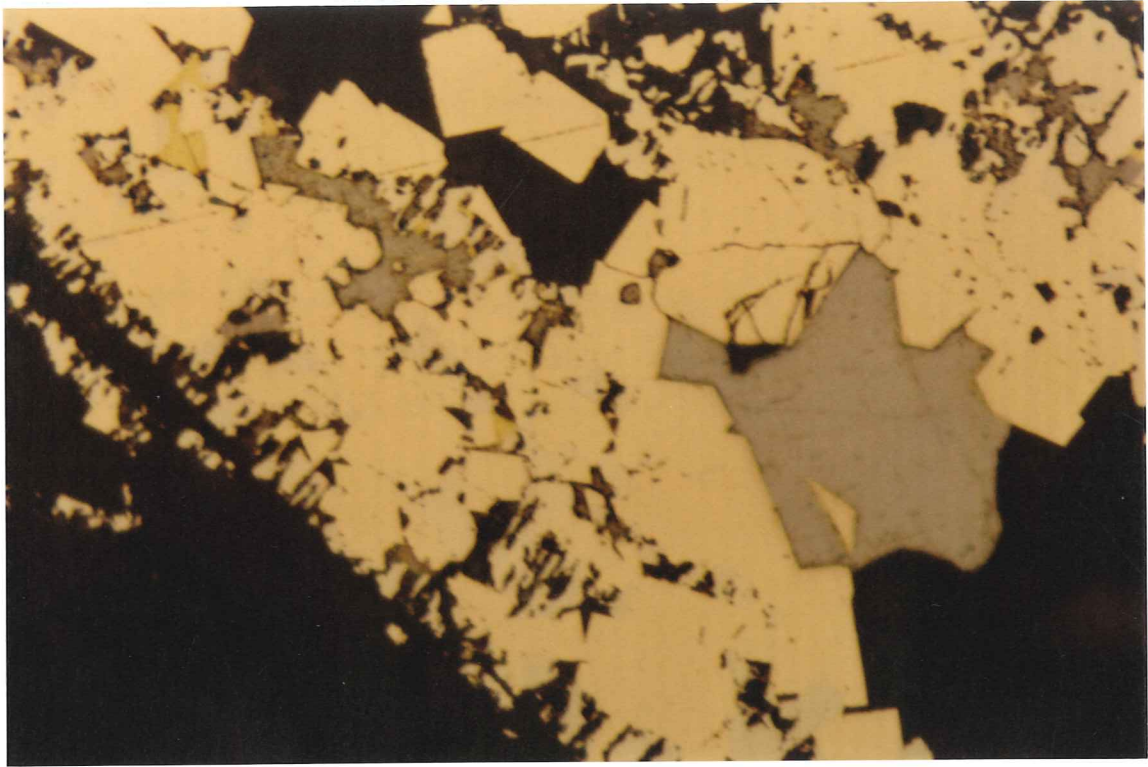


Figure 5a. Irregularly zoned, bright orange-luminescent calcite (Mn^{2+} activation) encompassing opaque minerals, primarily pyrite and marcasite. At lower left and upper right of photomicrograph earlier crystallizing, non-luminescent calcite is replaced by later, bright orange luminescent calcite. (CL photomicrograph; 1 cm on photo = 0.474mm). --->

Figure 5b. Same view and scale as figure 5a. (Transmitted light, crossed nicols [TLX]; 1 cm on photo = 0.474mm). ---->

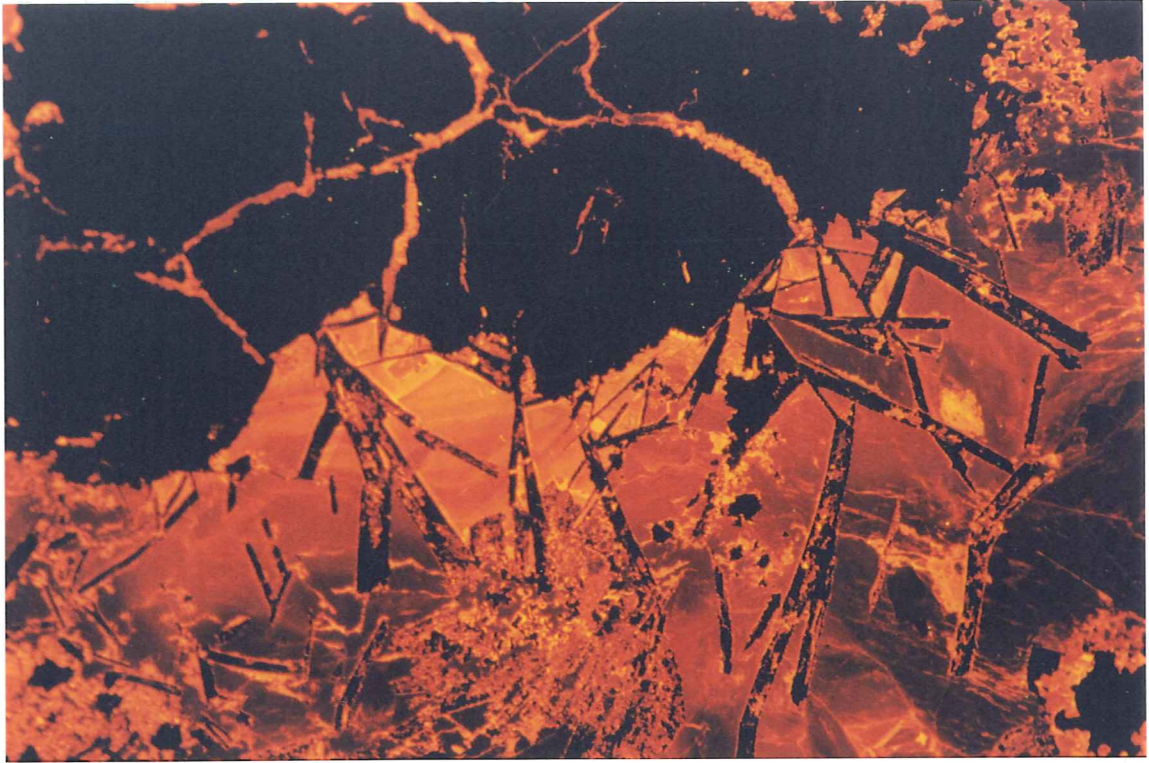


Figure 6a. Late, zoned and brightly orange-luminescent calcite rimming earlier, non-luminescent, pre-ore deposition calcite. (CL photomicrograph; 1 cm on photo = 0.172mm).

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Figure 6b. Same view and scale as Figure 6a. Note that the two different calcite parageneses are not readily observable using standard transmitted light petrography. (Transmitted light, crossed polars [TLX]; 1 cm on the photo = 0.172mm).

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