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A Preliminary Report on the Geology of the Volcanic-Rock-Hosted Barite Hill Gold Deposit, Carolina Slate Belt

By

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A PRELIMINARY REPORT ON THE GEOLOGY OF THE VOLCANIC-ROCK-HOSTED BARITE HILL GOLD DEPOSIT, CAROLINA SLATE BELT

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SLIDE 1 Location in Slate Belt. The Barite Hill mine is located in the southern part of the Carolina slate belt of South Carolina just north of the Georgia border.
SLIDE 2 Mine scene. Barite Hill went into production early in 1991, with open-pit mining and heap-leach extraction.
SLIDE 3 Background. Exploration has been active in the area since the mid-1970's, first for base metals, later for barite, and then for precious metals. Detailed geologic maps of the area and descriptions of other deposits were done at the University of Georgia mostly between 1977-82. Exploration work for Amselco from 1985-88 resulted in excellent maps and reports of Barite Hill. A small-scale study of Barite Hill was initiated by the U.S. Geological Survey in 1989, shortly after the property and data were purchased by Gwalia. The paper we are presenting today incoporates and summarizes some of the ealier work and gives preliminary results of the new work.
SLIDE 4 Summary. This is a summary of the main features of the deposit. Reserves are estimated to be 1.658 million tons of 1.3 g/t Au and 6.2 g/t Ag in the oxidized zone. Plans are for mining only the oxizided material because the amount of pyrite in unoxidized material. Host rocks are mainly sheared Lower Cambrian felsic volcanics with greenschist facies metamorphism. Schistosity and bedding dip steeply to the northwest; bedding is slightly overturned. Mineralized zones are lenticular with a pyritic low gold stage followed by a cross cutting high gold, low base-metal stage. There is widespread sericitic alteration. Gold occurs preferentially in fragmental rocks and is and associated with quartz and pyrite$\pm$barite. Gold and silver occur in native form and electrum and as tellurides with silver also as selenides. The mineralized zones are cut by a shear zone and NW-trending faults.
SLIDE 5 Regional geologic map. The Barite Hill mine is about 2 1/2 miles south of the Dorn mine at McCormick and is in the Lincolnton-McCormick district, which includes several gold and base metal mines and prospects on the flanks of the

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Lincolnton metadacite. The district also includes aluminum-silicate rich zones, such as the Graves Mountain kyantite mine and andalusite that outcrops near the Searl's pig farm mine. The Barite Hill deposit is in the unit locally referred to as the felsic pyroclastic sequence, which lies between the Lincolnton metadacite and an upper sedimentary sequence composed mainly of argillites. The district is in greenschist facies metamorphic rocks of the slate belt northwest of the Modoc zone. The rocks we'll describe today have greenschist facies mineral assemblages, but the prefix "meta-" has been omitted on most of the names to make the slides more legible.

SLIDE 6 Correlation Chart. The Lincolnton metadacite has been dated as early Cambrian and is thought to be comagmatic with the felsic pyroclastic sequence, and may be equivalent to the Persimmon Fork and Uwharrie Formations, although there are questions about the ages, especially for the Albemarle Group and Uwharrie Formation.

SLIDE 7 Mine location. The Barite Hill mine consists of two areas, the main pit area and Rainsford South. Detailed mapping of the felsic pyroclastic sequence by Bill Gunter allowed differentiation of units of predominantly volcanic origin from units that are predominantly clastic and defined map patterns that suggest folds. Schistosity is commonly developed both parallel to bedding and about 5 to 10^{o} from the bedding, with fabrics and orientations that suggest a relationship of schistosity to folding and shearing.

SLIDE 8 Barite Hill, main pit area. This is the detailed map of the lithologies in main pit area, from mapping by Joel Padgett and Dave Watkins from both drill core and trenches. The units dip steeply to the northwest, and where tops are found, they indicate overturned bedding, which is consistent with the regional interpretation of the section becoming younger to the southeast.

The felsic volcanic unit is typically composed of fine grained sericitic metatuffs commonly with quartz eyes, but also includes coarse-grained tuffs and breccias. The sedimentary unit includes medium- to coarse-grained epiclastic rocks that are typically chloritic and contain a variety of clasts including feldspar, quartz, and lithic material. There are also very fine grained argillites and siliceous layers that commonly occur at the tops of volcaniclastic units and above mineralized lenses and could include exhalites and vitric tuffs.

Mineralization is bounded on the south by a sill or stock of feldspar porphyry with plagiogclase and minor quartz phenocrysts in a fine-grained light green matrix. The unit is probably dacite, but is here called a feldspar porphyry, until more detailed petrograhic and chemical work is done. Numerous fine-grained mafic rocks are also present in section. Most are probably dikes or sills, but some have amygdaloidal tops and may be flows. Lenses of sulfide-rich rock, mostly pyrite, some places with base-metals, show up as gossan-like material at the surface. Quartz-barite rocks in which the protolith is obliterated, shown here in pink, are a conspicuous feature of the deposit,

SLIDE 9 Barite outcrop. ...and form prominent outcrops on the southeast side of the hill.

SLIDE 10 Map of main pit area with fragmental rocks and shear zone.

Two other important features of the geologic setting are a shear zone northwest of the porphyry and zones of fragmental rocks. The fragmental rocks generally have hydrothermal overprinting, but probably include pyroclastic and tectonic breccias. Note also, the late northwest trending faults that cut all of the units.

SLIDE 11 Map of main pit area with mineralized zones. The mineralized zones outlined by Amselco work are lenses that plunge gently to the northeast and cut contacts, with the most intense mineralization being roughly within the quartz-barite zone, but not confined to it. Gold values generally drop off in the metasedimentary rock and at the shear zone, and are displaced by the northwest trending faults, suggesting that both the shear zone and faults were active after mineralization.

SLIDE 12 Rainsford South. Relationships are similar in the Rainsford South zone, with the major differences being narrower mineralized zones, the absence of the quartz-barite rock, and a greater divergence of mineralized zones from regional lithologic trends.

SLIDE 13 Stages of mineralization. Two main stages of gold mineralization have been identified: an earlier low gold and a later high gold stage. There is widespread sericitic alteration, and the high gold mineralization is usually in complex cross-cutting veinlets and is associated with quartz and pyrite with or without barite. There is also base-metal mineralization without gold that is local and spacially associated with the feldspar porphyry.

Repeat SLIDE 11. Next, we will look at some drill core. I have chosen BHD 6 because it near the edge of a mineralized lens and has more of the protolith preserved and less overprinting than the more intensely mineralized areas.

SLIDE 14 Log of BHD 6. BHD 6 goes through about 150 feet of fragmental rocks below the oxidized zone, then through a pyritic layer, and then into fine-grained metasedimentary rocks, with grading suggesting that tops of the beds are toward the bottom of the drill hole. Then there is a coarse clastic zone, the shear zone, seen as intensely sheared metasedimentary rocks, finally, the feldspar porphry. Quartz-barite veins cut both the volcanic and sedimentary rocks.

SLIDE 15 BHD 6-52. This is fragmental rock from a depth of 52 feet. It is a polymictic matrix-supported breccia, with clasts of mostly volcanic material. It includes a silicious, pyritic fragment. The white spots are sericite.

SLIDE 16 BHD 6-59. At about 59 feet, the fragments are larger and pyrite-quartz stringers start appearing in the matrix,

SLIDE 17 BHD 6-75.5. **...**but also cutting clasts and earlier veinlets. The rounding of the clasts suggests a hydrothermal origin.

SLIDE 18 BHD 6-82. Some of the clasts are very large and include rock fragments, and the matrix here is completely replaced by pyritic veinlets.

SLIDE 19 BHD 6-132. Deeper in the hole, coarse bladed barite-quartz veins cut pyritic stringers.

SLIDE 20 BHD 6-154. Between 150 and 165 feet the rock is predominantly thinly laminated pyrite with quartz and barite.

SLIDE 21 BHD 6-162. Above the pyrite zone, are fine-grained rocks with graded bedding,

SLIDE 22 BHD 6-166. **...**that grade into rocks that contain rip-up clasts of the fine-grained beds. Further up in the section are intensely sheared rocks, and feldspar porphyry.
SLIDE 23 Feldspar porphyry--thin section. This is a thin section of the feldpar porphyry in polarized light, showing subhedral plagioclase in a fine-grained matix that has a schistosity that wraps around the felspar phenocrysts. This field of view is 2.2 mm in the long direction.
SLIDE 24 BHD 6 with chemistry. Next we will look at the distribution of metals and barium for BHD 6. High-gold zones are shown in dark pink, and low gold in light pink. One high gold zone occurs near the surface and another is associated with the fragmental rock that contains pyrite-quartz stringers. The high gold zones are surrounded by a low gold zone that ends at the contact of the pyrite zone with metasedimentary rocks. The high base-metal zone in the clastic rocks adjacent to the porphyry is probably the local base-metal mineralization that does not contain gold. High silver values are associated with both the gold and base-metal mineralization. The most abundant barite in this hole is in the low gold zone, but quartz-barite veins also cut metasedimentary rocks.
SLIDE 25 Whole thin section of pyritic zone. Judy Back has begun to do detailed petrographic studies on the Barite Hill rocks. This is the entire thin section in plane light in which we searched for gold using a scanning electron microscope. This thin section is from a rock with abundant pyrite stringers in the Rainsford South zone. Several distinct areas can be defined by textures. The area numbered 1 is least affected by shearing and silicification, and may have been a lithic clast. The area numbered 2 shows a well developed shear schistosity.
SLIDE 26 Area 2--Polarized light. This is the fabric of area 2 under polarized light, showing the strong preferred orientation defined by aggregates of pyrite (black) and muscovite. The field of view is about 2.2 mm in the long dimension.
SLIDE 27 Area 2--Reflected light. This is the same area in reflected light, showing elongation of pyrite along schistosity and muscovite cutting pyrite grains, suggesting that this pyrite was pre- to syntectonic.
Repeat of SLIDE 25. The areas numbered 3 are coarser grained segregations or veinlets that contain more abundant quartz that invades and engulfs the pyrite-muscovite schistosity. The red square outlines the area of the next slide, which is near the end of an area 3 veinlet.
SLIDE 28 SEM. This is an SEM photo of the area in the square. The shades are the opposite here as on the previous slide. The black is quartz, the dark gray blades are muscovite, white is pyrite, and the small bright spot in the square contains Au. The next slide will be a closer view of the area in the square.
SLIDE 29 SEM Closer view. This is the gold-bearing grain, surrounded by quartz. And now, zooming in on the area in the red square,
SLIDE 30 SEM Closest. A mottled texture can be seen. The grain is a Au-Ag telluride, probably sylvanite, with Au only in the larger and slightly brighter end of the grain.
SLIDE 31 Area 3 with gold grain--crossed nicols. This is the area that contained the gold viewed under crossed nicols, 2.2 mm in the long dimension, showing at the tip of

the arrow, the spot identified as gold on SEM, which is at the boundary of quartz grains.

SLIDE 32 Cu mineral, SEM. In other parts of the slide we found Ag, Pb, and Cu-bearing minerals generally in quartz-pyrite rich areas. This SEM photo shows typical relationships. The light gray mineral is a Cu-Fe-As-S mineral with minor zinc and antimony that has crystallized in intergranular area of subhedral pyrite crystals.

SLIDE 33 Mineralogy. This is a list of minerals from Barite Hill that were reported by Gunter and Padgett. They found gold in its native state and in sylvanite and electrum. Silver is present as native silver and in electrum, argentite, galena, hessite, and complex selenides and tellurides. Other minerals include base-metal sulfides and Cu-Pb-Bi tellurides and selenides.

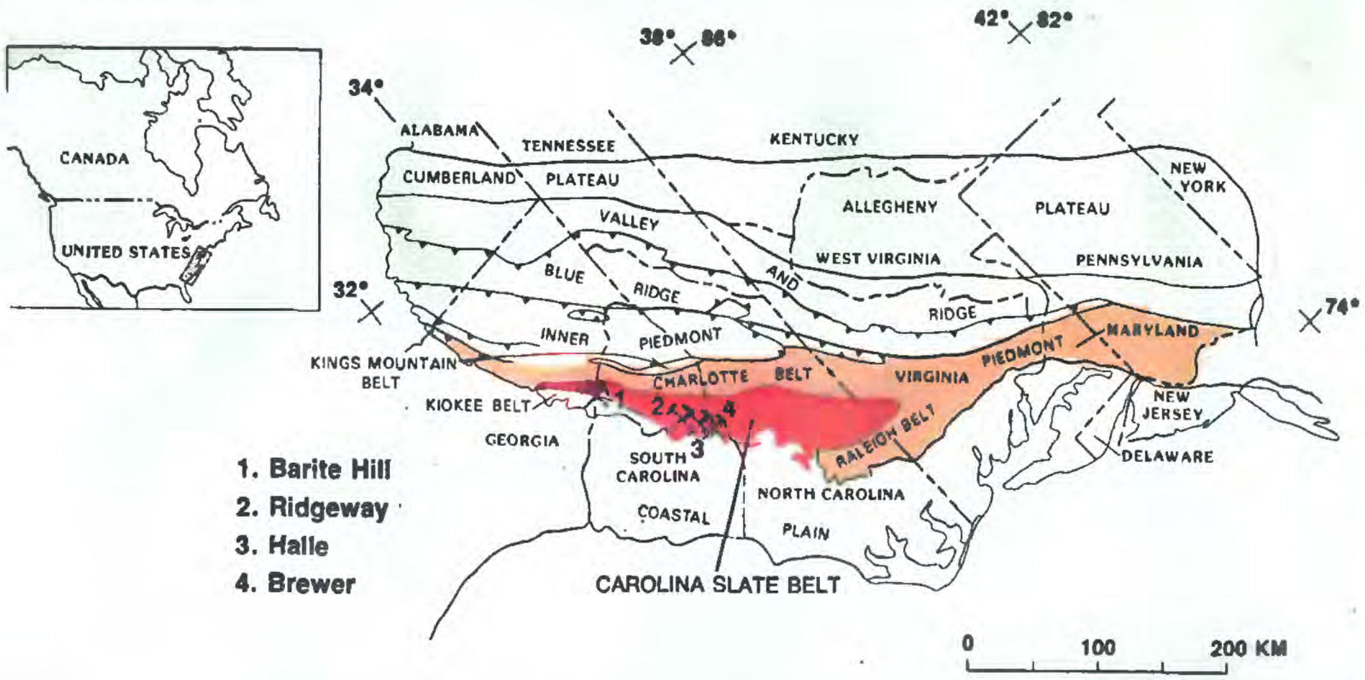
Repeat of SLIDE 25. There also quartz overgrowths that show up here as white spots and also occur in area 3 overprinting the strained quartz that is associated with the gold mineralization.

SLIDE 34 Late barite, thin section. In rocks with coarse-grained barite, barite crystals engulf gold-bearing quartz and pyrite suggesting that barite crystallized after gold. This slide is 2.2 mm in the long direction.

SLIDE 35 Supergene barite. Barite also formed much later as crystals in cavities in the oxidized zone along with iron oxides, suggesting supergene dissolution and reprecipitation.

SLIDE 36 Conclusions. This is a summary of some tentative interpretations of the features we have described. Mineral assemblages and alteration are consistent with an epithermal environment. The gold that we have seen is most commonly in veinlets cutting hydrothermally altered breccias, with veinlets so abundant in some places that they obliterate the protolith. The gold is generally associated with quartz and pyrite that show the effects of tectonism, plus or minus barite, which is later in the paragenesis. Gold is most commonly in intergranular areas or microfractures.

The sequence of tectonic events that we are beginning to unravel, suggests an order of events in which volcanism is followed by deformation that produced penetrative schistosity and shearing. This was followed by precipitation of gold from hydrothermal fluids either as a late phase of the major schistosity-producing event, or as a later event, which was followed by movement along shears and high-angle faults.



SLIDE 1

SLIDE 2

BACKGROUND

University of Georgia, Athens (1977-82)

Robert Carpenter
Gilles Allard

Martin Fay
Thomas Biggs
Verner Guthrie
Travis Paris

Amselco (1985-88)

Douglas Duskin
William Gunter
Joel Padgett
David Watkins

Present Study (1989-present)

SLIDE 3

SUMMARY

Reserves -- 1.658 MT of 1.3 g/t Au and 6.2 g/t Ag

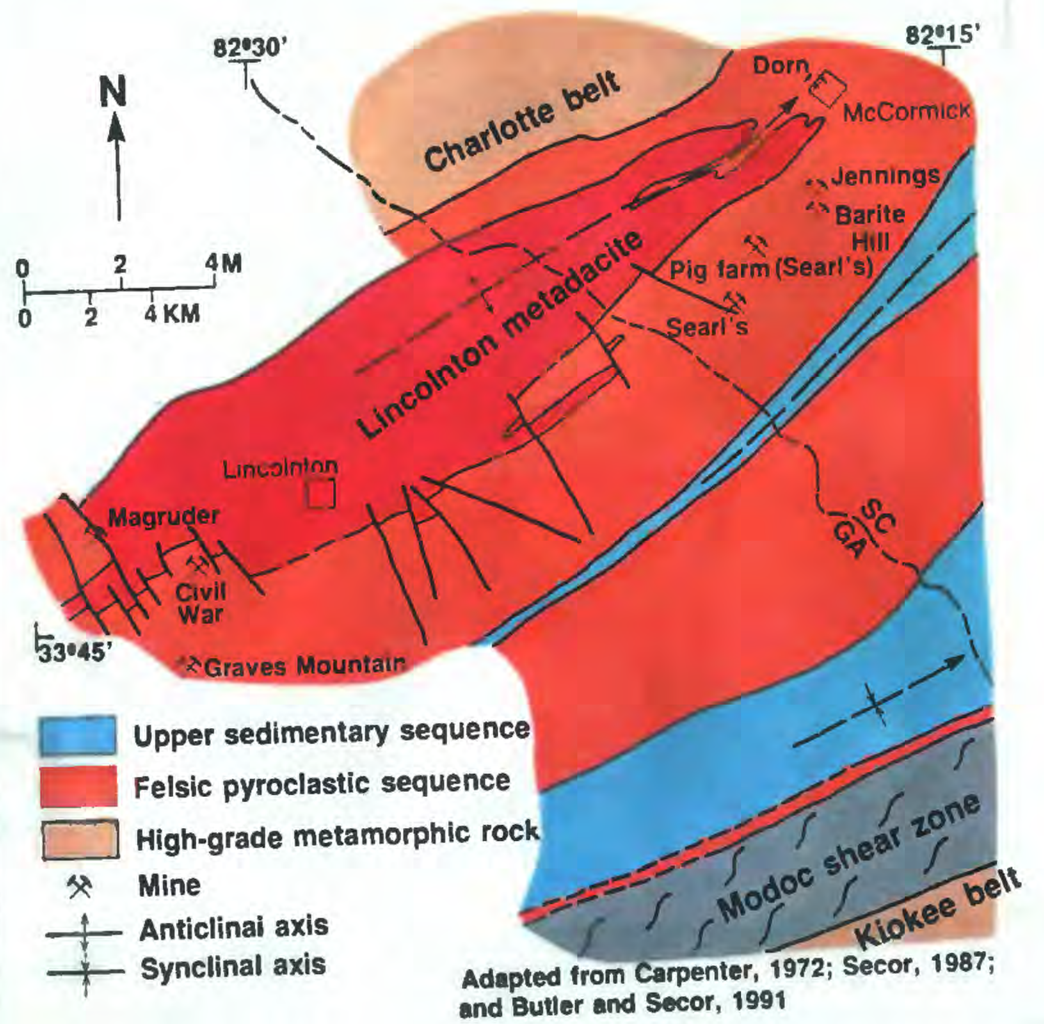
Host rocks -- Lower Cambrian felsic metavolcanics
Greenschist facies metamorphism
Steep dips to NW, overturned

Lenticular mineralized zones
Early high base metal-low gold stage followed by
  cross-cutting high gold-low base metal stage
Au zone preferentially in fragmental rocks
Au is intergranular, associated with
  pyrite, quartz ± barite

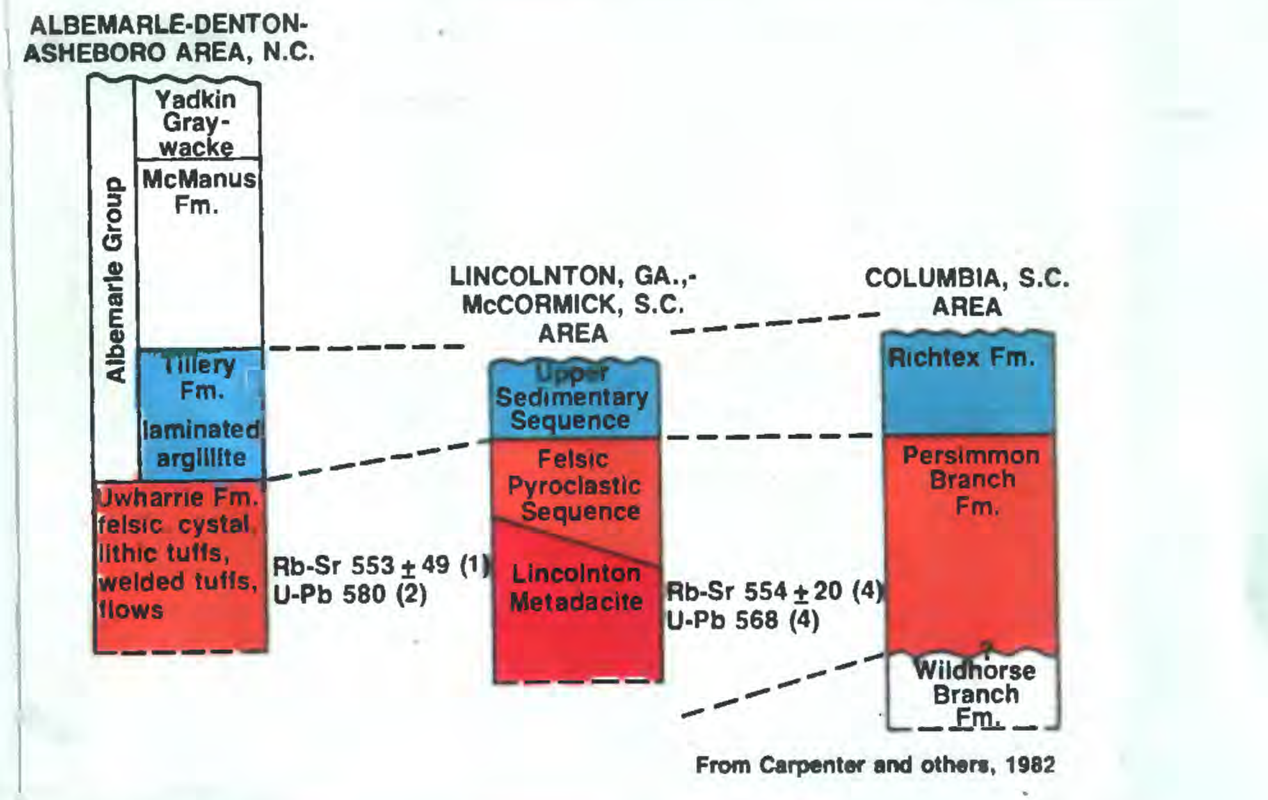
Au and Ag -- native, in electrum, sylvanite,
  tellurides, selenides

Mineralized zone cut by shear and faults

SLIDE 4



SLIDE 5



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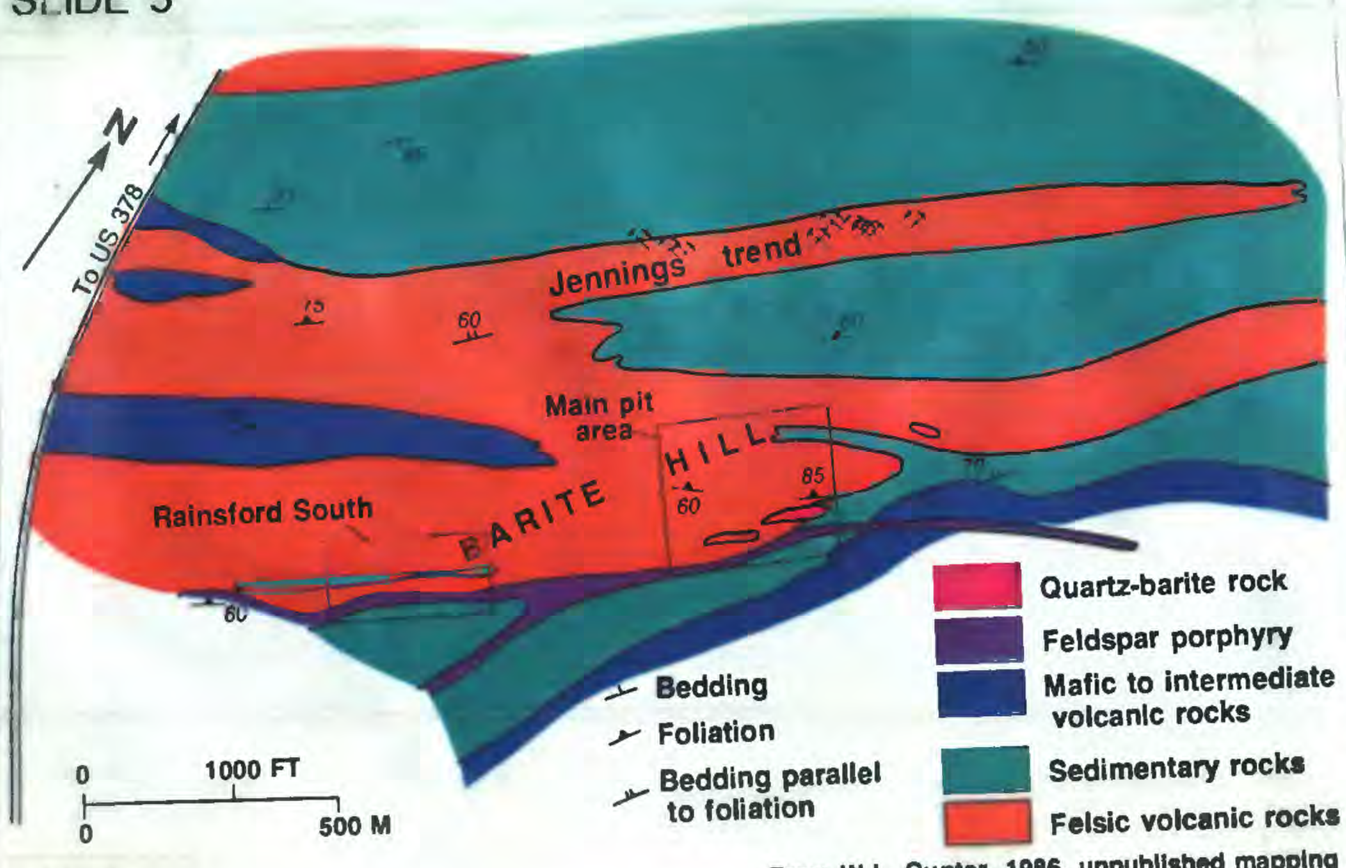
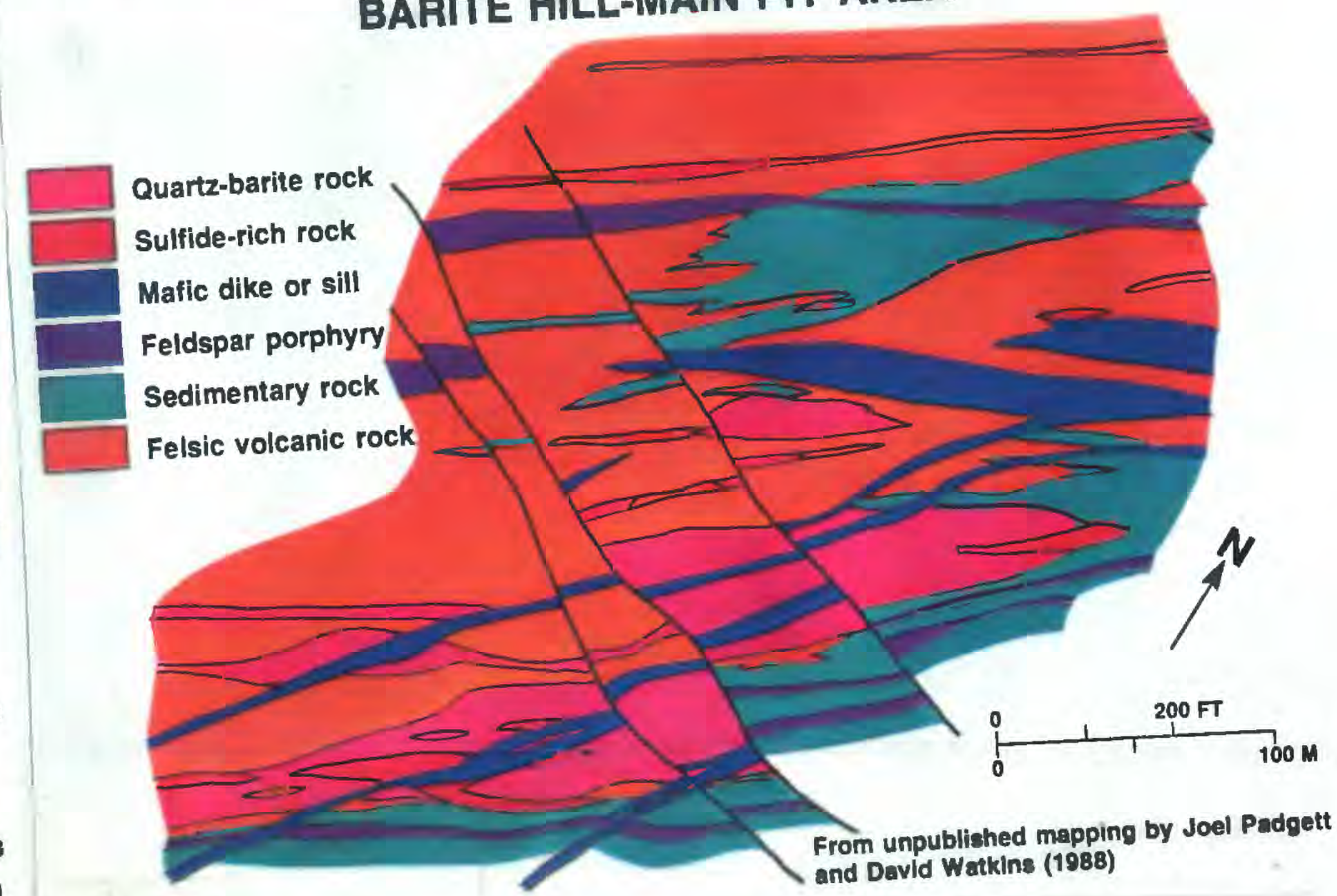


SLIDE 7

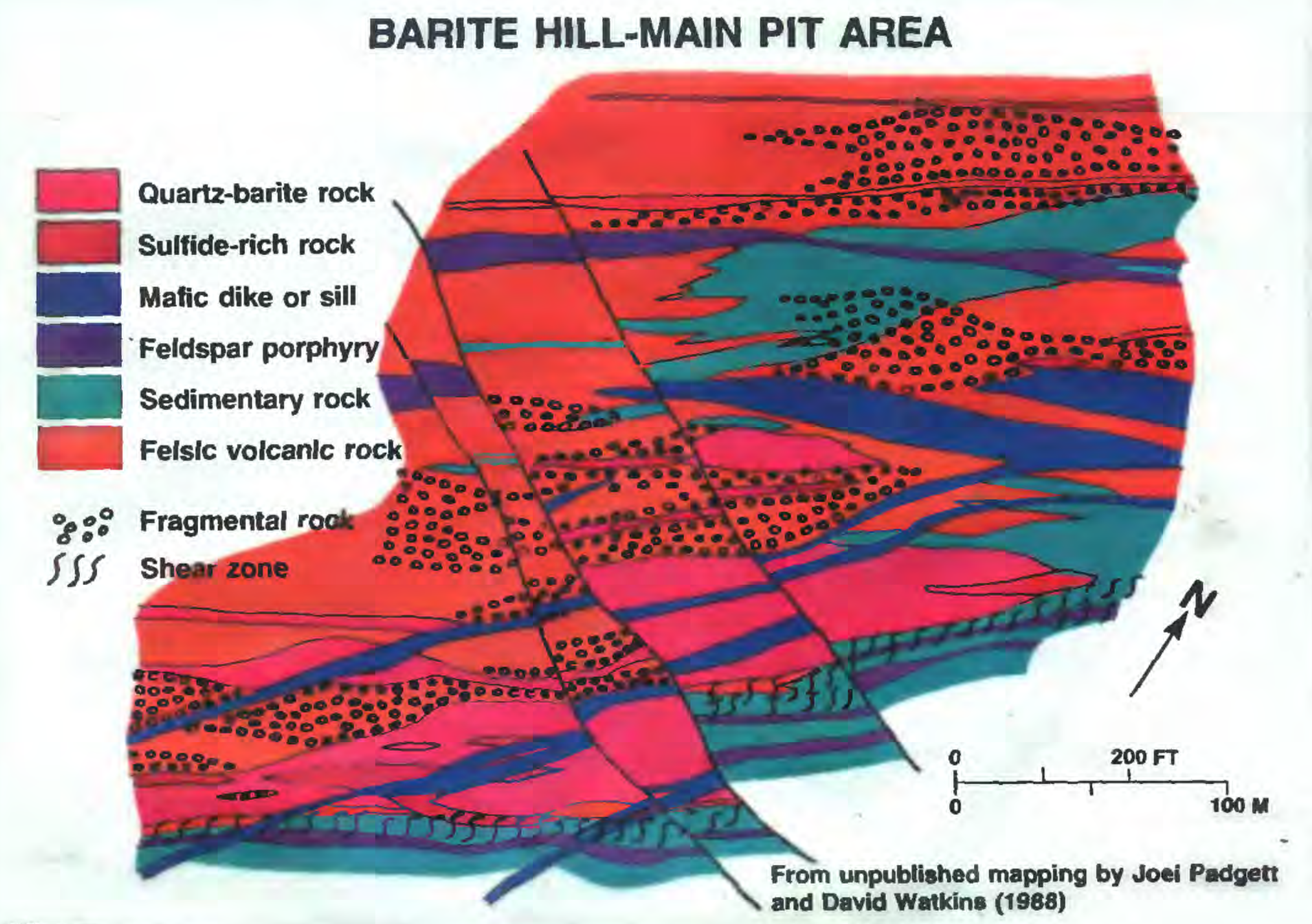
BARITE HILL-MAIN PIT AREA



SLIDE 8

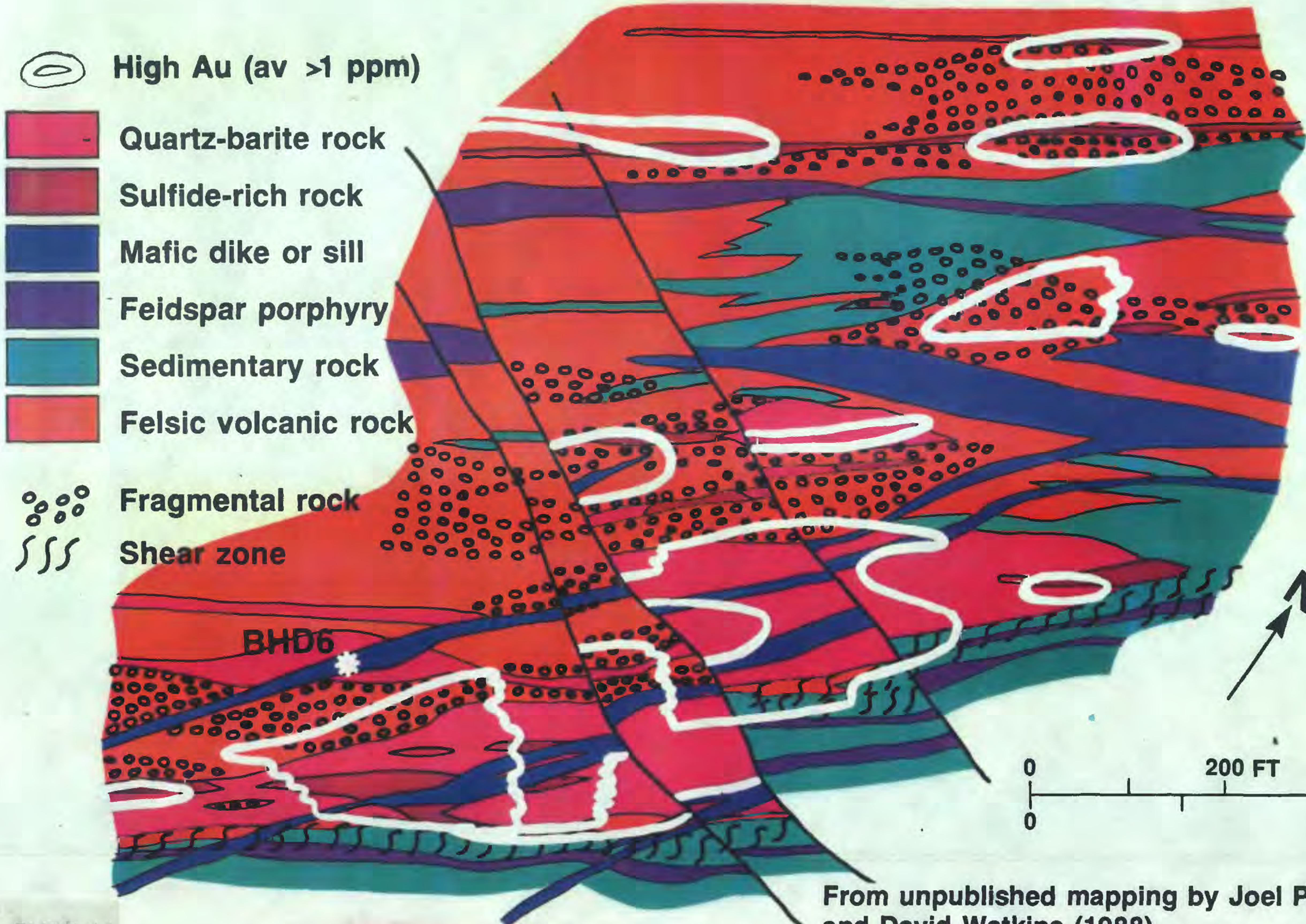
7

SLIDE 9



SLIDE 10

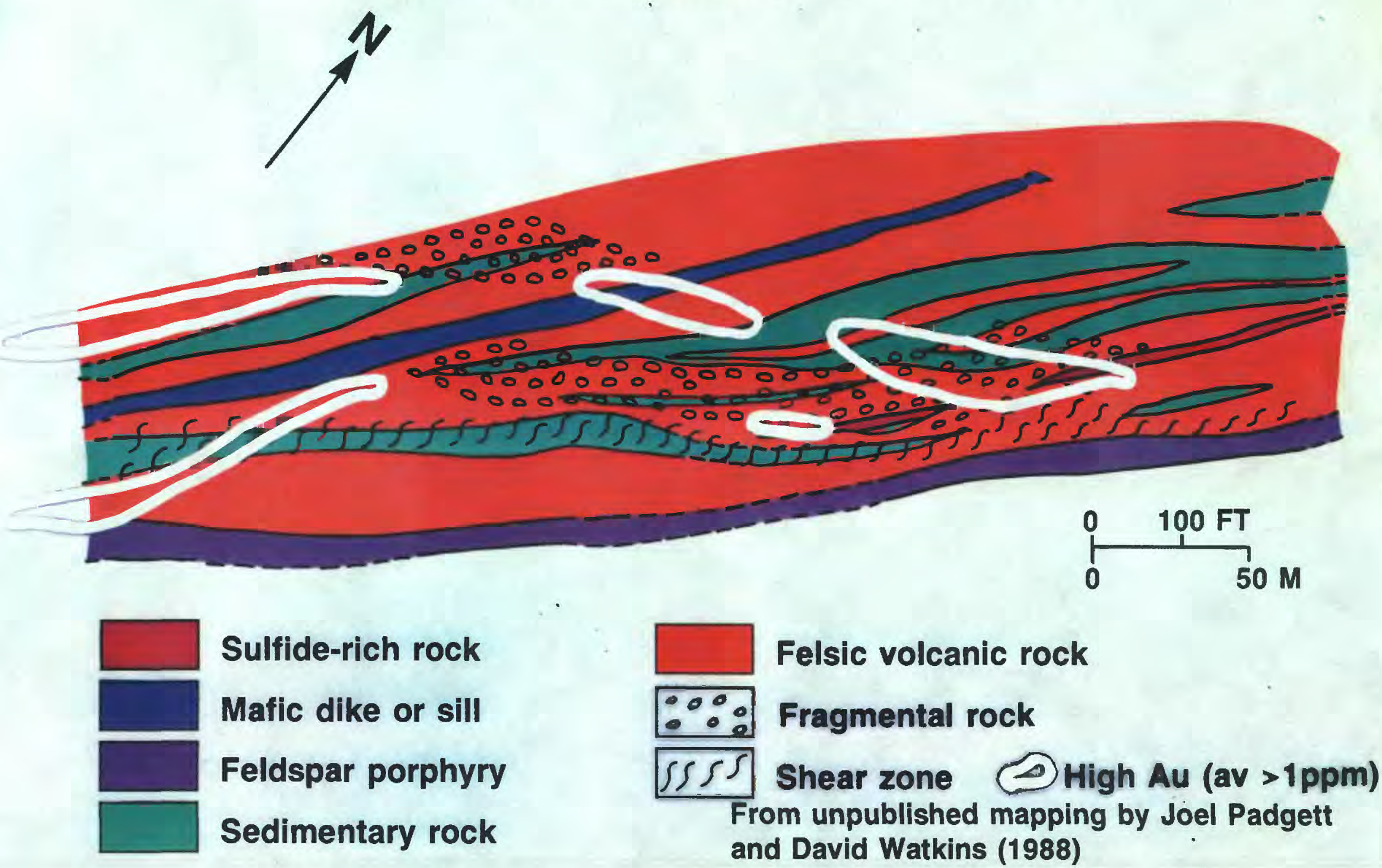
BARITE HILL-MAIN PIT AREA



From unpublished mapping by Joel Padgett and David Watkins (1988)

SLIDE 11

BARITE HILL-RAINSFORD SOUTH



From unpublished mapping by Joel Padgett and David Watkins (1988)

SLIDE 12

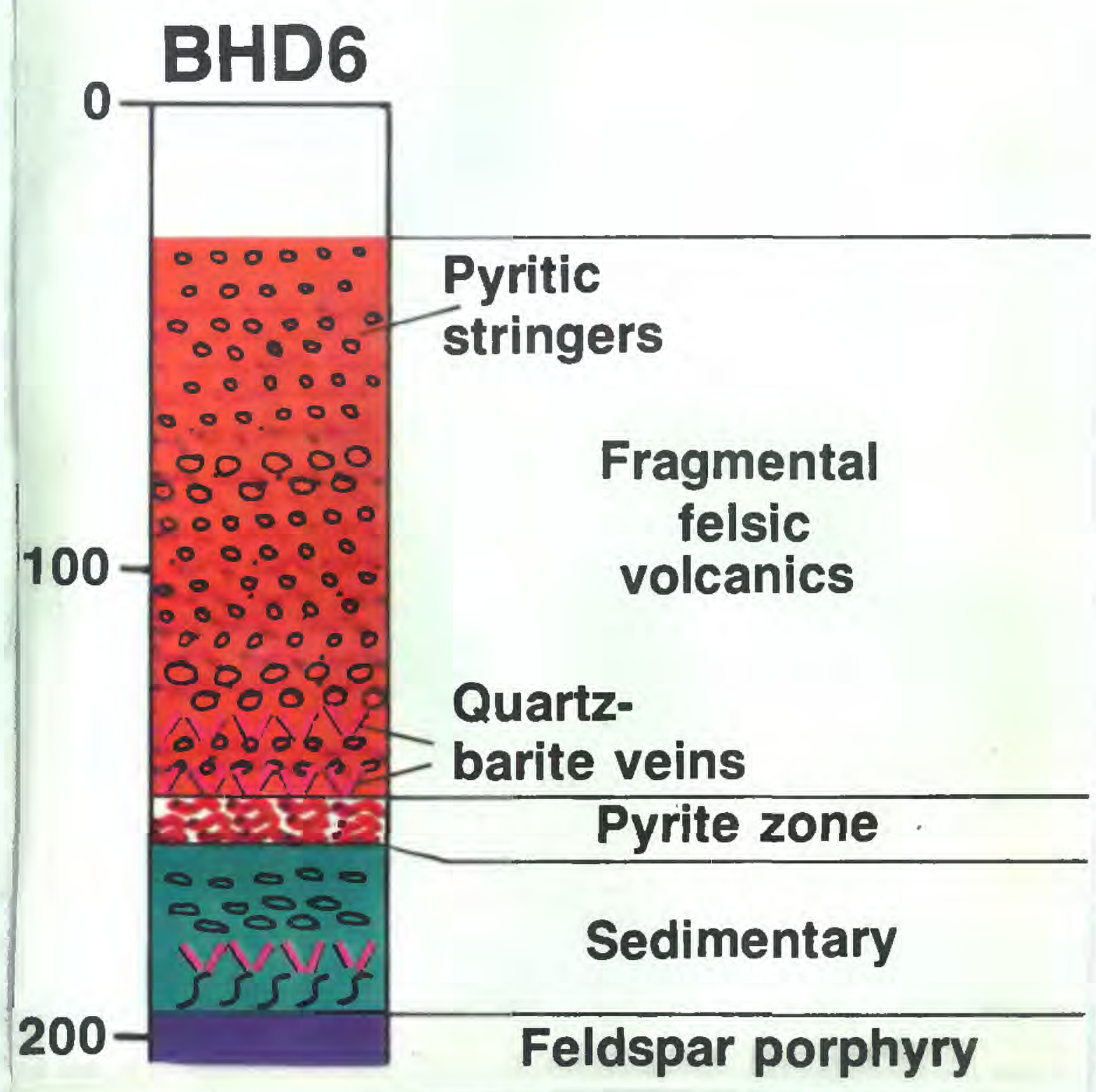
STAGES OF MINERALIZATION

Early --High base metal-low gold
Pyrite and locally base-metal sulfides with quartz + sericite ± barite

Late -- High gold-low base metal
Locally intense quartz-barite alteration

Complex cross cutting veinlets with pyrite and volumetrically minor base-metal sulfides, tellurides, and sulfosalts

SLIDE 13



SLIDE 14

SLIDE 15

SLIDE 16

12

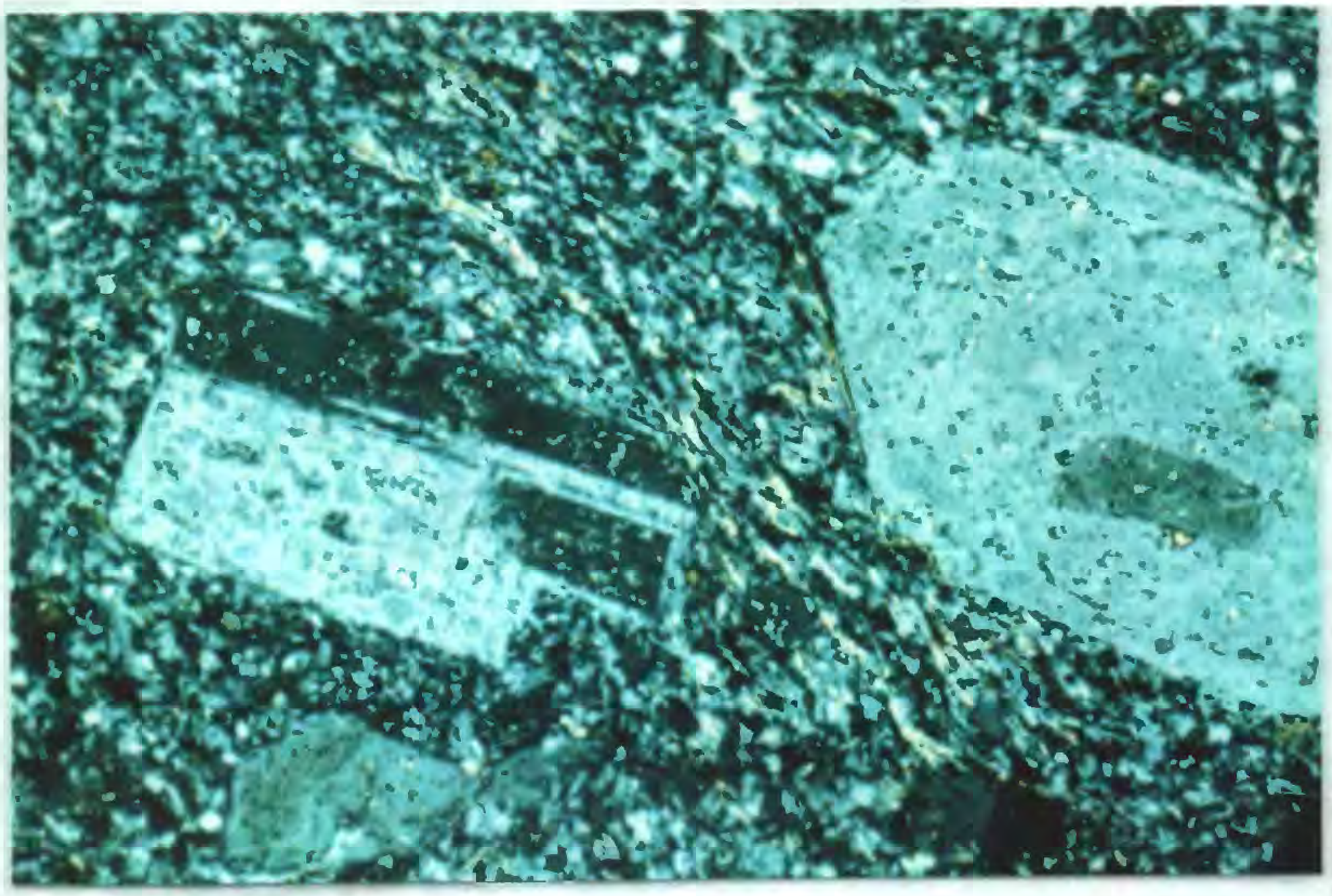
SLIDE 17

SLIDE 18

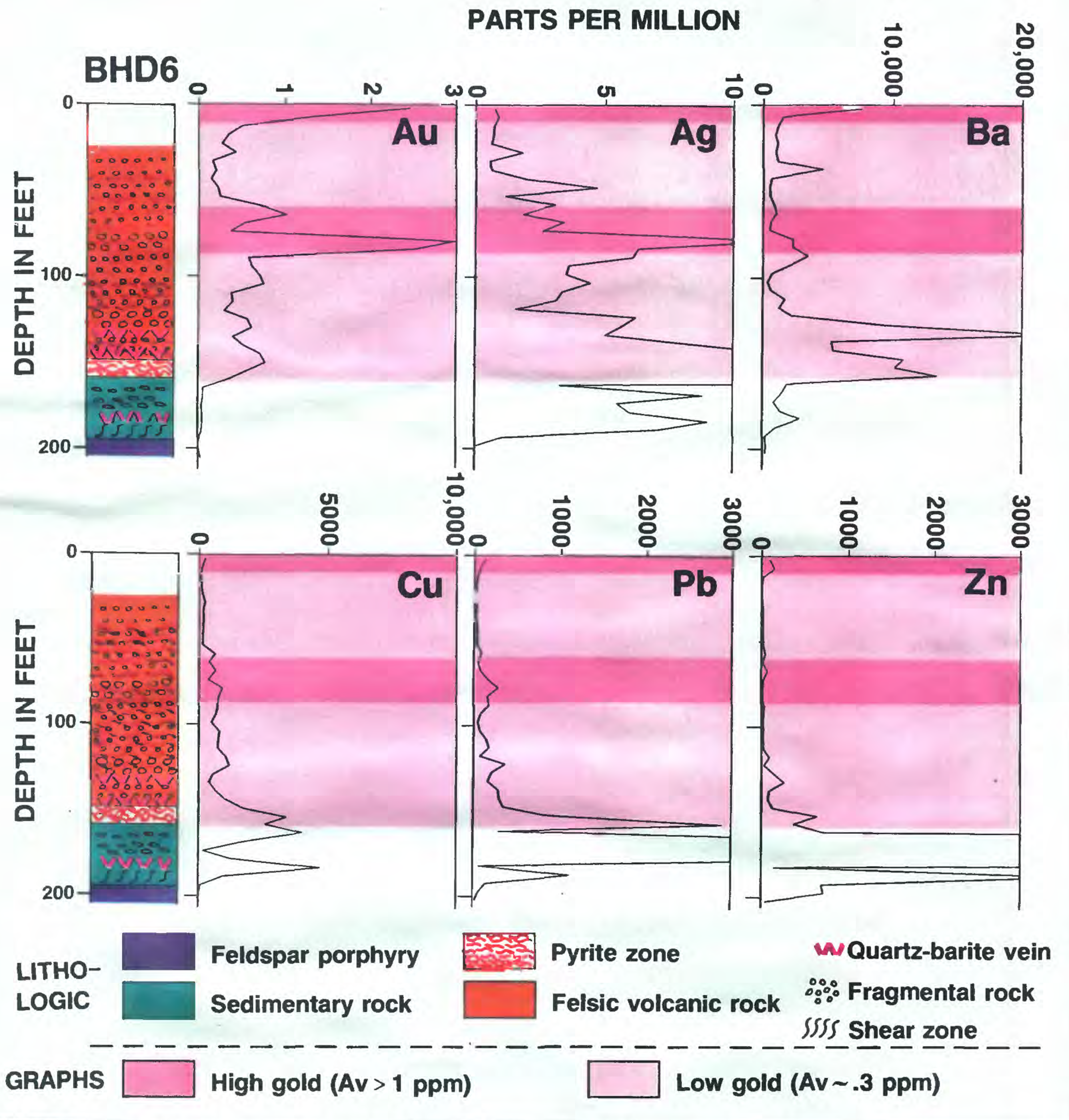
SLIDE 20

13

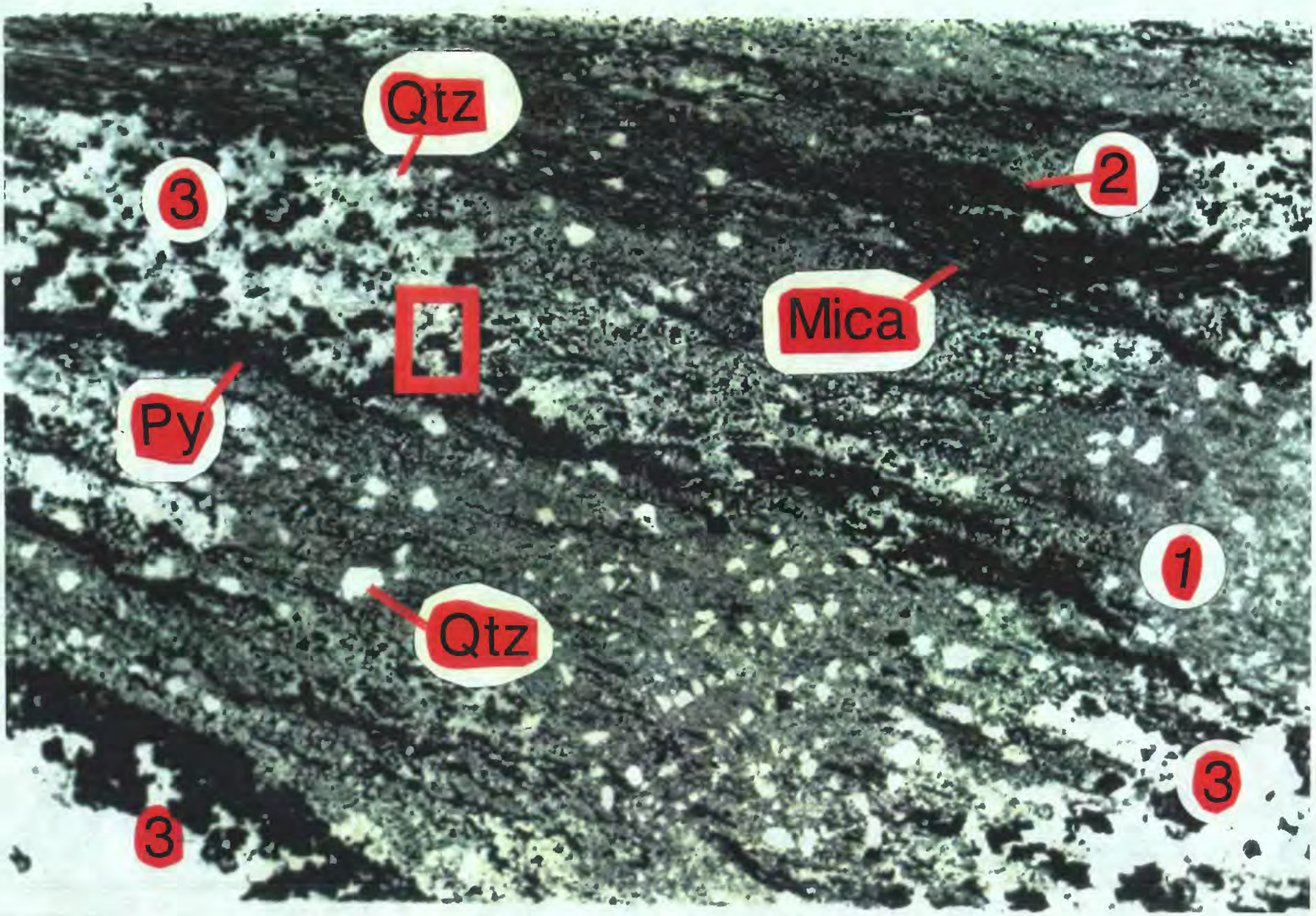
SLIDE 19



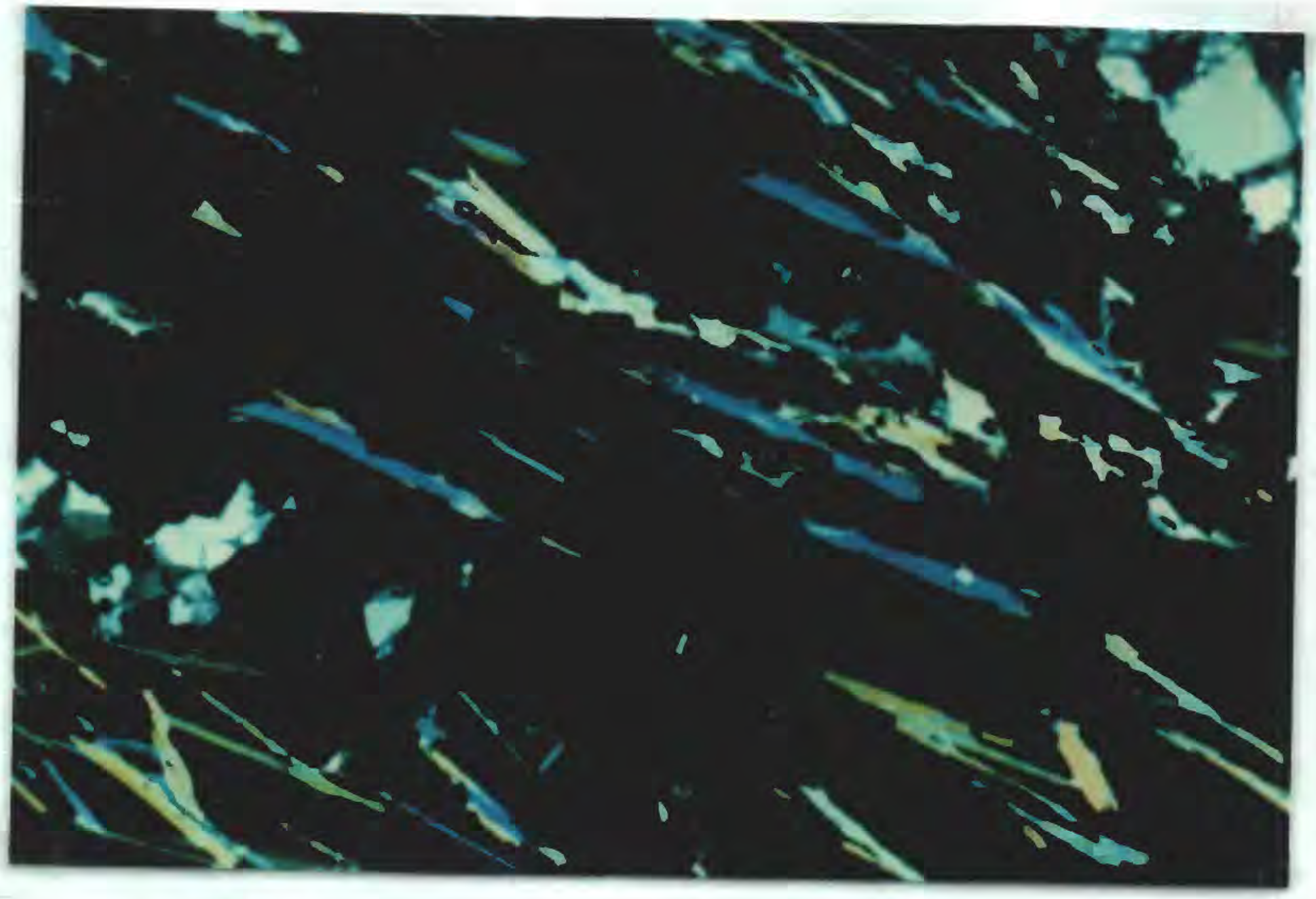
SLIDE 23


PARTS PER MILLION
BHD6
DEPTH IN FEET
0
100
200
Au
0
1
2
3
Ag
0
5
10
Ba
0
10,000
20,000
Cu
0
5000
10,000
Pb
0
1000
2000
3000
Zn
0
1000
2000
3000
LITHO-LOGIC
Feldspar porphyry
Sedimentary rock
Pyrite zone
Felsic volcanic rock
Quartz-barite vein
Fragmental rock
Shear zone
GRAPHS
High gold (Av > 1 ppm)
Low gold (Av ~ .3 ppm)

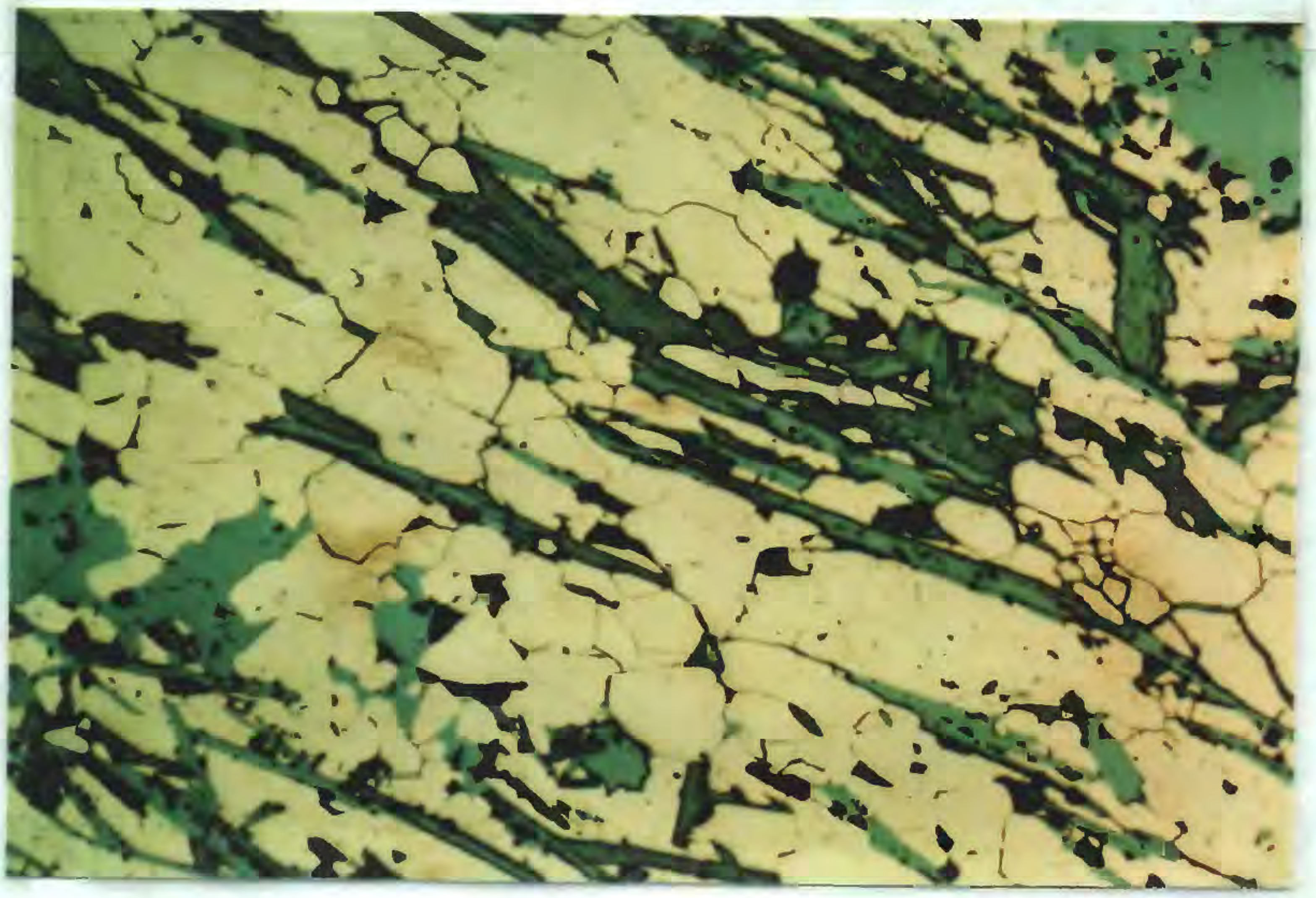
SLIDE 24



SLIDE 25



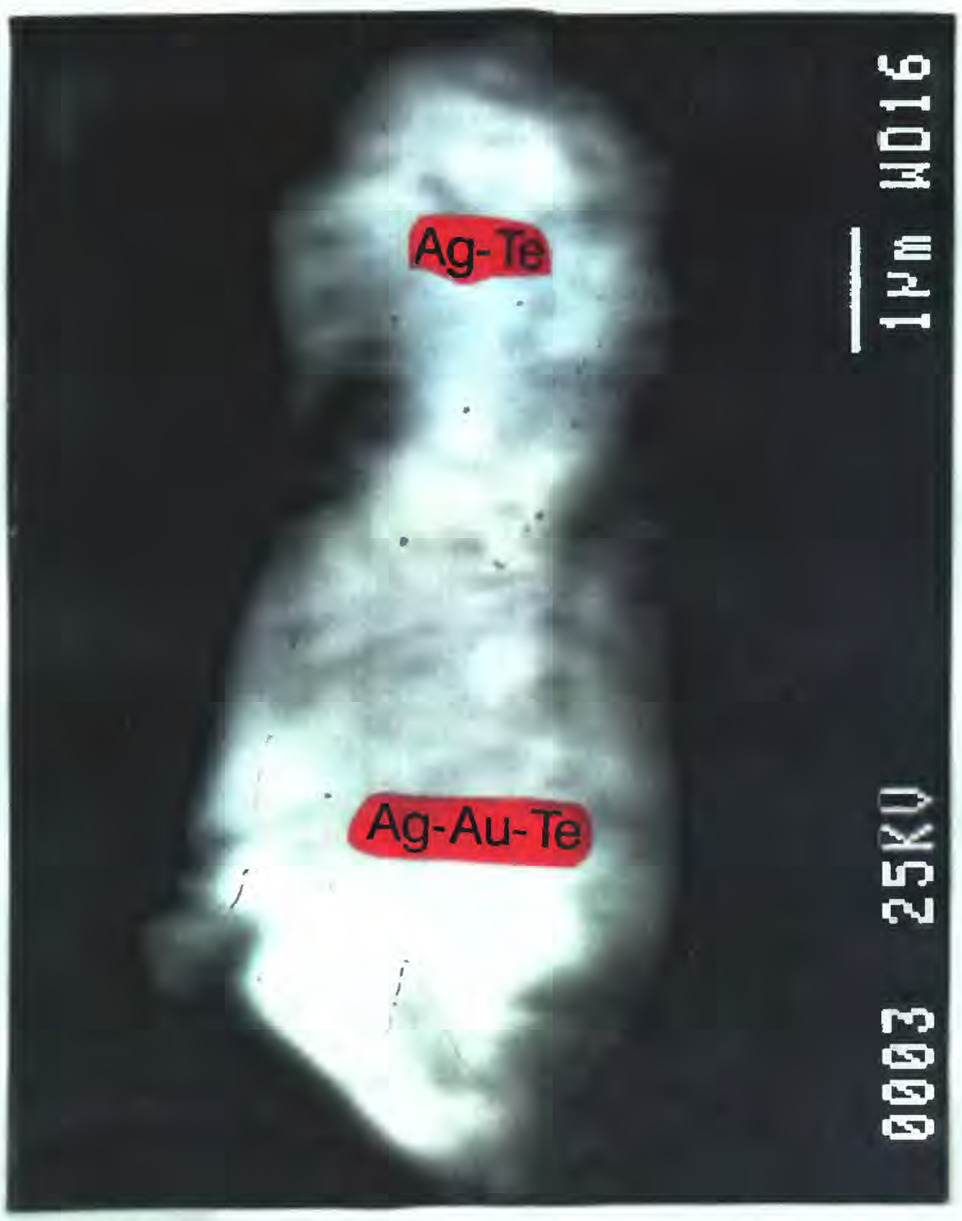
SLIDE 26



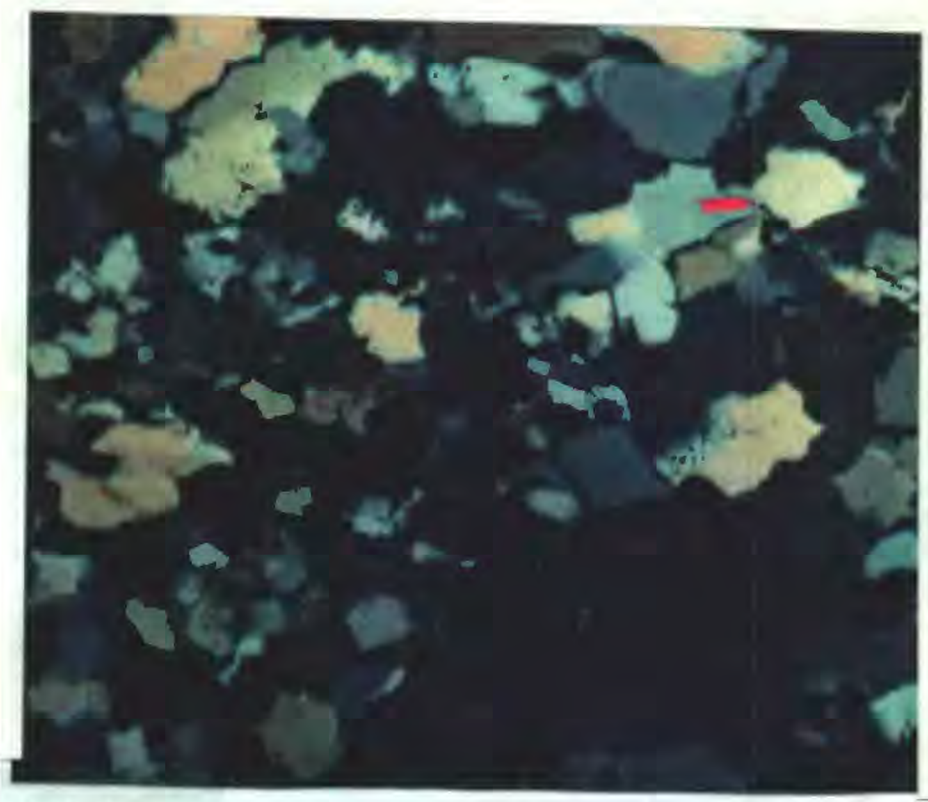
SLIDE 27

SLIDE 28

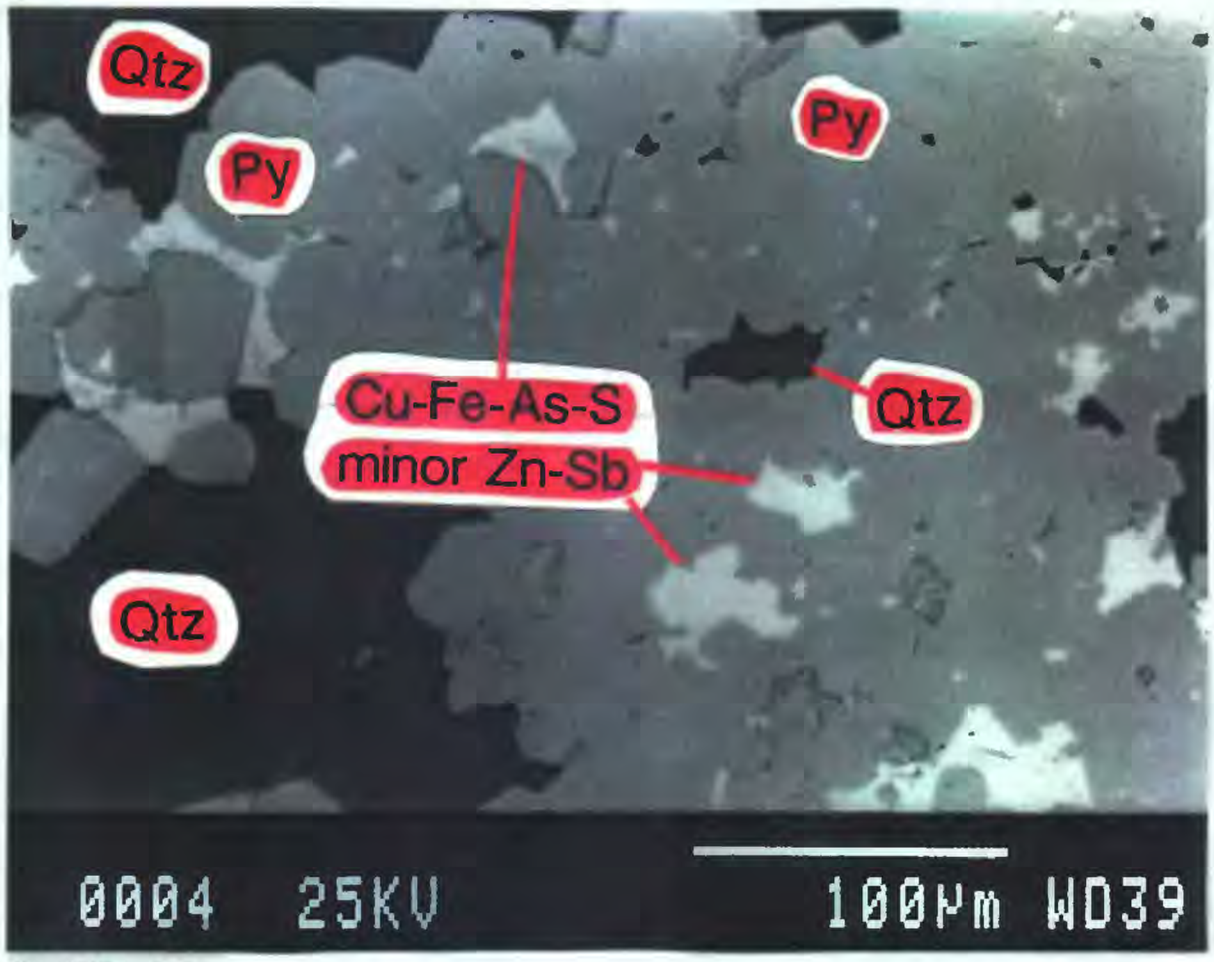
SLIDE 30



SLIDE 29



SLIDE 31



SLIDE 32

MINERALOGY

Au
Native gold Au
Sylvanite $(Au,Ag)Te_4$
Electrum AuAg

Ag
Native silver Ag
Electrum AuAg
Argentite Ag_2S
Galena PbS
Hessite Ag_2Te
Complex selenides and tellurides

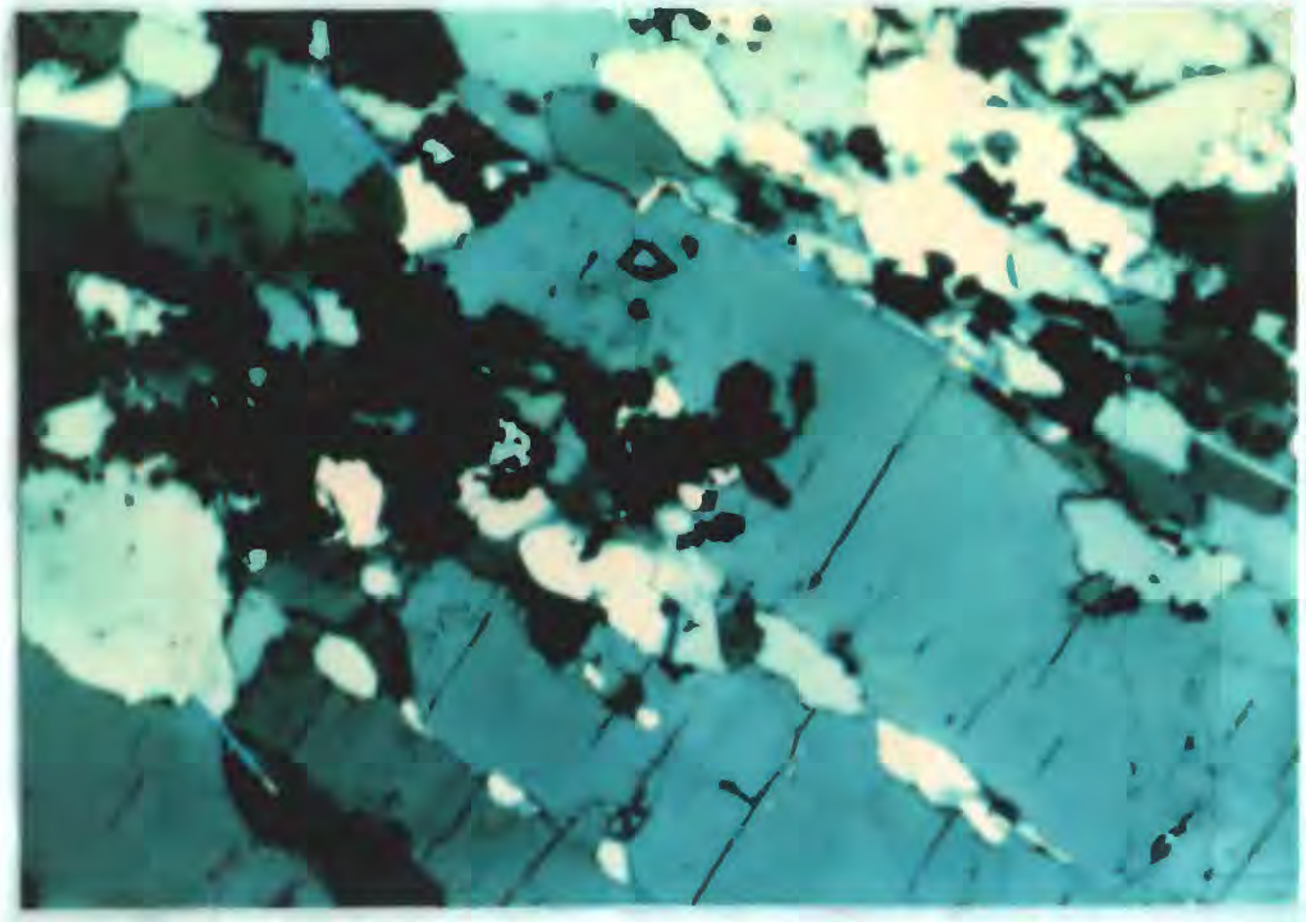
Cu
Chalcopyrite $CuFeS_2$
Chalcocite Cu_2S
Bornite
Cu-Pb-Bi tellurides and selenides

Pb
Galena PbS

Zn
Sphalerite ZnS

From Gunter and Padgett, 1988

SLIDE 33



SLIDE 34

SLIDE 35

CONCLUSIONS

A. Epigenetic environment

B. Location of gold
   - Veinlets cutting hydrothermally altered breccias
   - Associated with tectonic quartz, pyrite ± later barite
   - Intergranular and in fractures

C. Relative timing
   1. Volcanism
   2. Penetrative schistosity
   3. Au-bearing hydrothermal fluids and tectonism
   4. Faulting

SLIDE 36