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PETROGRAPHICAL AND MINERALOGICAL STUDY OF SIX SAMPLES FROM GOLD - COPPER EXPLORATION PROGRAM IN BIDJOVAGGE AREA, NORTHERN NORWAY

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1 Introduction, samples and methods

Project geologist Osmo Inkinen sent six samples from the gold - copper exploration project in Bidjovagge area (northern Norway) in October 1992 to Geoanalytical Laboratory (*GAL*) of Outokumpu Mining Services (*OMS*) for petrographical study. The aim of this study is to give microscopical description on the samples and to determine the mineral composition of the sent specimens.

Table 1. *Studied samples and their Cu (wt.%) & Au (ppm) contents.*

DDH	Metres	Rock type	Cu, wt.%	Au, ppm
UV-15	6.9 m	breccia / conglomerate	-	0.0
S 274 B	114.9 m	amphibolite	0.89	8.2
S 186 B	130.3 m	albite felsite	3.85	50.1
S 54 E	247.6 m	sericite quartzite	0.02	6.9
N 296 D	80.5 m	graphite felsite	2.79	14.4
N 296 D	86.7 m	black schist	2.09	28.1

Polished thin sections and polished sections were prepared from the samples. Samples were studied microscopically under the transmitted light by Leitz ORTHOPLAN and under the reflective light by Leitz MM-6. Photomicrographs were taken to illustrate the mineral textures. The compositions of some minerals were determined semiquantitatively by Princeton Gamma Tech System 4Plus energy dispersive spectrometer (EDS) connected to Cameca SX-50 electron microprobe.

Samples are given in Table 1. In Tables and Figures, mineral abbreviations given in Table 2 were used.

Table 2. *Mineral abbreviations, and their stoichiometric formulas.*

Abbreviation	Name	Formula
ab	albite	$NaAl_2Si_3O_8$
ank	ankerite	$Ca(Mg,Fe^{2+},Mn)CO_3$
bt	biotite	$K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2$
bn	bornite	Cu_5FeS_4
cal	calcite	$CaCO_3$
cc	chalcocite	Cu_2S
cp	chalcopyrite	$CuFeS_2$
chl	chlorite	$(Mg,Fe^{2+},Fe^{3+},Mn)(AlSi_3)O_{10}(OH)_8$
Co-pn	Cobalt pentlandite	$(Co,Fe,Ni)_9S_8$
cv	covellite	CuS
di	digenite	Cu_9S_5
dol	dolomite	$(CaMg)(CO_3)_2$
goe	goethite	$FeOOH$
Au	gold	Au
grf	graphite	C
hbl	hornblende	
ilm	ilmenite	$FeTiO_3$
kfs	K-feldspar	$KAlSi_3O_8$
kln	kaolinite	$Al_2Si_2O_5(OH)_4$
mt	magnetite	Fe_3O_4
mc	marcasite	FeS_2
mln	melonite	$NiTe_2$
mu	muscovite	$K_2Si_6Al_6O_{20}(OH)_4$
pgn	paragonite	$Na_2Si_6Al_6O_{20}(OH)_4$
py	pyrite	FeS_2
po	pyrrhotite	$Fe_{1-x}S$
qtz	quartz	SiO_2
ru	rutile	TiO_2
tz	topaz	$(AlF)_2SiO_4$

2 Petrography and mineralogy

Summary of the microscopical observations of the samples is given in Table 3.

Table 3. *Summary on the microscopical observations of the samples.*

DDH	Metres	Field name	Microscopical name	Main minerals	Sulfides
UV-15	6.9 m	breccia / conglomerate	albite felsite brecciated by ankerite - chlorite	ab, qtz, ank, chl	cp, py
S 274 B	114.9 m	amphibolite	metadiabase	amp, ab, scp, qtz	cp, py, mc
S 186 B	130.3 m	albite felsite	albite felsite	ab, qtz, ilm	po, cp, py, pn
S 54 E	247.6 m	sericite quartzite	albite-sericite-quartz schist	ab, mu, qtz	py, cp, mln
N 296 D	80.5 m	graphite felsite	supergenically altered rock, carbonate - quartz - Cu-sulfide rock	cal, qtz, goe	bn, cc, di, cv, cp
N 296 D	86.7 m	black schist	black schist with quartz - chlorite - sulfide portions	qtz, grf, chl	cp, bn, py, Co-pn

2.1 Sample UV-15 / 6.9 m

Macroscopical observations

Sample is heterogeneous. It consists of pink angular fragments, the interstices of which are filled with coarse grained white carbonate surrounded by fine grained black chlorite. The diameter of the fragments varies from less than 1 mm to 2 cm. Pink fragments are medium to fine grained showing occasionally layering-like texture. Disseminated sulfides can be seen macroscopically.

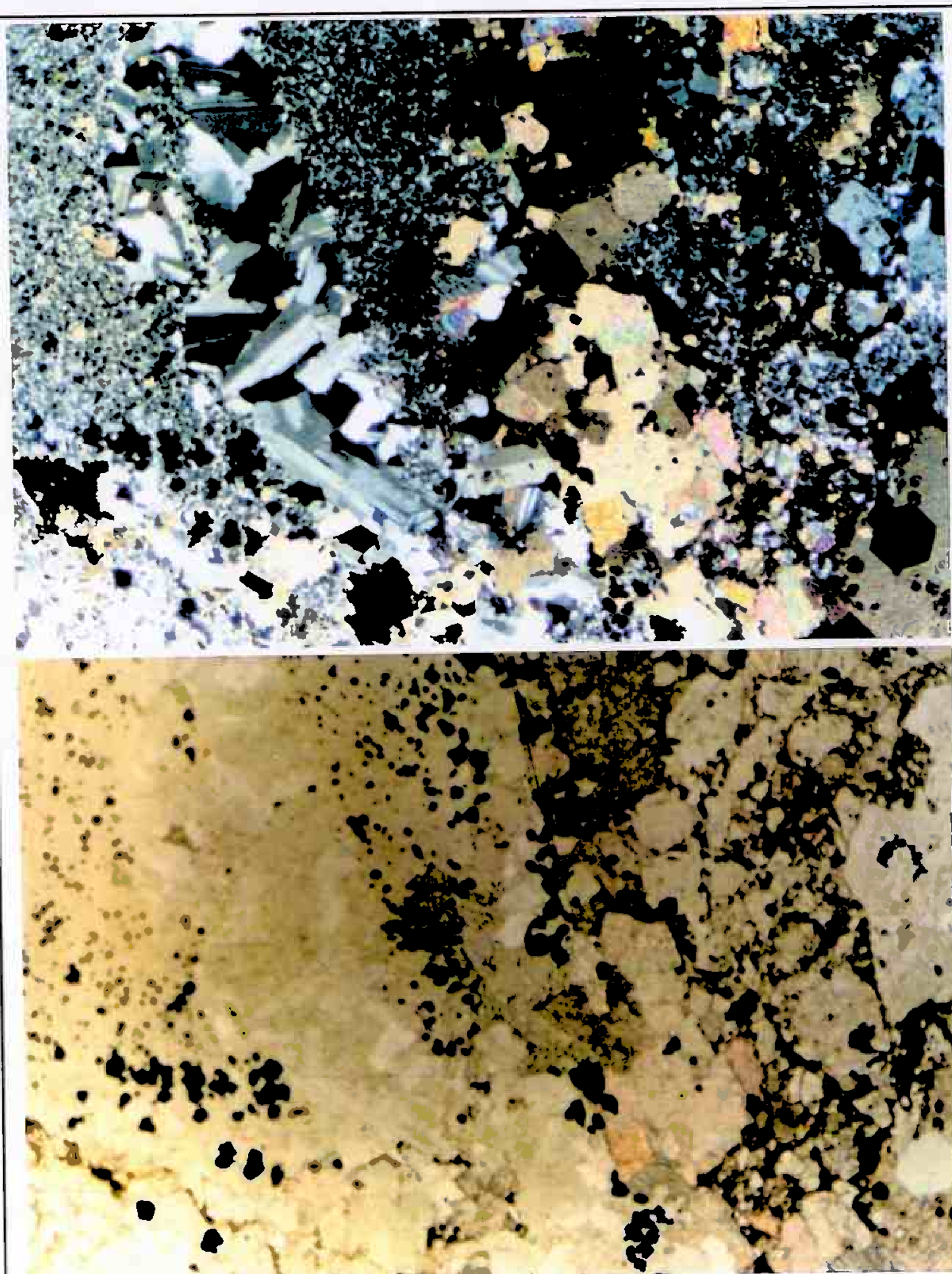
Microscopical observations

Sample is fine grained pink albite felsite, which is brecciated by material rich in carbonate (Fig. 1). Albite felsite consists of polygonal albite, minor quartz, magnetite and rutile. Grain size varies from 20 to 50 μm.

Table 4. *Microscopical observations, sample UV-15/6.9 m. (M/A/T = main mineral (> 10 %) / accessory (1-5 %) / trace mineral (< 1 %), ø = diameter of grains in µm).*

Min	Assemblage	M/A/T	Mode of occurrence	ø / µm	Note
ab	ab felsite	M	polygonal in fine grained	20-50	
qtz	albite felsite	A	polygonal	20-50	
ru	albite felsite	A	euhedral grains	20	
mt	albite felsite	A	euhedral grains, partly replaced by hematite	35	(EDS)
crb	breccia	M	euhedral coarse grains, clearly in breccia veins but also in albite felsite	> 1000	ankerite in composition, (EDS) spectrum in Fig. xx
qtz	breccia	M	anhedral	1000	chlorite inclusions, rich in fluid inclusions, undulatory extinction
ab	breccia	M	euhedral	1000	crb inclusions
bt	breccia	A	associating crb	100	
mu	breccia	A	associating crb	100	greenish
amp	breccia	A	euhedral, with crb	300-400	strong pleochroism: yellow - deep green
chl	breccia ?	M	occurs both in breccia and in albite felsite, often in between these rock types	20-100	brownish abnormal interference colour
hm	breccia ?	A	with mt, replacing it and intergrown with it	300	mt incl., (EDS)
py	breccia	A	euhedral grains	150	
cp	breccia	T	inclusions in py		

Breccia material consists of coarse grained carbonate, which is rimmed by fine grained dirty green chlorite. Coarse quartz, albite and amphibole together with medium grained biotite and muscovite occur together with carbonate and are obviously belonging to breccia paragenesis.



Magnification 18 X — *1000 µm*

Fig. 1. *Sample UV-15/6.9. Fine grained albite felsite is brecciated by coarse grained material composed of ankerite, albite, quartz. Quite dense fine grained magnetite dissemination can be seen in albite felsite. In between albite felsite and vein material there occurs fine grained chlorite (black material filling the interstices). Pyrite (coarse black spots) is being associated with ankerite. Above crossed nicols, below plane polarized light.*

Coarse albite can at least partly belong to albite felsite paragenesis, but carbonate and chlorite inclusions speak for breccia assemblage. Some albite felsite fragments contain breccia like chlorite, and it looks like chlorite could belong to albite felsite paragenesis as well as breccia paragenesis.

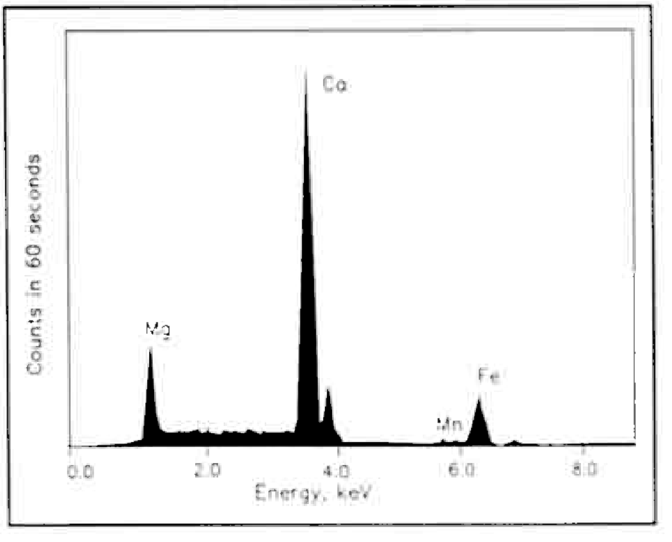
Magnetite (ø = 35 µm) occurs in albite felsite, and obviously is belonging to that assemblage. Hematite occurs replacing magnetite, but also intergrown with magnetite. Hematite-magnetite particles occur often in contact with albite felsite and breccia material, and are clearly coarser than single magnetite grains.

Euhedral pyrite (ø = 100 µm) grains are mainly associated with breccia material (Fig. 3).

Amphibole is associated with carbonate. It is coarse grained varying from brownish to dark green in colour.

The composition of carbonate was determined by EDS. Spectrum is shown in Fig. 2. Ca/(Mg+Fe) ratio is close to 1 and Mg/Fe ratio is about 3.2. According to Deer, Howie & Zussman (1963) carbonate is ankerite.

Fig. 2. *EDS spectrum of carbonate in sample UV-15/6.9 m.*



As a conclusion it can be stated, that albite felsite comprising fine grained (ø = 20 - 50) albite, quartz, rutile and magnetite, is brecciated by coarse - medium grained carbonate, quartz, albite, biotite, muscovite, hematite, and pyrite material. Fine grained chlorite often occurs in between these two rock types. No gold grains were found in the section.

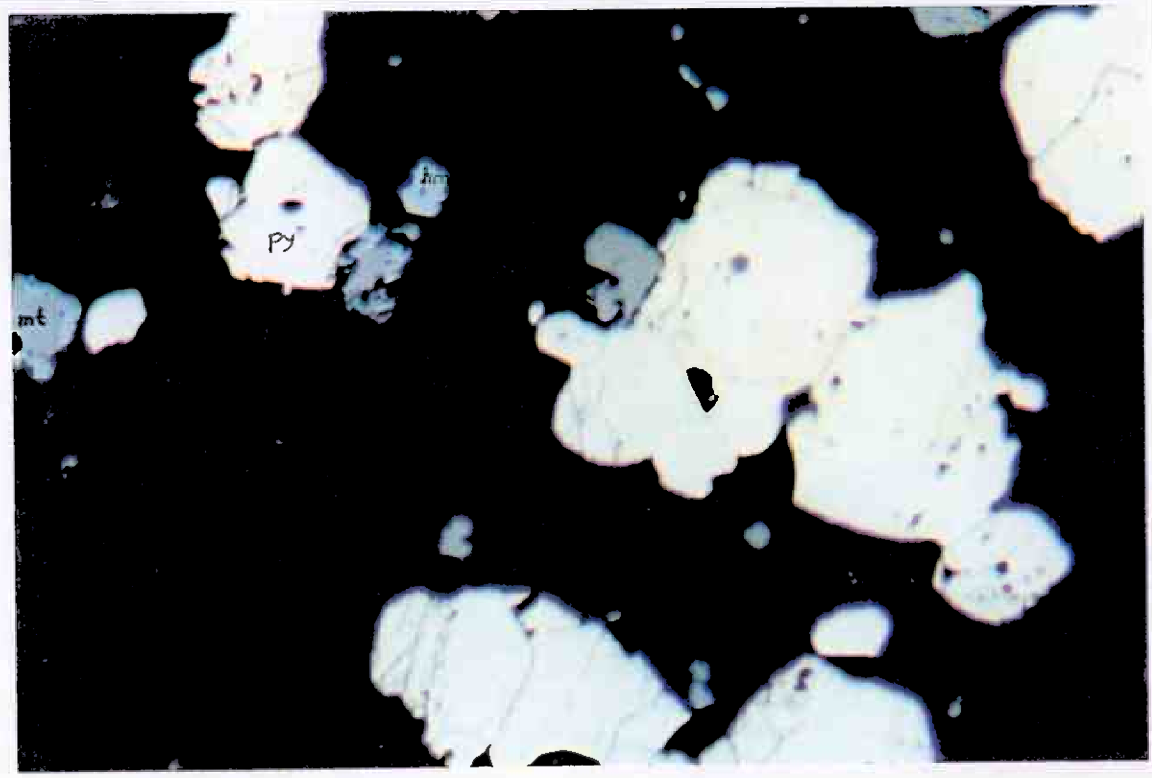


Fig. 3. *Sample UV-15/6.9. Disseminated pyrite (py). Hematite (hm) replaces magnetite (mt). Reflective light.*

2.2 Sample S 274 B / 114.9

Macroscopical observations

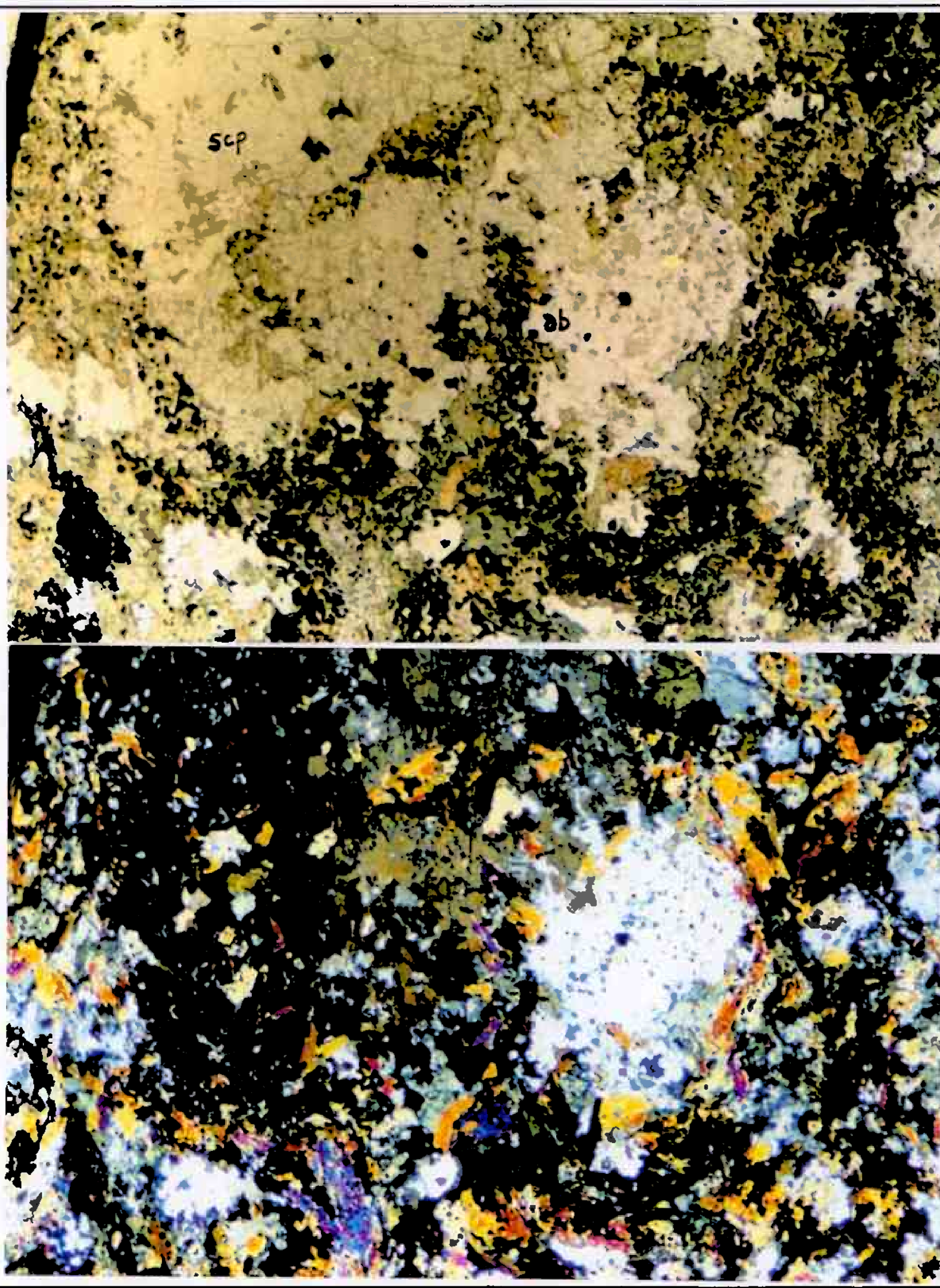
Black to dark green fine to medium grained massive rock. Unoriented amphibole needles can be seen macroscopically. Chalcopyrite dissemination is visible.

Microscopical observations

Sample is metadiabase showing relic diabase textures of euhedral plagioclase laths and anhedral clinopyroxene filling the interstices (Fig. 4). Plagioclase has been replaced by albite (ø = 600 μm) and scapolite. Clinopyroxene is replaced by amphibole. Scapolite occurs as "porphyroblasts" enclosing worm-like quartz inclusions.

Magnetite and ilmenite are relatively abundant occurring as eu- and subhedral inclusions in amphibole. Chalcopyrite and pyrite are the most common sulfides. They occur as dissemination (Fig. 5). Marcasite was found as inclusions and on the edge of one relatively big pyrite grain.

Amphibole is according to semiquantitative analysis hornblende, chemical composition being roughly 15 wt.% FeO, 15 wt.% MgO, 10 wt.% Al_2O_3, 10 wt.% CaO, and 55 wt.% SiO_2.



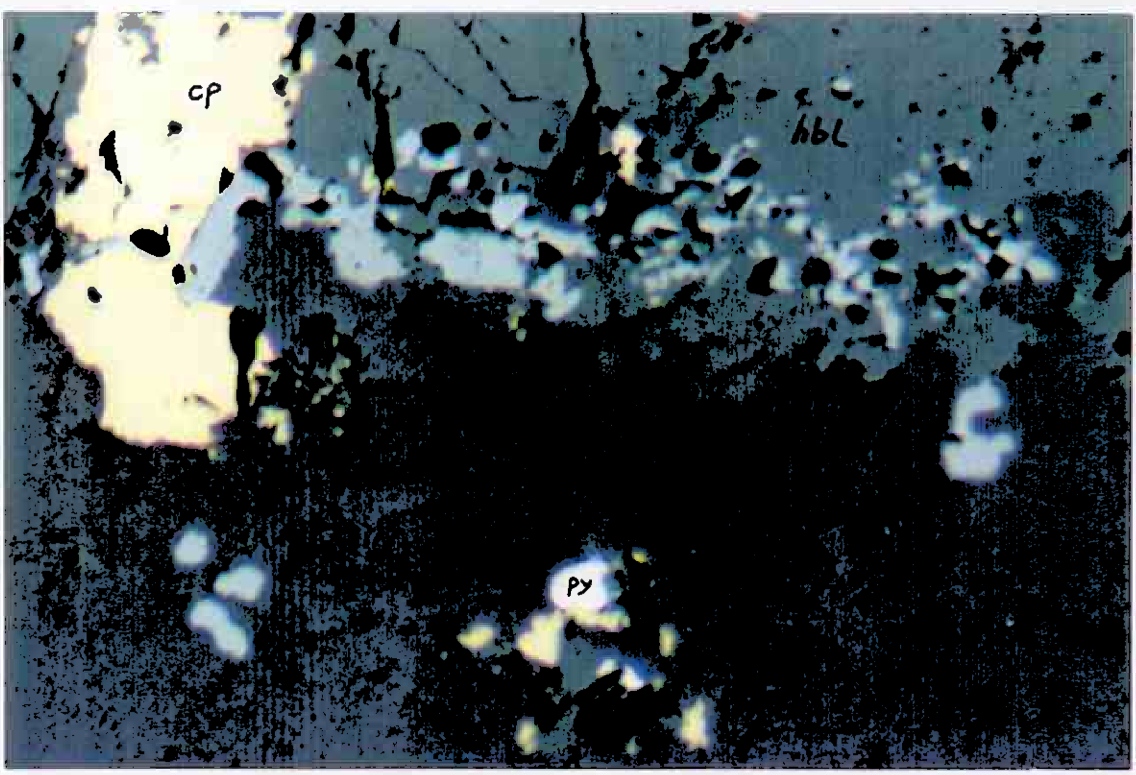
Magnification 170 X 1000 µm

Fig. 4. *Sample S274B/114.9. Metadiabase. Diabase texture can still be seen relicly. Plagioclase laths have been replaced by albite (ab) and scapolite (scp). Clinopyroxene is totally replaced by amphibole. Ilmenite ± magnetite grains occur as inclusions in amphibole.*

According to semiquantitative EDS analysis scapolite is mizzonite (Me_{55}) in composition. Cl content is about 2 wt.%, Na_2O is about 5 wt.%, Al_2O_3 25 wt.%, SiO_2 55 wt.%, S < 0.5 wt.%, and CaO 10 wt.%.

Table 5. *Microscopical observations, sample S274B/114.9 m. (M/A/T = main mineral (> 10 %) / accessory (1-5 %) / trace mineral (< 1 %), ø = diameter of grains in µm).*

Min	M/A/T	Mode of occurrence	ø / µm	Note
amp	M	prismatic pale grass green to bluish green grains	200	hornblende *(EDS)*
ab	M	relic plg laths	600	altered to sericite slightly
scp	M	large porphyroblast	6000	mizzonite (Me_{55}) *(EDS)*, rich in worm like qtz inclusions
qtz	M	worm-like incl. in scp, amp, ab	100	
mt	A	euhedral grains, as clusters in amp	100	py & cp incl.
ilm	A			
cp	A	dissemination in amp	up to 200	
py	A	with cp, inclusions in cp	up to 200	cp & mt incl., mc inclusions
mc	T	inclusions in py	80	
Au	T	inclusions in amp		associated with worm-like qtz inclusions



Magnification 82 X — 200 µm

Fig. 5. *Sample S274B/114.9 m. Disseminated chalcopyrite and one pyrite in metadiabase composed mainly of albite (ab) and hornblende (hbl).*

Magnification 850 X — *20 µm*

Fig. 6. *Sample S274B/114.9 m. Three gold grains as inclusions in hornblende (hbl) together with quartz (qtz) and chalcopyrite (cp). Reflective plane polarized light.*

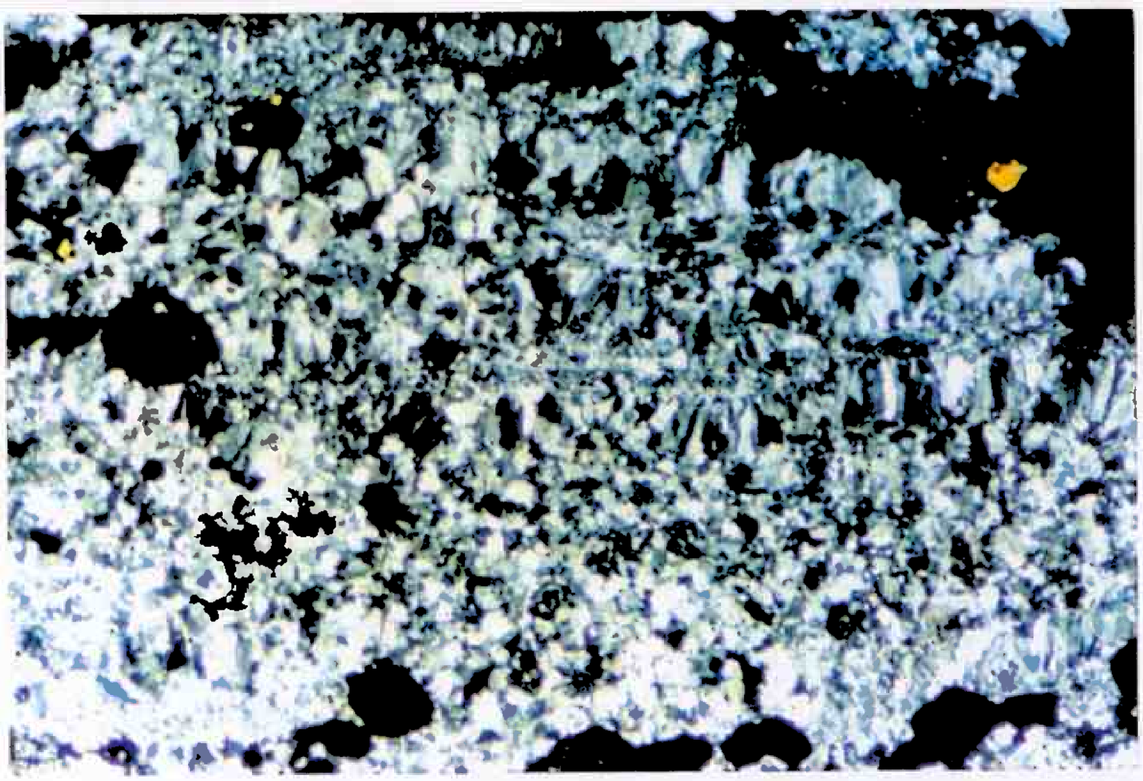
Nine gold grains were found in polished sections. They are relatively small, the coarsest one being 6 μm in diameter (Fig. 6). All except one are associated with quartz, both occurring as inclusions in hornblende. One small gold grain is associated with chalcopyrite both occurring as inclusions in hornblende.

2.3 Sample S 186 B / 130.3 m

Macroscopical observations

Gray - pale gray fine grained, lineated, layered rock. Intense chalcopyrite veins and veinlets are mainly parallel to layering. In different layers colour varies from white to black.

Microscopical observations



Magnification 18 X — *1000 μm*

Fig. 7. *Sample S186/130.3 m. Relatively coarse grained albite felsite. Coarse (ø = 200 μm) albite laths associates with sulfide veins. Their length axis is perpendicular to the wall of the veins. Transmitted light, crossed nicols.*

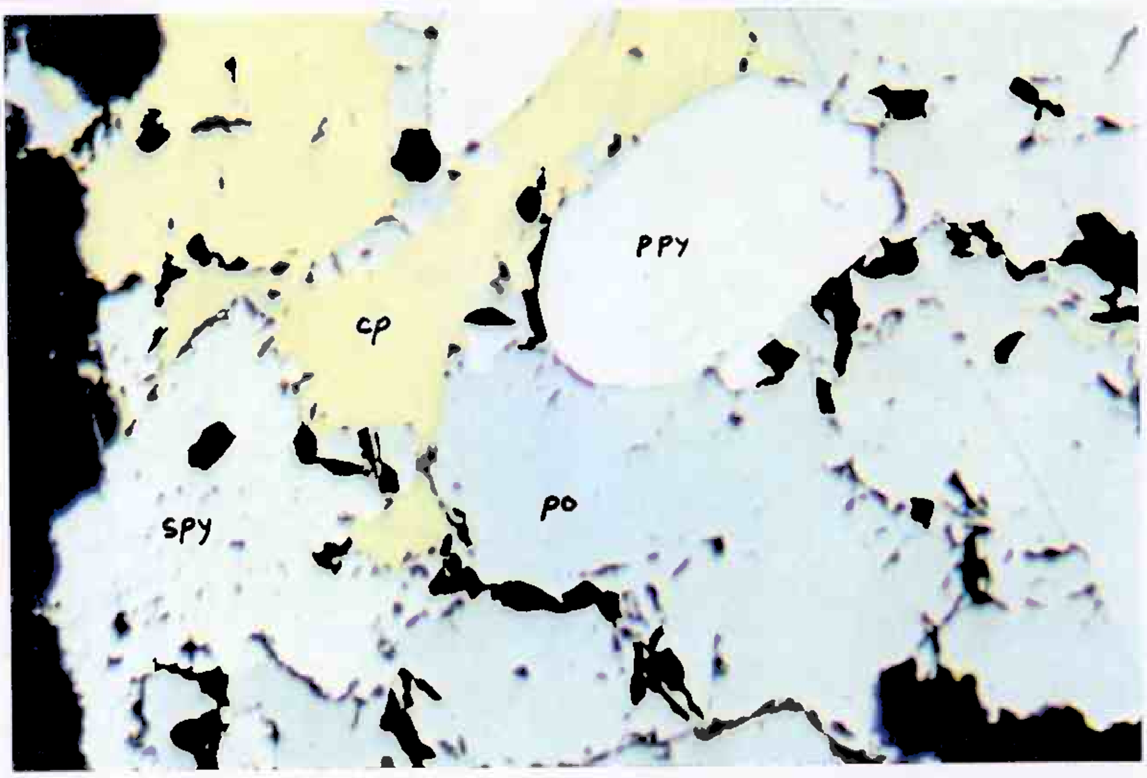
Sample is relatively coarse grained albite felsite, not lineated (Fig. 7). Grain size varies from 20 μm in the fine grained parts to 200 μm in the coarser grained parts. Coarser parts dominate. Albite is mainly anhedral, some coarse grains are subhedral. Coarsest albites (ø = 200 μm) are rimming sulfide veins. The length axis of these albite laths is perpendicular to the vein (Fig. 7).

Sulfides occur as veins. Chlorite, muscovite/paragonite, biotite and carbonate are associated with sulfide veins. Fine grained chlorite often rims sulfide veins.

Pyrrhotite dominates over pyrite. These two coexist but it is not common, that they occur in contact. Ilmenite occur as subhedral grains in groundmass but also with sulfide veins.

Two different pyrites were observed (Fig. 8). *Primary* one is euhedral, grains are about 400 μm in diameter. Polished surface is clean. It occurs in contact with pyrrhotite. *Secondary* one is dirty on its surface, it occurs enveloping pyrrhotite. According to semiquantitative electron microprobe analysis primary pyrite is rich in Co, and the secondary one contains more Ni than the primary one.

Six gold grains were found by optical microscopy. They all occur in a one cluster shown in Fig. 9. They associate with secondary pyrite after pyrrhotite, both Au and pyrrhotite occurring as inclusions in chalcopyrite.

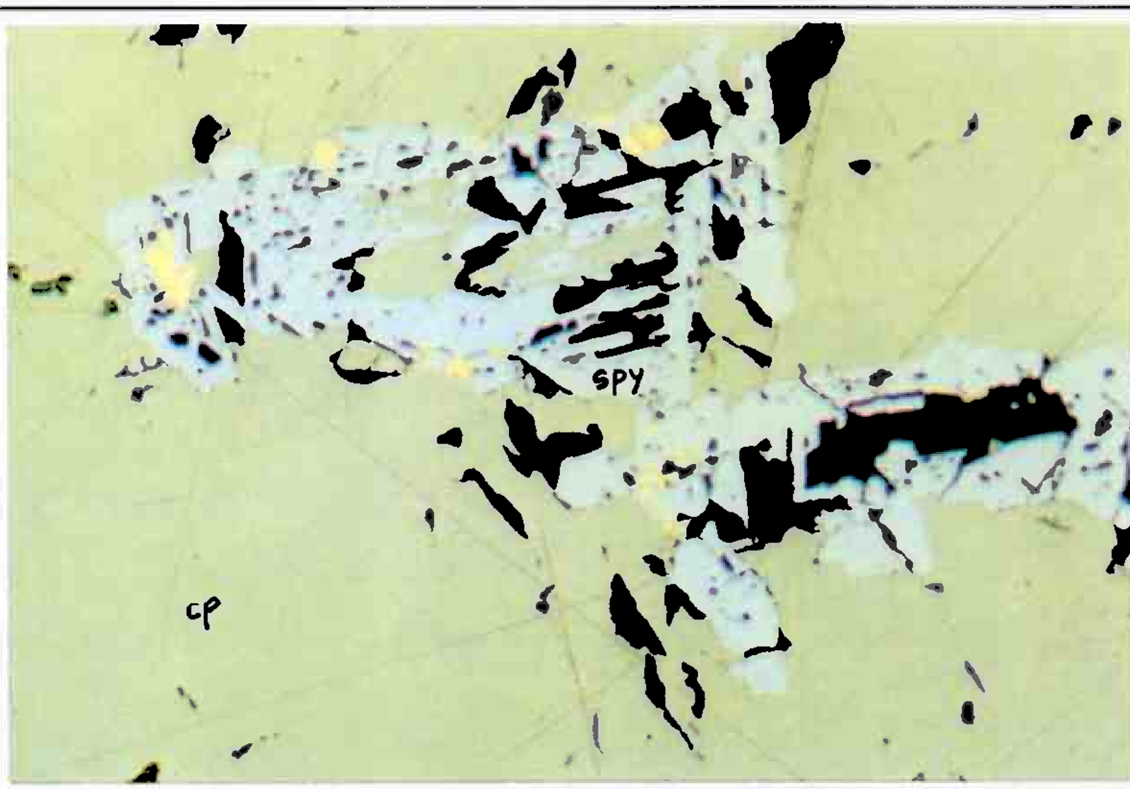


Magnification 170 X — *100 μm*

Fig. 8. *Sample S186/130.3 m. Primary and secondary pyrite (ppy, spy, respectively). Primary one takes good polishing, is richer in Co and poorer in Ni compared to the secondary one, which is an alteration product of pyrrhotite (po), and contains small magnetite inclusions. Reflective plane polarized light.*

Table 6. *Microscopical observations, sample S186B/130.3 m. (M/A/T = main mineral (> 10 %) / accessory (1-5 %) / trace mineral (< 1 %), ø = diameter of grains in µm).*

Min	M/A/T	Mode of occurrence	ø / µm	Note
ab	M	polygonal grains in ground mass	20 - 200	
qtz	M	polygonal grains in groundmass	20 - 200	
chl	A	associated with sulfide veins, rimming them	5-20	Often rims sulfide veins
mu/ pgn	A	small grains, associated with sulfide veins		
crb	A	small grains with sulfide veins		
ilm	M		70	
cp	A	dissemination	35 (100)	
po	A	dissemination with cp	35	altered partly to second. py
py	A	two morphological forms, primary and secondary	50	secondary is an alteration product of pyrrhotite, primary richer in Co, secondary richer in Ni
pn	T	exsolutions in po	20	
Au		inclusions in cp together with secondary py	< 20	contains several percentages Ag, Fig. xx



Magnification 340 X   50 µm

Fig. 9. *Sample S186/130.3 m. Cluster of gold grains with secondary pyrite (spy) (after pyrrhotite) both as inclusions in chalcopyrite (cp). Reflective light.*

2.4 Sample S 54 E / 247.6 m

Macroscopical observations

Fine grained greenish pale gray schist. Some rusty spots indicate scarce sulfide dissemination.

Microscopical observations

Sample is lineated fine grained albite-sericite-quartz schist (Fig. 10). Rutile occurring as prismatic lineated needles up to 300 μm in length is a common accessory.

Parallel to schistosity slightly coarser (ø = 100 μm) diffuse eyes and veinlets can be seen. These eyes are composed of albite, quartz, biotite, pyrite ± carbonate.

Table 7. *Microscopical observations, sample S54E/248.6 m. (M/A/T = main mineral (> 10 %) / accessory (1-5 %) / trace mineral (< 1 %), ø = diameter of grains in μm).*

Min	M/A/T	Mode of occurrence	ø / μm	Note
ab	M	polygonal grains, coarser grains in eyes	25 / 100	
mu /src	M	lineated flakes	20	*(EDS)*
qtz	M	polygonal grains, coarser in eyes	25 / 100	
ru	A	lineated prisms	30 (up to 300)	30
bt	A	lineated flakes, often associated with coarser eyes	200	
crb	A	in eyes, as veinlets	10	
py	T	dissemination associating coarser eyes	20	
cp	T	rare inclusions in py	5	
mln	T	dissemination, associated with coarser eyes	40-110	*(EDS)*, Fig. xx

Pyrite grains about 20 μm in diameter are associated with coarser veinlets. Eight melonite ($NiTe_2$) grains (identified by EDS) were found, being associated with coarse grained veins (Fig. 11). Grains varying from 40 to 110 in diameter are in all the cases in contact with silicates, i.e. albite, quartz and biotite.

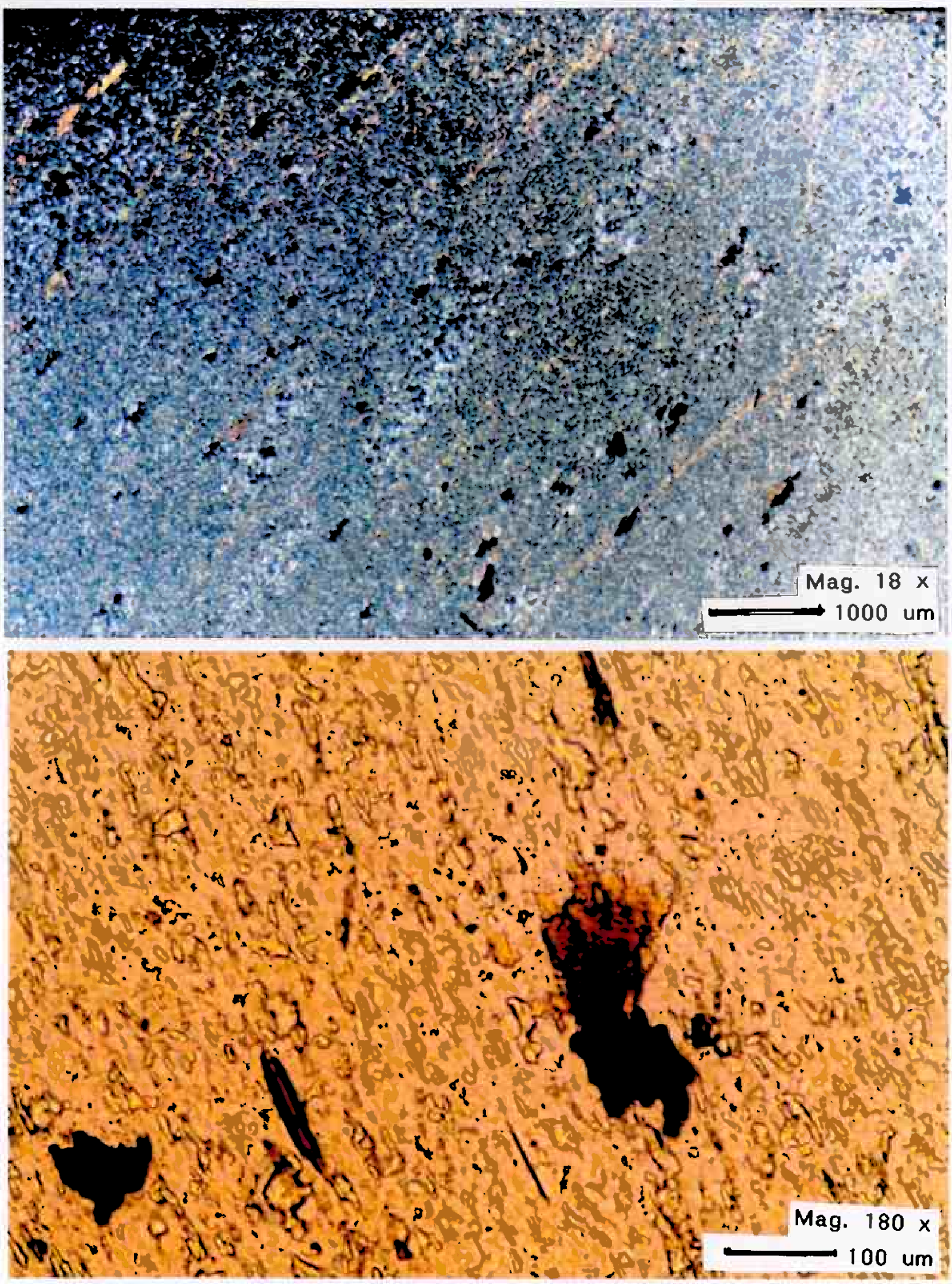
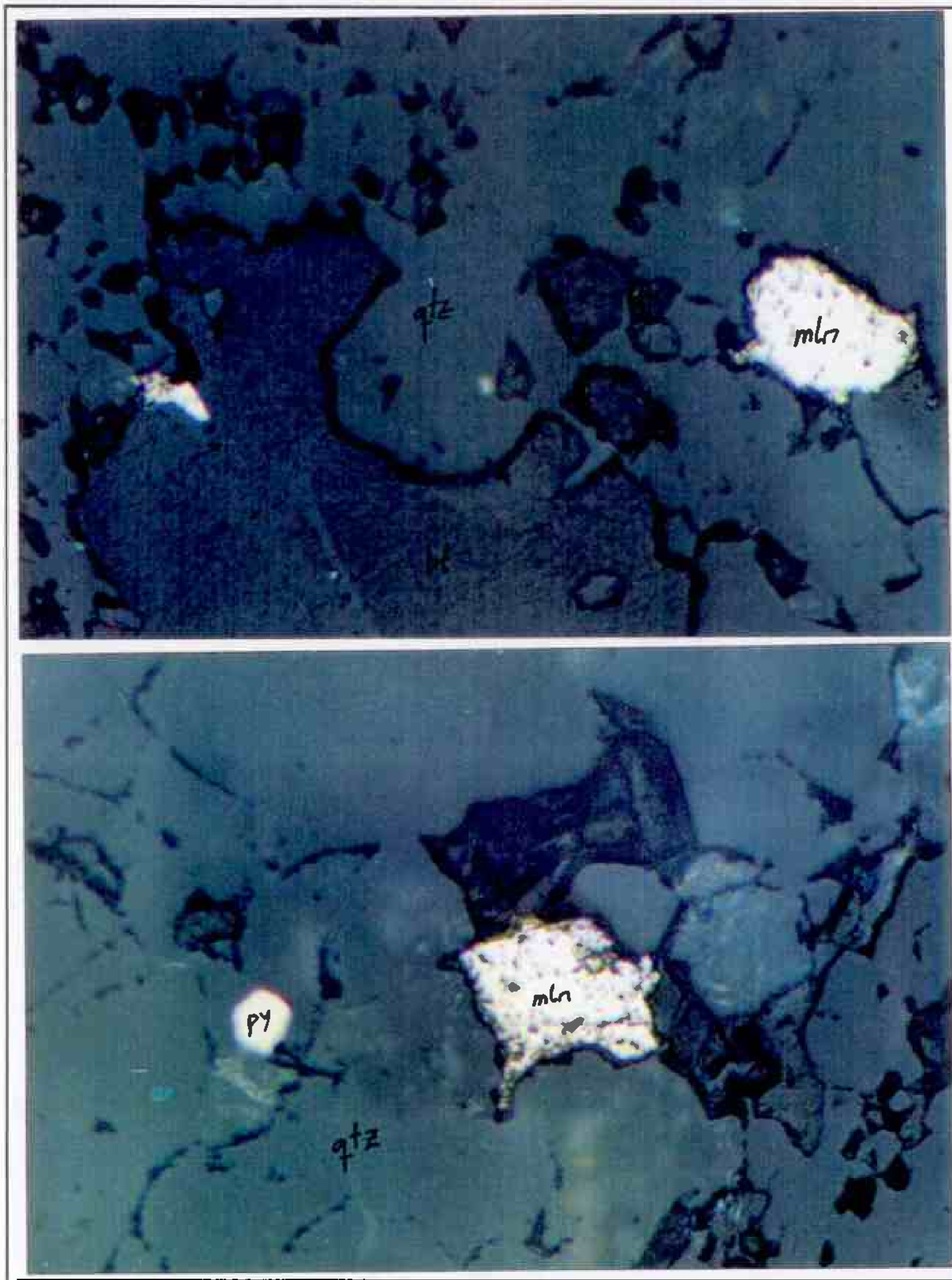


Fig. 10. *Sample S54E/247.6 m. Lineated albite-sericite-quartz schist with coarser grained quartz veinlets. Sulfides associates with biotite and coarser quartz. Above: transmitted light, crossed nicols; Below: transmitted plane polarized light.*



Magnification 340 X — *50 µm*

Fig. 11. Sample S54E/248.6 m. Three melonite ($NiTe_2$) grains associating medium grained quartz (qtz) veinlets and biotite (bt). Reflective plane polarized light.

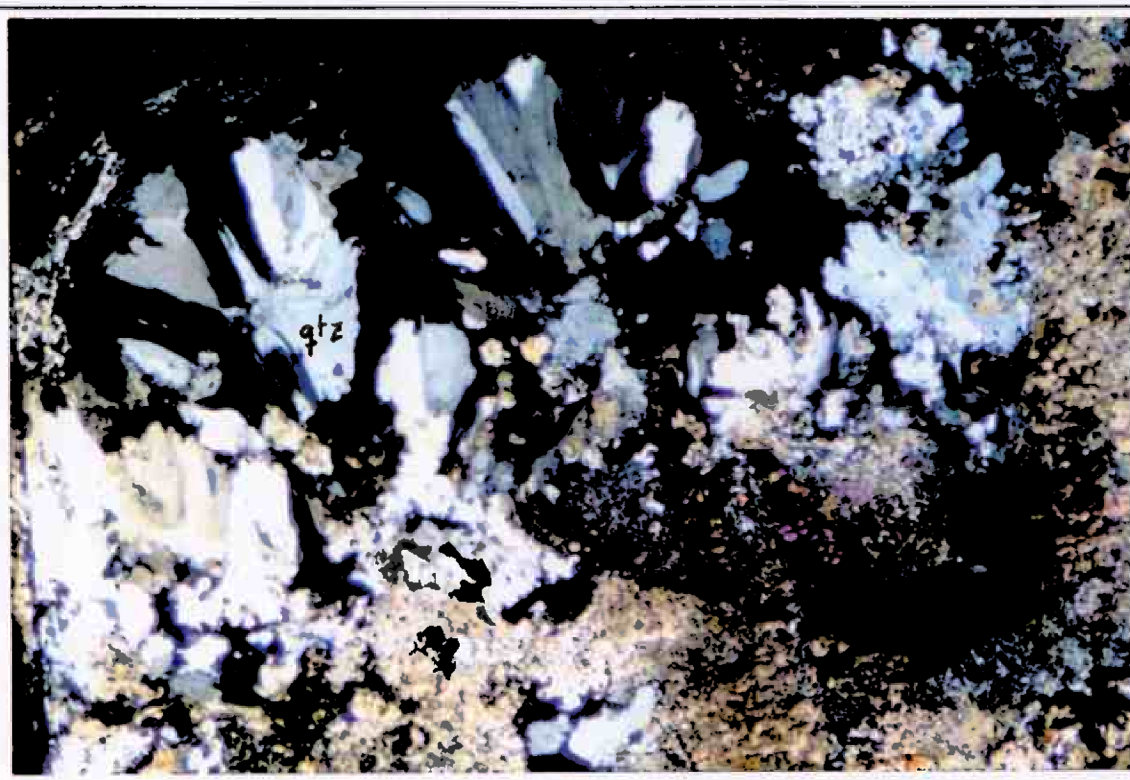
2.5 Sample N 296 D / 80.5 m

Macroscopical observations

Black medium - fine grained rock with brown and red rusty spots.

2.6 Microscopical observations

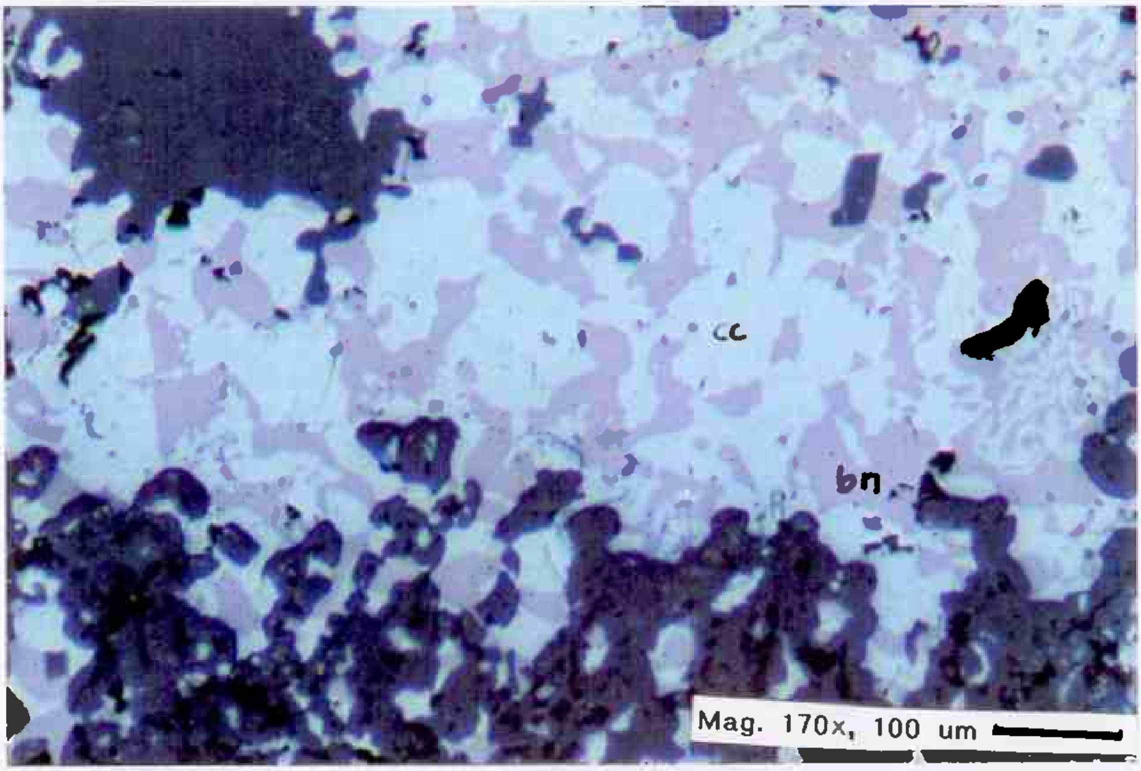
Sample is totally supergenically altered. It consists of carbonate, quartz, chlorite, Fe-hydroxides and Cu-sulfides (Fig. 12). Carbonate is calcite in composition (determined by EDS). Grains are either rounded (ø = 100 μm) or ragged (ø = 3500 μm). Calcite is intergrown with ragged quartz and sulfides. Some relic texture can be seen in ragged big calcite grains. Cu-sulfide inclusions are ordered as rings of about 100 μm in diameter.



Magnification 18 X — 1000 μm

Fig. 12. Sample N298D/80.5 m. Supergenically altered rock, at the moment carbonate-quartz rock. "Hairy" quartz (qtz) occurs as fracture fillings. Transmitted light, crossed nicols.

Ragged quartz grains are intergrown with calcite. Another textural form of quartz can be seen. "Hairy" quartz fills the cracks with Cu-sulfides (Fig. 12). These grains are spherulically ordered, grains are bent.



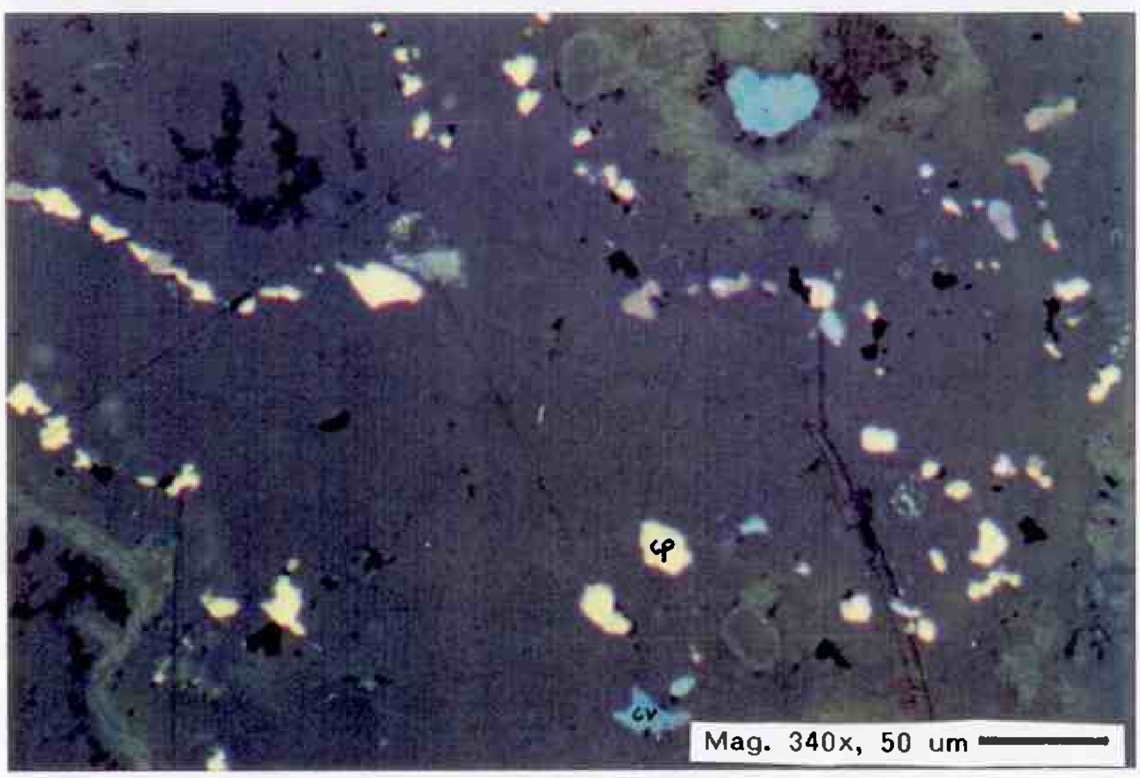


Fig. 13. *Sample N296/80.5 m. Above: Chalcocite-bornite occur as ragged grains intergrown with each other. Below: Chalcopyrite (cp), covellite, bornite dissemination forming ring-texture in a calcite grain. Reflective plane polarized light.*

Table 8. *Microscopical observations, sample N296D/80.5 m. (M/A/T = main mineral (> 10 %) / accessory (1-5 %) / trace mineral (< 1 %), ø = diameter of grains in µm).*

Min	M/A/T	Mode of occurrence	ø / µm	Note
crb	M	anhedral roundish grains or ragged grains intergrown with sulfides & quartz	100-3500	Calcite in composition (*EDS*), Cu sulfide inclusions form relic ring-texture (Fig. xx)
qtz	M	Intergrown with calcite. "Hairy" grains fill the cracks	500	
goe	M	Fills cracks in calcite, as an alteration product of Fe ± Cu sulfides	-	Relic sulfide droplets
hm	A	Associates with goethite	20	
chl	A	Fine grained laths	5	
bn	A	ragged grains, intergrown with chalcocite and digenite	100	
cc	A	ragged grains intergrown with bornite	100	
di	A	ragged droplets, intergrown with bornite	30	
cp	A	As inclusions in cal	5	Forms ring-texture
cv	A	as inclusions in cal	5	Forms ring-texture

Sulfides are of secondary origin. Primary Cu-Fe-sulfide droplets have been replaced by Fe-hydroxide and secondary Cu-sulfides, which include bornite, chalcocite, digenite and covellite. Bornite and chalcocite occur as ragged intergrown grains (Fig. 13). Chalcopyrite (primary ?) can be found as inclusions in calcite forming ring-textures together with bornite-digenite and covellite (Fig. 13).

No gold grains were detected by optical microscopy although the analysed Au content is 14 ppm. Probably gold is camouflaged in Fe-hydroxides ± secondary Cu sulfides.

2.7 Sample N 296 D / 86.7 m

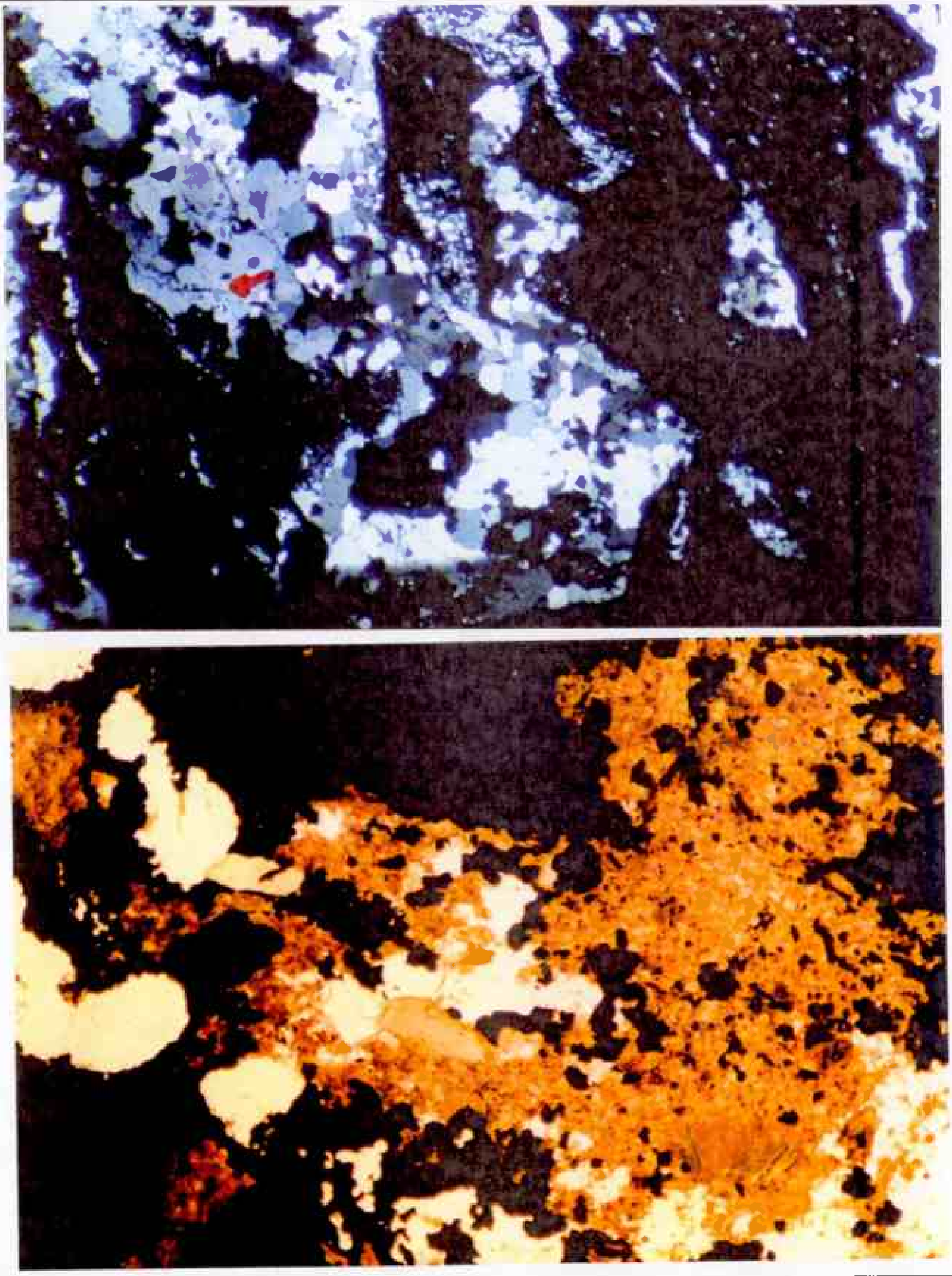
Macroscopical observations

Fine grained layered black schist with white - pale gray portions/layers, chalcopyrite dissemination and rusty spots.

Microscopical observations

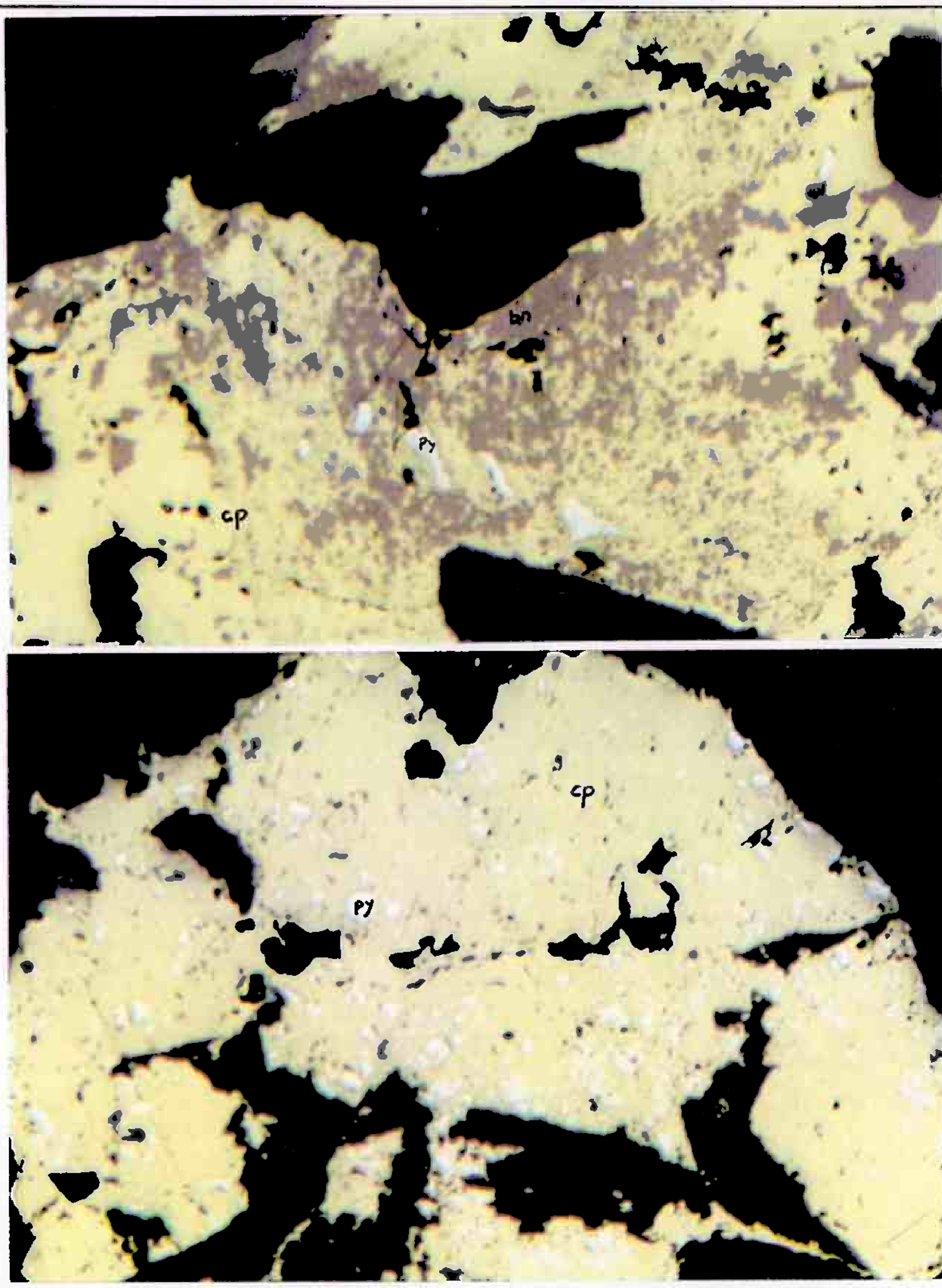
Sample is black schist with quartz - sulfide - chlorite portions (Fig. 14).

Black schist portions are composed of fine grained (< 20 µm) lineated graphite, quartz and albite. Black schist gradually changes in to coarse grained portions rich in quartz. Zone rich in albite (ø = 100 µm) is found often between these two portions. In the rims of the coarse portions coarse grained quartz contains numerous graphite inclusions.



Magnification 170 X —— *100 µm*

Fig. 14. *Sample N296D/86.7 m. Quartz and sulfide veined black schist. Above: Quartz veins (white-gray) are mainly parallel to schistosity of the black schist (black). Note graphite inclusions in quartz (pointed by red arrow). Transmitted light, crossed nicols. Below: chlorite often rims sulfides. Brown and green chlorite in the view. Transmitted plane polarized light.*

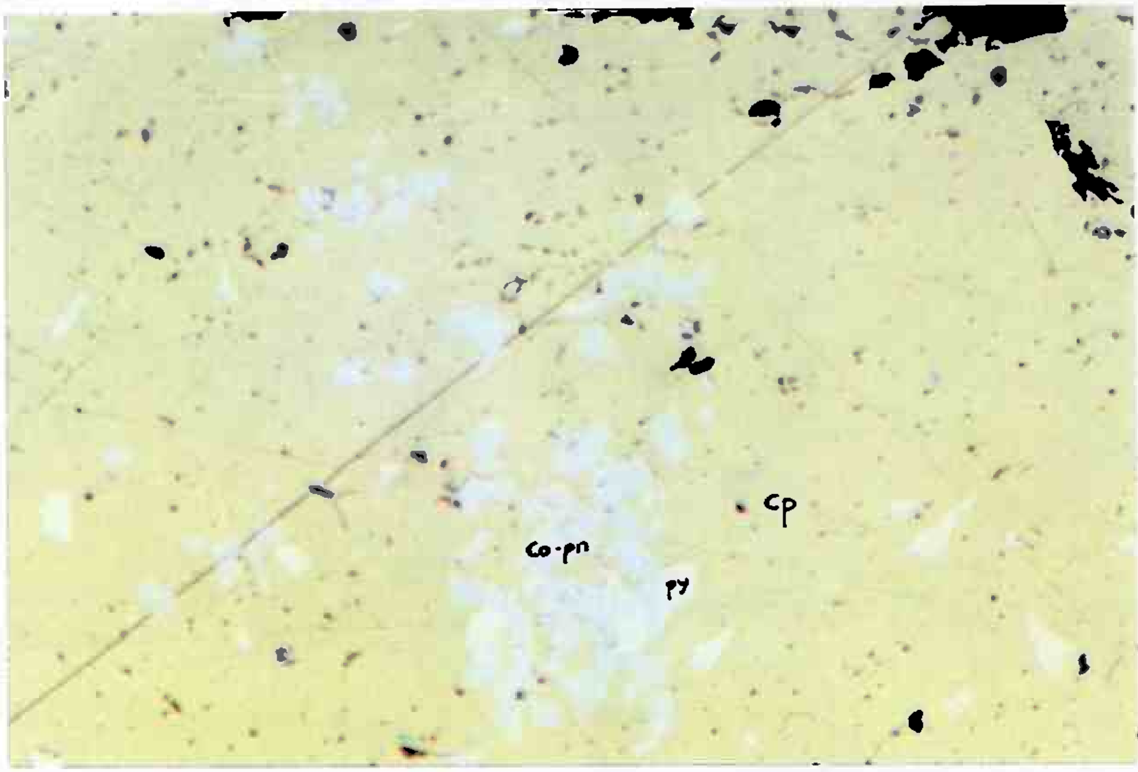


Magnification 82 X — 200 µm

Fig. 15. *Sample N296D/86.7 m. Chalcopyrite (cp) (often intergrown with bornite (bn)) has replaced pyrite, relics occur as inclusions. Reflective plane polarized light.*

Table 9. *Microscopical observations, sample N296D/86.7 m. (M/A/T = main mineral (> 10 %) / accessory (1-5 %) / trace mineral (< 1 %), ø = diameter of grains in µm).*

Min	M/A/T	Mode of occurrence	ø µm	Note
qtz	M	as coarse grains enclosing graphite, fine grained in black schist portions	200	undulatory extinction
grf	M	small lineated flakes in black schist, also as inclusions in coarse quartz grains	< 10	
chl	M	1) brownish green as fine grained monomineralic mass enveloping sulfides, 2) green chlorite as an alteration product of biotite	< 10 / 200	
ab	A	in black schist portions and next to it as polygonal grains	< 20 / 100	
bt	A	as flakes associating coarse quartz portions	250	altered to green chlorite, resorbed grains in qtz
tz	A	associating with bt	250	uncertain identification
cp	M	replaces py, intergrown with bn	300	
bn	A	intergrown with cp	300	
py	A	relics in cp	35	
Co-pn	T	ragged inclusions in cp	25	



Magnification 340 X — *50 µm*

Fig. 16. *Sample N296D/86.7 m. Pyrite (py) and cobalt pentlandite (Co-pn) inclusions in chalcopyrite. Reflective plane polarized light.*

Two petrographically different types of chlorites can be seen. The more common form is brownish green fine grained (< 10 μm) chlorite, which envelopes sulfide droplets as monomineralic mass. Green chlorite occurs as an alteration product of biotite.

Biotite flakes (ø = 200 μm) associate sulfides, chlorite and coarse quartz. Biotite has altered partly to green chlorite.

Coarse quartz has numerous inclusions, which speaks for Si addition and the growth of quartz at the expense of other minerals. Coarse quartz contains graphite, chlorite and biotite inclusions. Graphite inclusions still show lineated texture of the black schist (Fig. 14). Chlorite inclusions form relic grain boundaries. Biotite inclusions are ragged, resorbed.

A colourless mica-like grains associated with biotite were found in a thin section. The optical properties (+, l-, n etc.) resemble most topaz, but the identification could not be justified by EDS and it remains as uncertain.

Sulfides occur as ragged droplets and veinlets up to several cm's in diameter (Figs. 15 and 16). They associate coarse grained portions but do also contain black schist inclusions. Droplets are composed of chalcopyrite, bornite, pyrite and cobalt pentlandite.

Chalcopyrite and bornite are intergrown with each other. Chalcopyrite has replaced pyrite, which occurs as relic inclusions (ø = 35 μm) in chalcopyrite. Cobalt pentlandite occur as anhedral ragged inclusions (ø = 25 μm) in chalcopyrite.

No gold grains were found in polished section by optical microscopy.

3 Summary and Conclusions

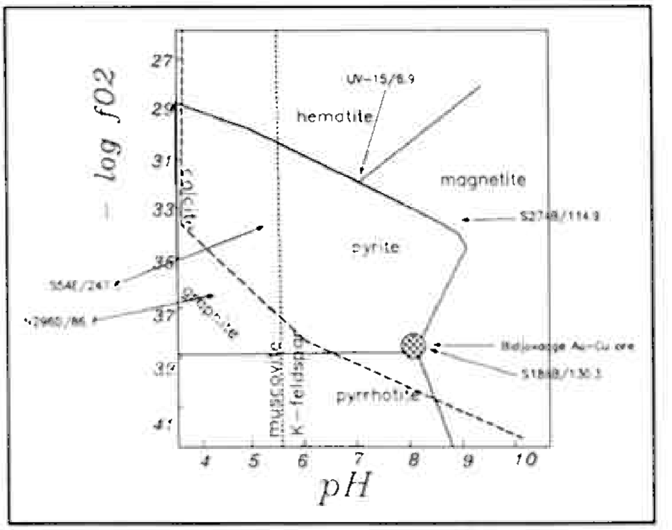
Six samples from the Au exploration program in the Bidjovagge area were studied petrographically at Geoanalytical Laboratory of Outokumpu Mining Services. Textures were described and minerals identified. In Table 10 the summary on Fe-S-O paragenesis and Au observations are given.

Observations are in harmony with the features described by Lamberg & Toikkanen (1991). The critical minerals to define the $a(O_2)$ and pH conditions in the fluid-rock interaction are graphite, pyrite, pyrrhotite, magnetite, hematite, albite and paragonite. In the ore, the mineral paragenesis was found to be pyrrhotite-pyrite-magnetite (Lamberg & Toikkanen 1991). In Fig. 17 schematic pH-$f(O_2)$ diagram is shown. Of the studied samples UV-15/6.9 locates on the hematite-magnetite-pyrite invariant point, S274B/114.9 on magnetite-pyrite join, S186B/130.3 in pyrrhotite-pyrite-magnetite (ilmenite) invariant point, S54E/247.6 in pyrite field, and N296D/86.7 in graphite±pyrite field. Sample N296D/80.5 m is oxidized supergenically, and it does not show the paragenesis of the time of Au-ore formation. Sample S186B/130.3 is the only one, in which the mineral paragenesis is similar to that typically in Bidjovagge Au-Cu-Te ore. Other samples represent rather the margins of the ore than the true mineralisation.

Table 10. *Summary on the microscopical observations of the samples.*

DDH	Metres	Rock type	Sulfide paragenesis	Fe-S-O paragenesis	Other diagnostic	Au ppm	Au grains
UV-15	6.9 m	brecciated albite felsite	py-cp	mt-hm-py	ab, ank	0	-
S 274 B	114.9 m	metadiabase	cp-py ± mc	mt-py-mc (ilm)	ab	8.2	inclusions in amp with qtz
S 186 B	130.3 m	albite felsite	cp-po-py-pn	po-py (ilm)	ab	50.1	inclusions in cp with po
S 54 E	247.6 m	albite - quartz - sericite schist	py-cp-mln	py	mu, ab	6.9	-
N 296 D	80.5 m	supergene alteration (calcite rock)	bn-cc-di-cv cp	goe-hm	cal	14.4	-
N 296 D	86.7 m	Quartz altered black schist	cp - bn - py - Co-pn	(py)	grf	28.1	-

Fig. 17. *Schematic pH-logf(O_2) diagram for the Fe-S-O system (Lamberg & Toikkanen, 1991). The locations of the studied samples are shown by arrows.*



4 References

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Lamberg, P. and Toikkanen, P. (1991) Chemical, Petrographical and Mineralogical Study of Five Mineralized Drill Holes Containing Au-Cu(-Te) Ore (C2-, C3-, C4-, E and K-Ore), and Its Immediate Surroundings in Bidjovagge Au-Cu Ore, Finnmark, Norway - With Interpretations of the Adjacent Alterations.. *Unpubl. rep. of Geoanalytical Laboratory of Outokumpu Mining Services. 074/Bidjo, ore types/PPL,PT/1991, August 23, 1991. 126 p, 8 Appendices.*