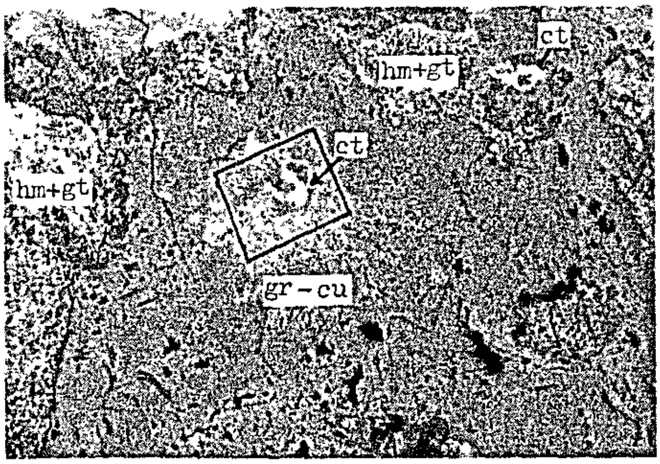
APX. I-4-(2) PHOTOMICROGRAPHS, SECONDARY ELECTRON IMAGES AND CHARACTERISTIC X-RAY IMAGES OF POLISHED SECTIONS OF SURFACE SAMPLES

APX.I-4-(2) PHOTOMICROGRAPHS, SECONDARY ELECTRON IMAGES* AND CHARACTERISTIC X-RAY IMAGES OF POLISHED SECTIONS OF SURFACE SAMPLES



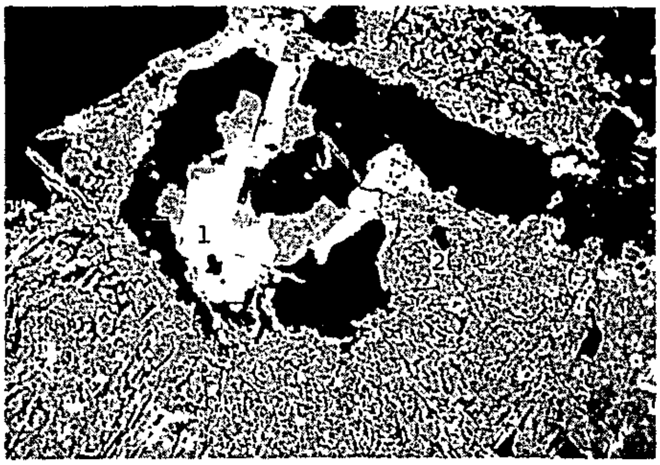
open nicol 0.5mm

1) A-7274(a)

Iron oxide-green copper mineral ore (stock pile).

Very fine-grained, flaky hematite-goethite aggregates, copper oxide and radiating fibrous transparent copper mineral.

ct: cuprite, hm: hematite
gt: goethite,
gr-cu: transparent copper mineral.

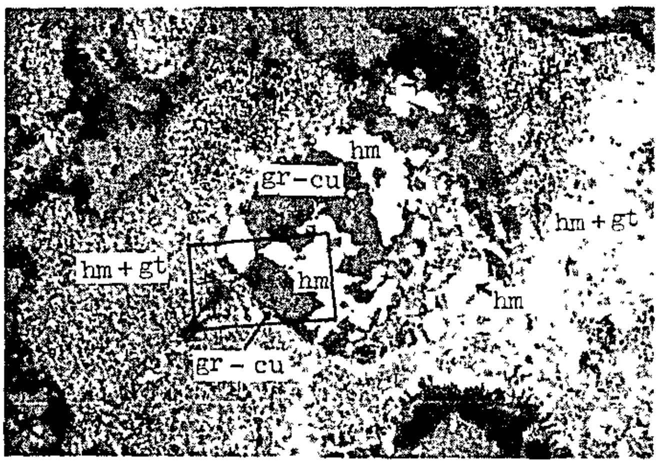


0.1mm

2) A-7274(a)

Secondary electron image and analyzed spots by EPMA.

1. cuprite: Cu-((Ca?)).
2. transparent copper mineral: Cu-(Si)-((Ca))-((Zn)).



open nicol 0.5mm

3) A-7274(b)

Very fine-grained, flaky hematite-goethite aggregates surrounding well-shaped hematite and transparent copper mineral.

hm: hematite, gt: goethite
gr-cu: transparent copper mineral.

* The areas of the secondary electron images are shown on the pair-photomicrographs. Note the left hand is reversed to the right hand comparing the secondary electron image with the pair-photomicrograph.

0.1mm

4) A-7274(b)

Secondary electron image and analysed spot by EPMA.

transparent copper mineral: Cu-(Ca)-(Si)-((Fe)).

open nicol

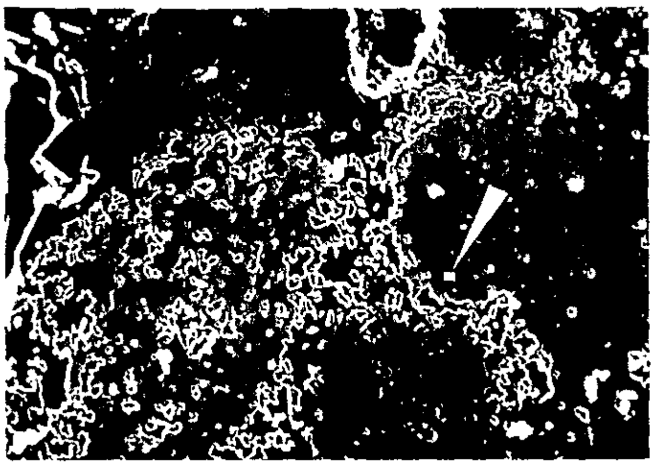
0.5mm

5) A-8011

Banded iron oxide-calcite manto.

Disseminated flaky hematite and hematite aggregates.

hm: hematite.



0.1mm

6) A-8011

Secondary electron image and analyzed spot by EPMA.

hematite: Fe-((S))-((Ca)).

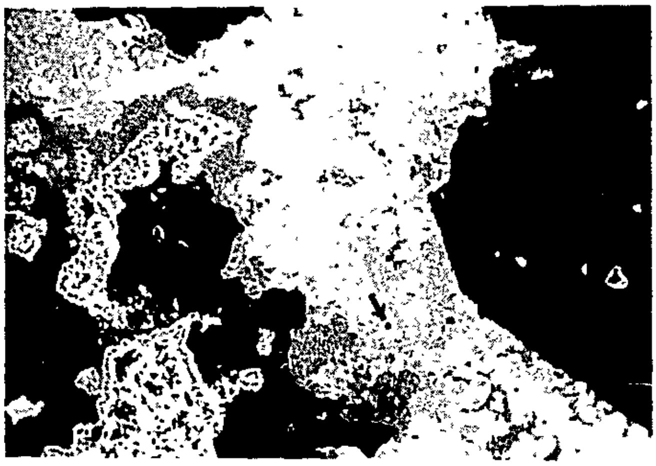
7) A-8095

Iron oxide-green copper mineral-calcite manto.

Interstitial copper oxides.

ct: cuprite,
tn: tenorite,
hm: hematite, gt: goethite.

open nicol 0.5mm



8) A-8095

Secondary electron image and analyzed spot by EPMA.

cuprite: Cu-((S))-((Ca)).

0.1mm

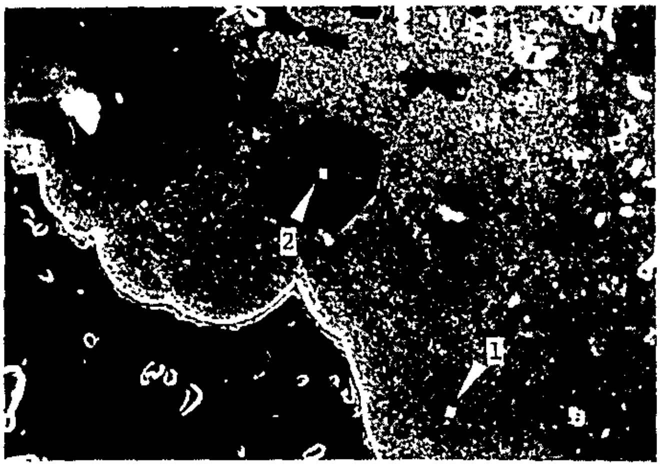
9) A-80910

Iron oxide-green copper mineral-calcite vein.

Flaky, very fine-grained hematite-goethite aggregate surrounded by colloform hematite including goethite.

hm: hematite, gt: goethite.

open nicol 0.5mm

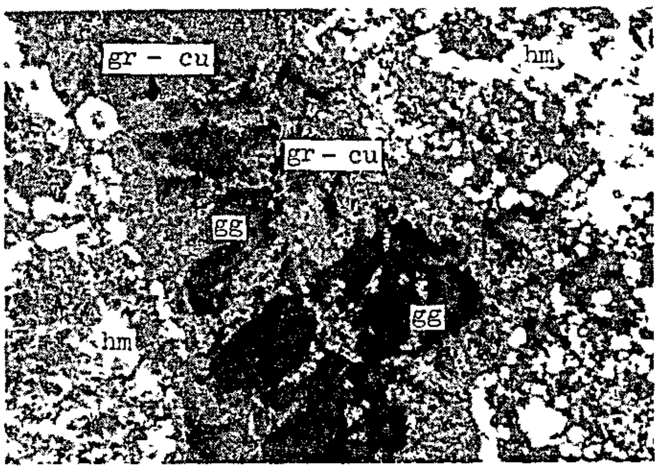


0.1mm

10) A-80910

Secondary electron image and analyzed spots by EPMA.

1. hematite : Fe-(Ca).
2. goethite : Fe-((Cu))- ((Ca)).



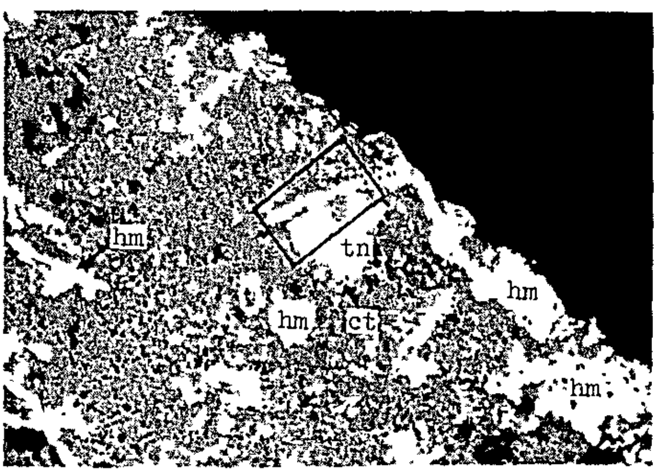
open nicol 0.1mm

11) A-8102

Iron oxide-green copper mineral vein.

Transparent copper minerals surround hematite and gangue minerals.

hm: hematite,
gr-cu: transparent copper mineral,
gg: gangue minerals.



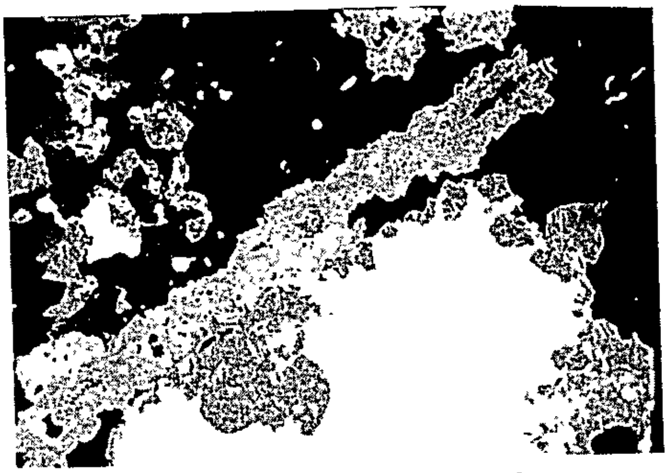
open nicol 0.5mm

12) A-8103(a)

Iron oxide-green copper mineral vein.

Copper oxides are disseminated with hematite.

ct: cuprite, tn: tenorite,
hm: hematite.



0.1mm

13) A-8103(a)

Secondary electron image and analyzed spot by EPMA.

hematite: Fe-(Sb)-(Ca)-((As)).

0.5mm

open nicol

14) A-8103(b)

Liesegang texture made up by hematite, goethite and gangue minerals.

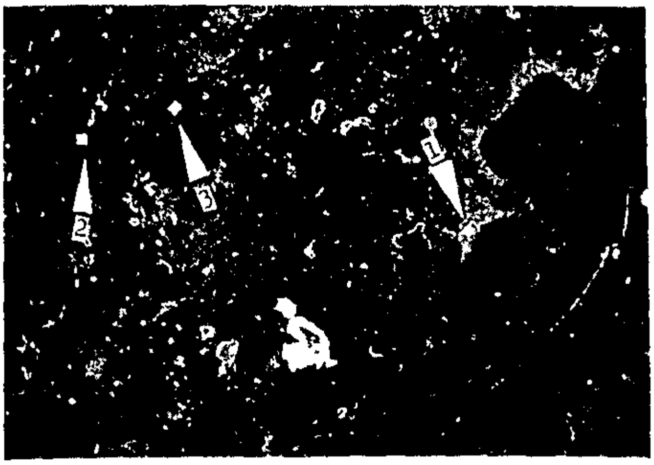
0.5mm

open nicol

15) A-8103(c)

Boxwork texture of hematite. Cells are filled with transparent green copper minerals and gangue minerals.

hm: hematite,
gr-cu: transparent copper mineral.

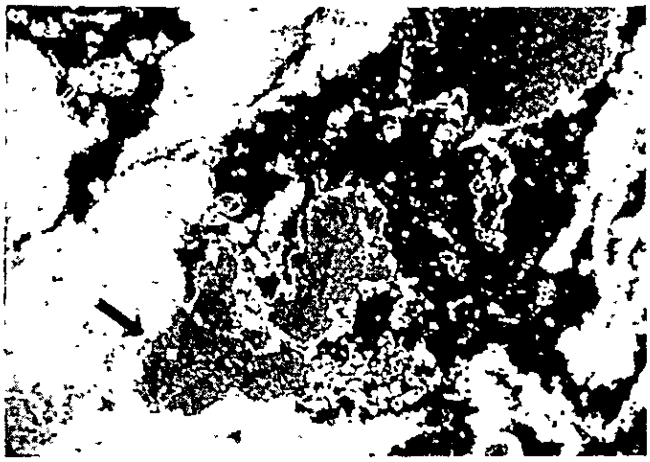


0.1mm

16) A-8103(c)-(1)

Secondary electron image and analyzed spots by EPMA.

1. green copper mineral : Cu-((Ca))-((Si?)).
2. hematite : Fe-(Pb)-((Sn)).
3. gangue mineral : (Fe)-(Cu)-((Pb))-((Sb))-((Sn))-((Ca))-((Si)).



0.1mm

17) A-8103(c)-(2)

Secondary electron image and analyzed spot by EPMA.

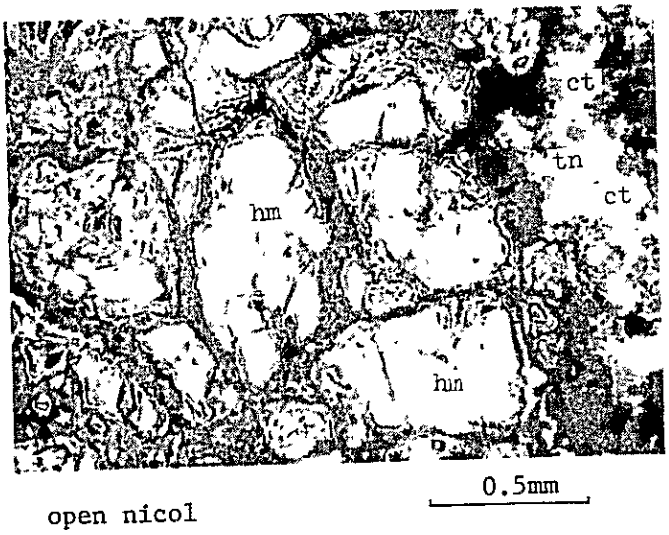
green copper mineral: Cu-(Si)-((Ca)).

open nicol 0.5mm

18) A-8104

Iron oxide-green copper mineral vein.

Discontinuous liesegang texture of hematite and gangue minerals.



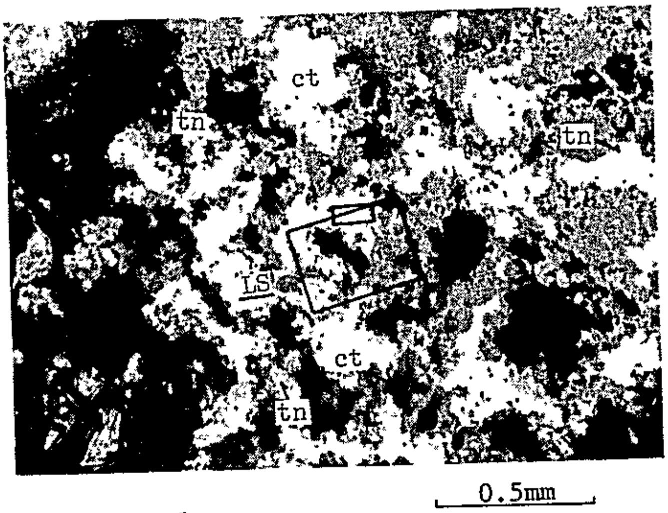
open nicol

19) A-8105(a)

Green copper mineral-iron oxide vein.

Hematite pseudomorphs after crushed pyrite, showing an atoll-to-liesegang texture. Copper oxides are concentrated nearby hematite-rich part.

hm: hematite, ct: cuprite, tn: tenorite.

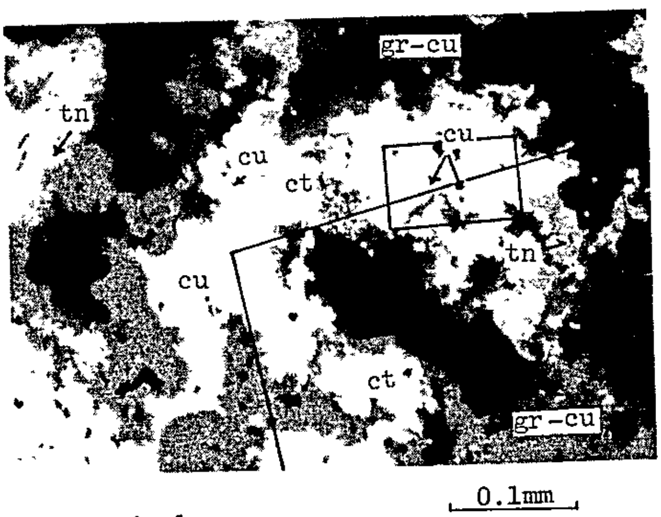


open nicol

20) A-8105(b)

Copper oxides-concentrated part. Copper oxides are enclosed by transparent copper mineral.

ct: cuprite, tn: tenorite, gr-cu: transparent copper mineral, LS: line scanning.

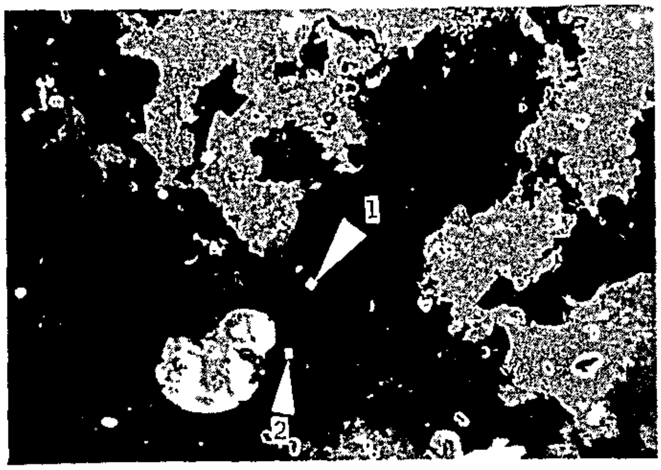


open nicol

21) A-8105(b)

Enlargement of examined area. Native copper is included in cuprite.

cu: native copper, ct: cuprite, tn: tenorite, gr-cu: transparent copper mineral.

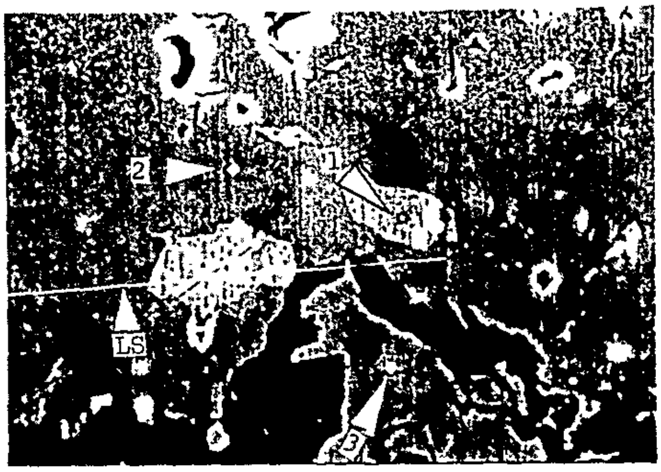


0.1mm

22) A-8105 (b)-(1)

Secondary electron image and analyzed spots by EPMA.

1. gangue mineral (calcite): Ca-((Cu)).
2. transparent copper mineral: Cu.

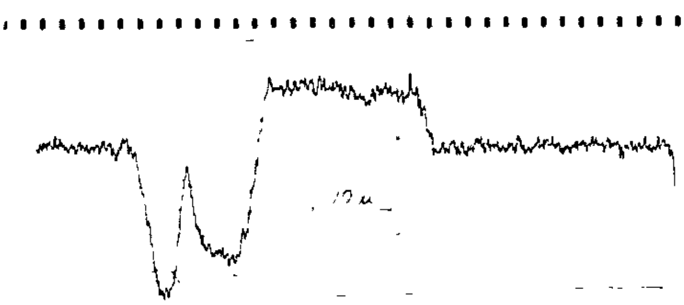


0.02mm

23) A-8105 (b)-(1)

Secondary electron image, analyzed spots, and scanned line by EPMA.

1. native copper : Cu.
2. cuprite : Cu-(O).
3. cuprite : Cu-(O).



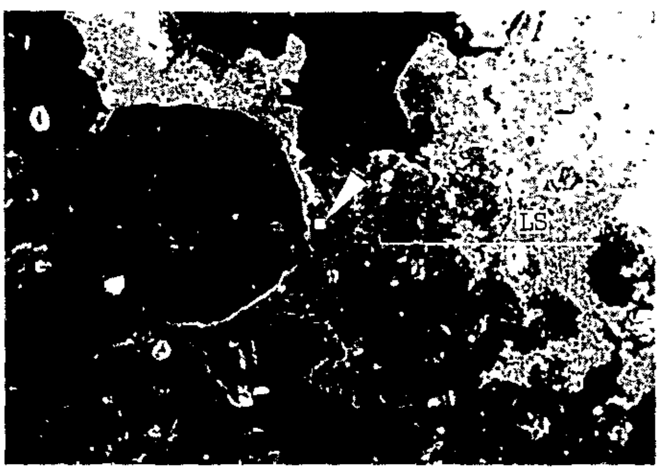
24) A-8105 (b)-(1)

Cu-Kα scanning pattern along above line. Note the scanning direction is reversed.
Conditions; 20KV,
0.008 μA,
5000 cps.

0.02mm

25) A-8105 (b)-(1)

Cu-Kα image of above area.

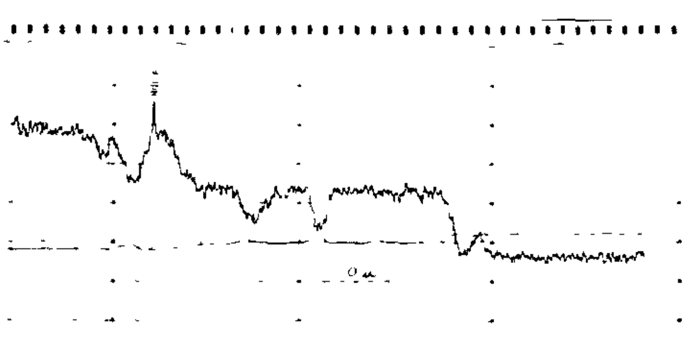


0.04mm

26) A-8105 (b)-(2)

Secondary electron image analyzed spot, and scanned line by EPMA.

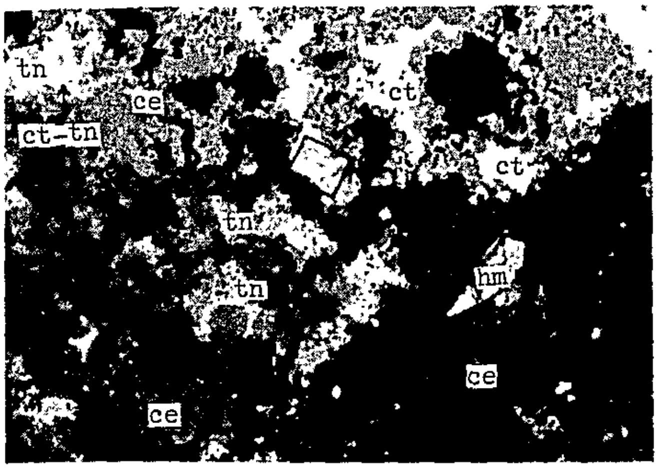
tenorite: Cu-(O)-((Si)).



27) A-8105 (b)-(2)

Cu-Kα scanning pattern along above line. Note the scanning direction is reversed.

Conditions; 20KV,
0.009 μA,
5000 cps.

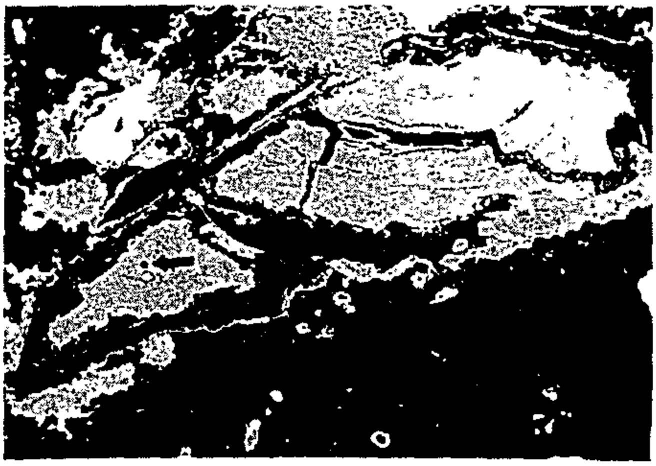


open nicol   0.5mm

28) A-8105 (c)

Another part where copper oxides are concentrated.

ct: cuprite, tn: tenorite,
ct-tn: cuprite-tenorite intermediate phase,
ce: cerargyrite.

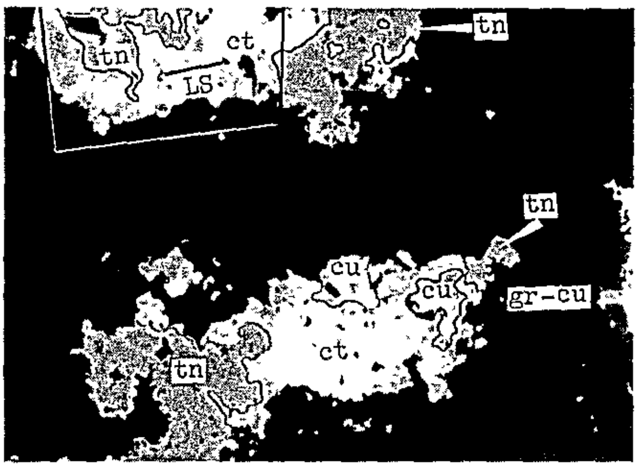


0.1mm

29) A-8105 (c)-(1)

Secondary electron image and analysed spot by EPMA.

hematite: Fe-(Sb)-(Ca)-((Cu)).



open nicol   0.1mm

30) A-8105 (c)-(2)

Partial enlargement.

Zoning of native copper→cuprite→tenorite→transparent copper mineral.

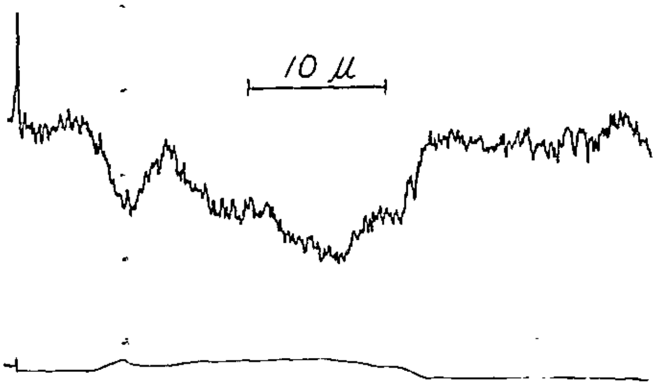
cu: native copper,
ct: cuprite, tn: tenorite
gr-cu: transparent copper mineral,
LS: line scanning.

0.04mm

31) A-8105 (c)-(2)

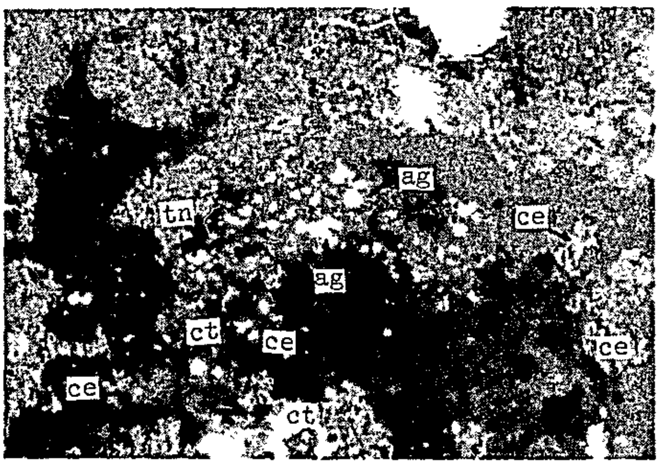
Secondary electron image, analyzed spot, and scanned line by EPMA.

tenorite: Cu-(O)-((Si)).



32) A-8105 (c)-(2)

Cu-Kα scanning pattern along above line. Note the scanning direction is reversed.
Condition; 20KV,
0.0075 μA,
5000 cps.



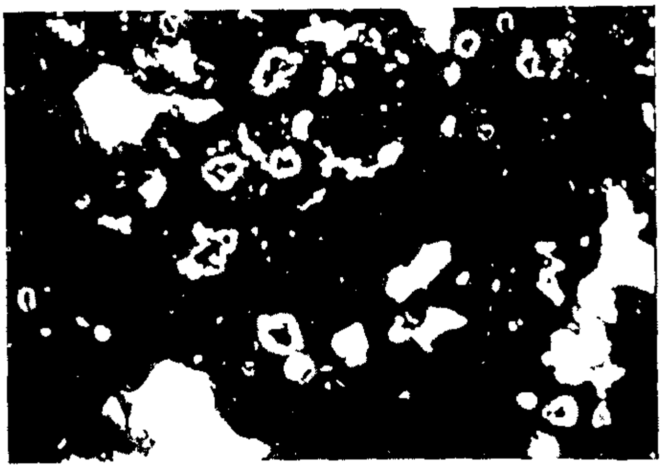
open nicol

0.1mm

33) A-8105 (d)

Silver mineral-concentrated part.

ag: native silver,
ce: cerargyrite,
ct: cuprite,
tn: tenorite.

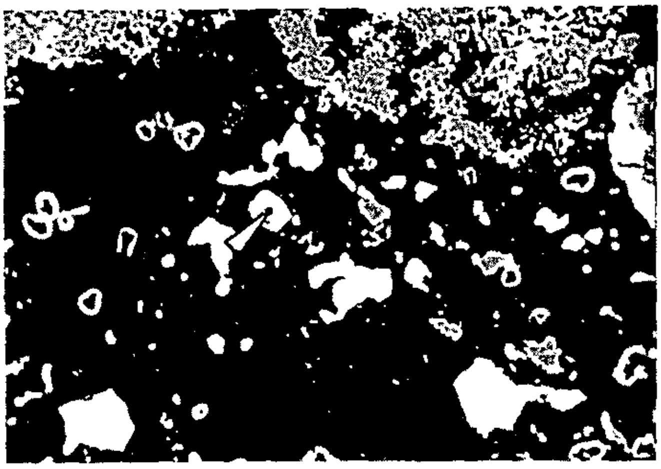


0.04mm

34) A-8105 (d)-(1)

Secondary electron image and analyzed spot by EPMA.

cuprite: Cu-(Ca).

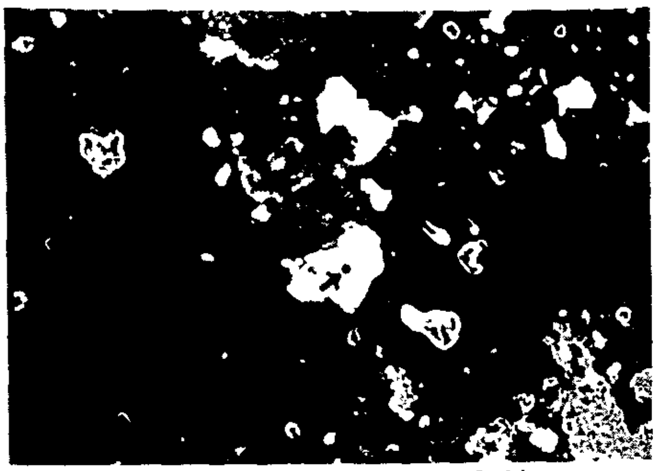


0.04mm

35) A-8105 (d)-(2)

Secondary electron image and analyzed spot by EPMA.

native silver: A-((S))-((Ca)).

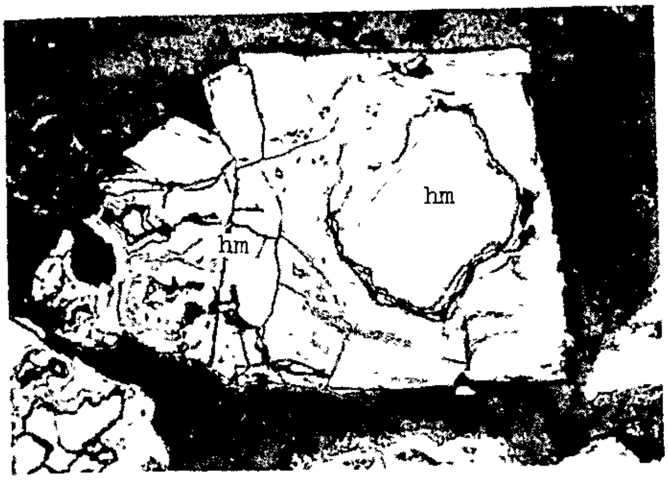


0.04mm

36) A-8105 (d)-(3)

Secondary electron image and analyzed spot by EPMA.

cerargyrite: Ag-(Br)-(I)-(Cl)-((Cu))-((Ca))



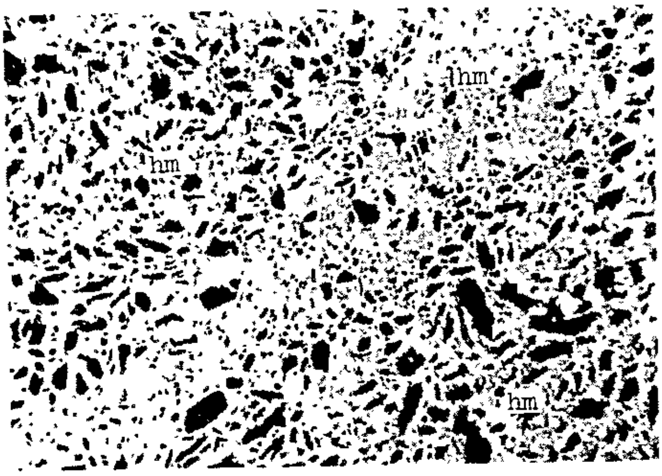
open nicol 0.5mm

37) E-7

Iron oxide-green copper mineral vein.

Crushed pyrite is completely oxidized to colloform hematite.

hm: hematite.



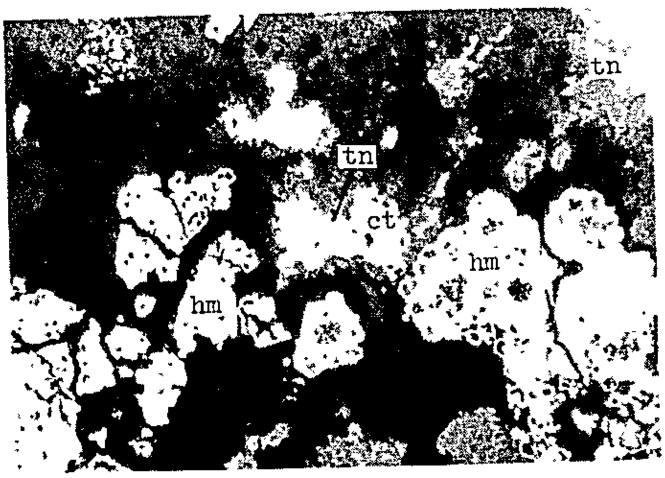
crossed nicols 0.05mm

38) E-14

Iron oxide vein.

Porous, very fine-grained, weakly banded hematite.

hm: hematite.



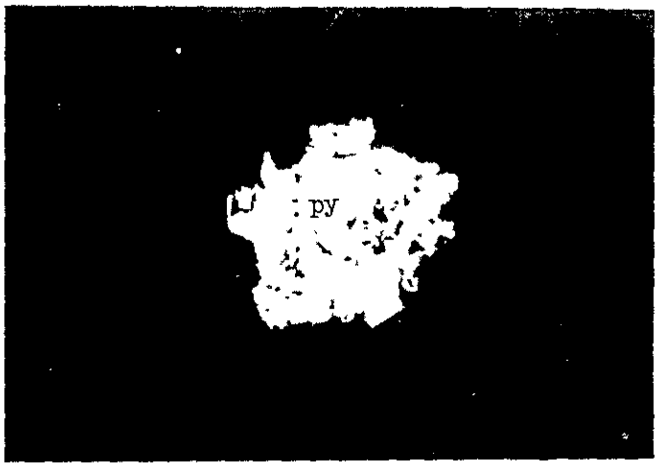
open nicol 0.5mm

39) E-38

Iron oxide-green copper mineral vein.

Crushed hematite pseudomorphs after pyrite, and copper oxides.

hm: hematite,
ct: cuprite,
tn: tenorite.



open nicol 0.5mm

40) G-15

Pyrite small dot in marl.

py: pyrite.

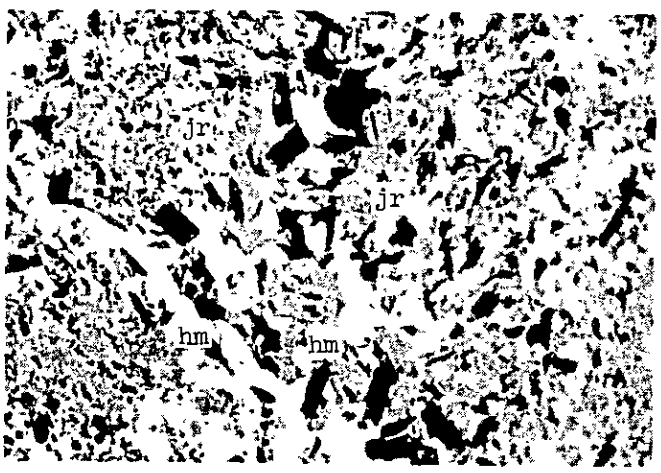
open nicol 0.5mm

41) G-30

Iron oxide manto.

Colloform hematite ring bordering very fine-grained hematite-goethite aggregates.

hm: hematite,
gt: goethite.

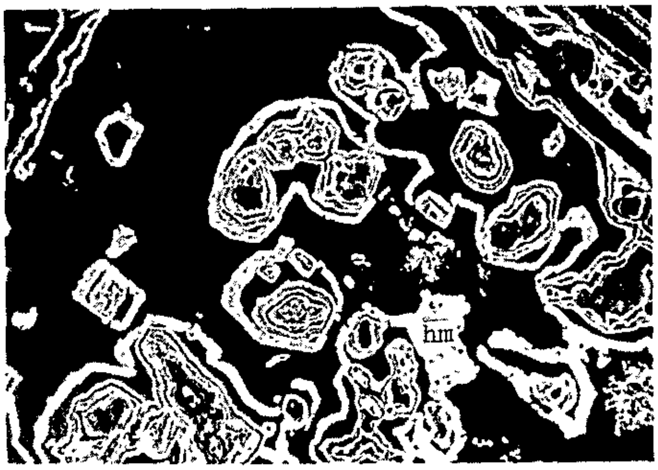


open nicol 0.1mm

42) Jarosite-iron oxide manto.

Flaky aggregates of jarosite and colloform hematite. Jarosite was confirmed by a X-ray powder diffraction.

jr: jarosite,
hm: hematite.



open nicol 0.5mm

43) G-82

Garnet-quartz-calcite-iron oxide-green copper mineral vein.

Liesegang texture of hematite, goethite and gangue minerals replacing pyrite.

hm: hematite.

APX.I-4-(3) QUALITATIVE ANALYSIS OF ORE MINERALS OF SURFACE SAMPLES BY ELECTRON PROBE MICROANALYZER

No.	Sample No.	Examined mineral	Fe	Cu	Pb	Zn	Ag	Sb	Sn	As	S	Ca	Si	Br	I	O	Cl
1	A-7274 APE	transparent copper mineral		S								VW	W				
2		cuprite		S								T					
3		transparent copper mineral	VW	S								W	W				
4	A-8011 APE	hematite	S								VW	VW					
5	A-8095 APE	cuprite		S													
6	A-80910 APE	hematite	S									W					
7		goethite	S	VW								VW					
8	A-8103 APE	hematite	S					W		VW		W					
9		transparent copper mineral		S								W	M				
10		ditto		S								VW	T				
11		gangue mineral	W	W	VW			VW	VW			VW	VW				
12		hematite	S		W				VW								
13	A-8105 APE	native silver					VS				VW	VW					
14		cuprite		S								W					
15		cerargyrite		VW			VS					VW		M	M		M
16		native copper		S													
17		cuprite		S												W	
18		tenorite (paratenorite)?		S									VW			W	
19		calcite		VW								S					
20		transparent copper mineral		S													
21		tenorite (paratenorite)?		S												W	
22		hematite	M	VW				W				W					

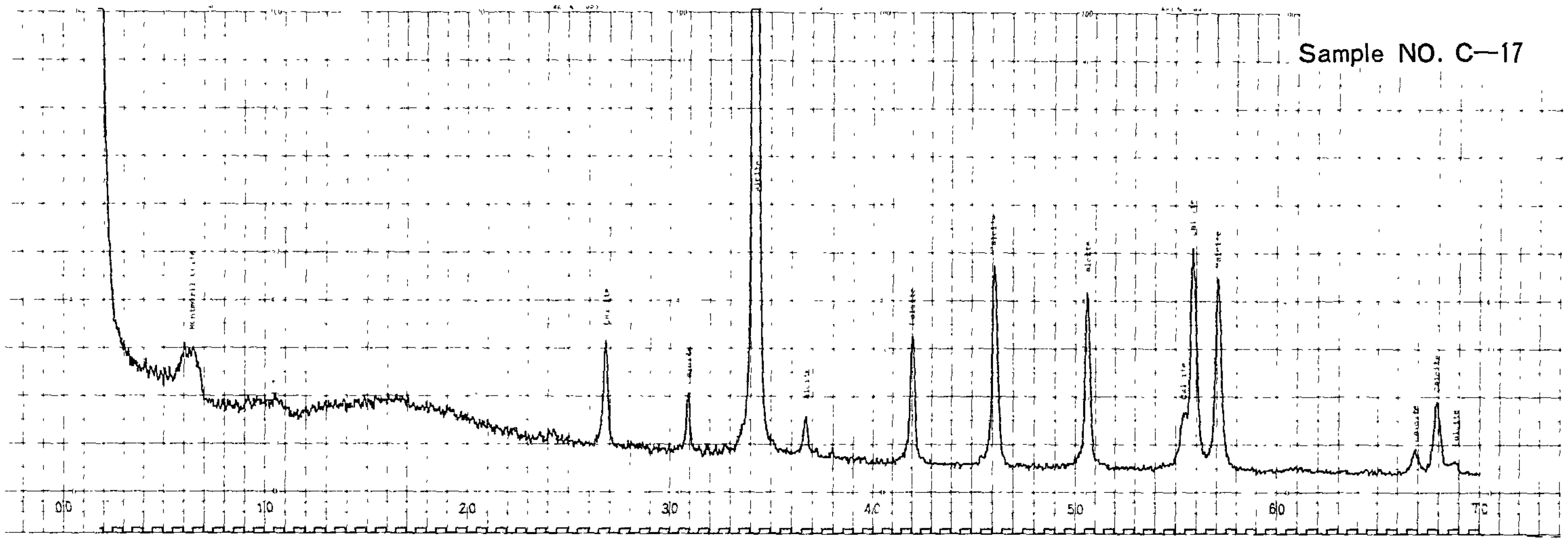
VS: very strong M: moderate VW: very weak
S: strong W: weak T: trace

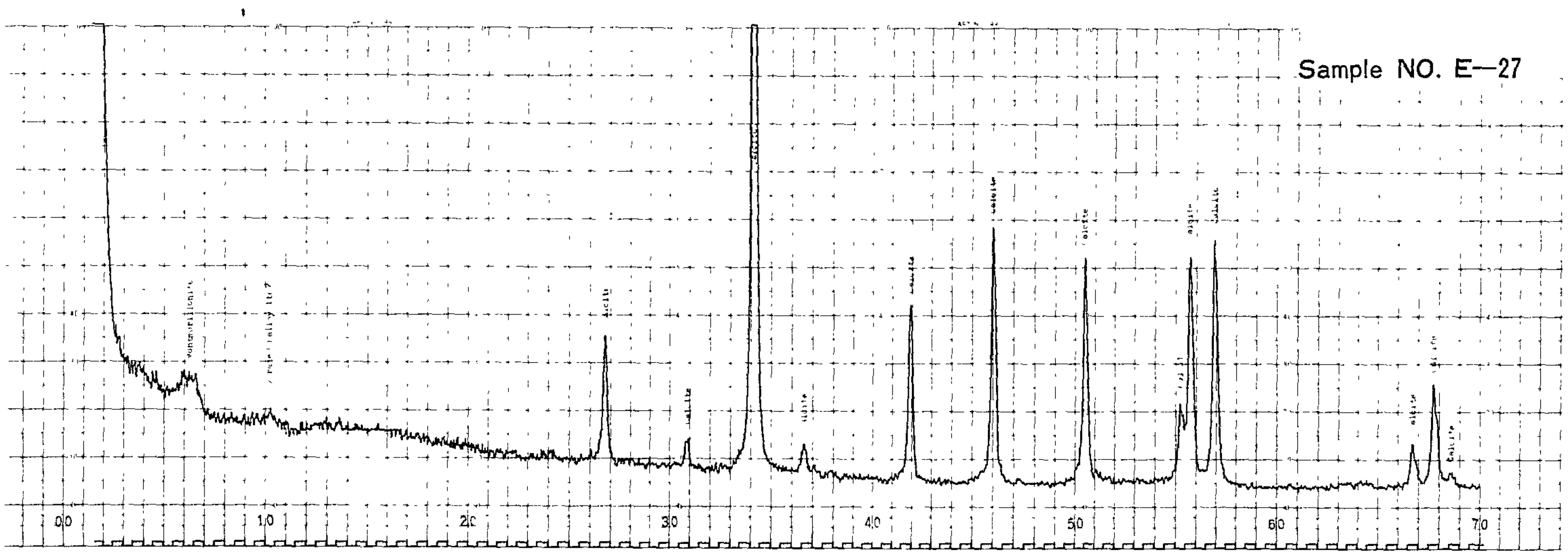
APX. 1-5-(1) DETECTED MINERALS BY X-RAY DIFFRACTIONS

No.	Sample No.	Coordinates E	Coordinates N	Occurrence	Natrojar-osite	Goethite	Quartz	Calcite	Montmorill-onite	Hydrated halloysite
1	C-17	647683	3123562	Colloform calcite along a fracture zone.				++++	++	
2	E-27	647653	3125128	White limestone altered along bedding plane.				++++	+	?
3	E-42	648350	3124348	Altered white pulverulent limestone in contact with an iron oxide-green copper mineral vein.				++++	+	
4	G-44	646950	3123552	Yellow brown jarosite adjacent to an iron oxide manto.	++++	++	+			
5	SLM-2	646955	3123553	Aggregates of light brown flaky minerals.	++++					

++++ very abundant, +++ abundant, ++ common, + rare, ? uncertain

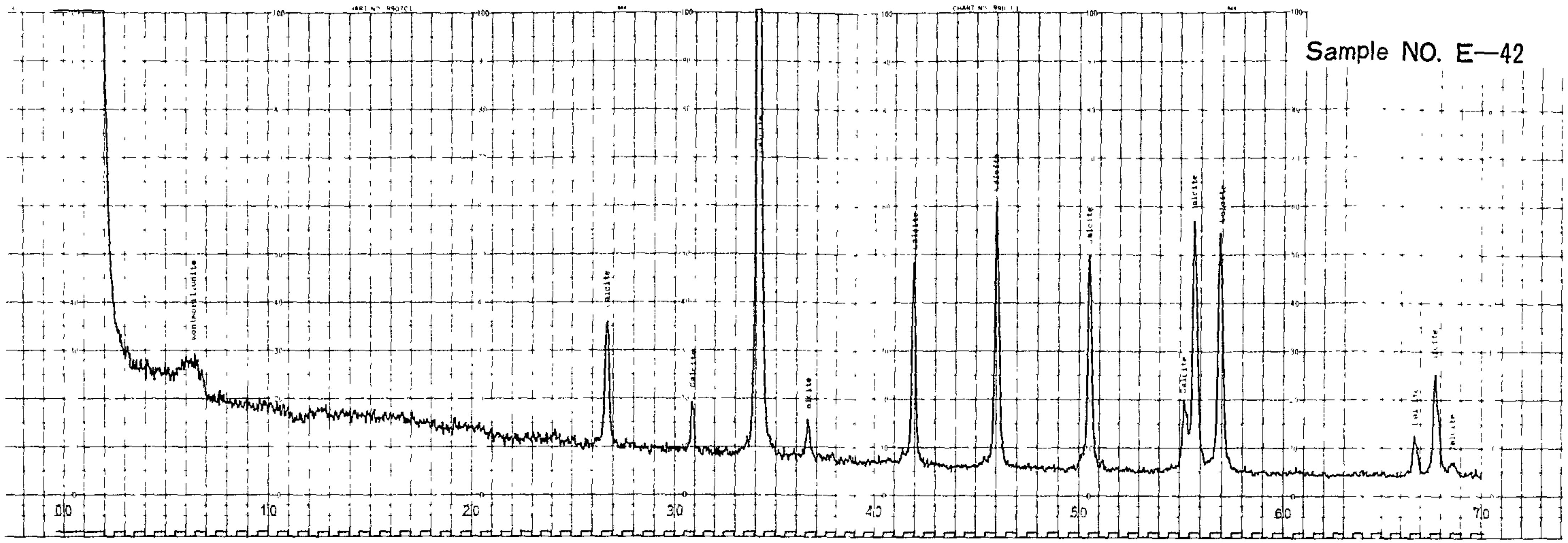
APX. I-5-(2) CHARTS OF X-RAY DIFFRACTIONS





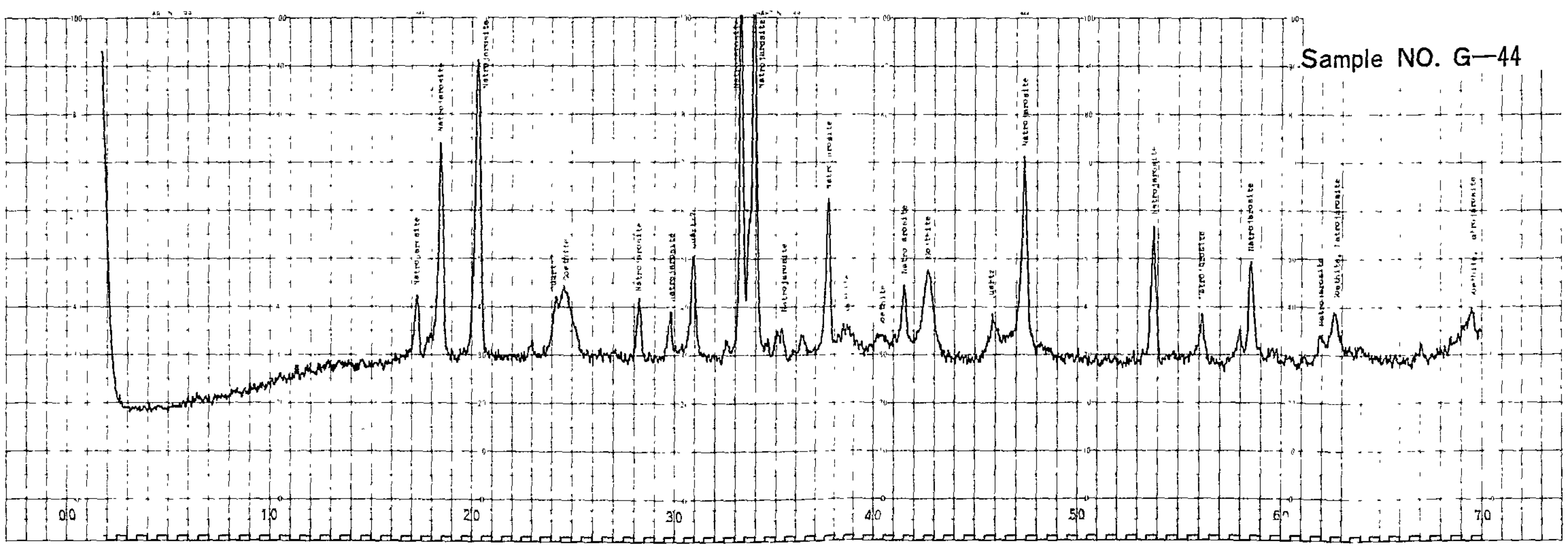
CONDITION

Target	Co	
Filter	Fe	
Voltage	40	KV
Current	20	mA
Ratemeter	200	
Multiplier	1.0	
Count full scale	2000	c/s
Time Constant	1	sec
P.H.A	3-080-200	
Divergent Slit	1	
Receiving Slit	0.3	mm
Soller Slit		
Glancing Angle		
Scanning Speed	2	°/min
Chart Speed	20	mm/min
Date	53. 12. 13	
Operator		



CONDITION

Target	Co	
Filter	Fe	
Voltage	40	KV
Current	20	mA
Ratemeter	200	
Multiplier	10	
Count Full Scale	2000	c/s
Time Constant	1	sec.
P.H.A.	3-080-300	
Divergent Slit	1	°
Receiving Slit	0.3	mm
Soller Slit		°
Glancing Angle		°
Scanning Speed	2	°/min
Chart Speed	20	mm/min.
Date	53. 12. 13	
Operator		



CONDITION

Target	Co	
Filter	Fe	
Voltage	40	KV
Current	20	mA
Ratemeter	400	
Multiplier	10	
Count Full Scale	4000	c/s
Time Constant	1	sec.
P H A.	3-080-300	
Divergent Slit	1	°
Receiving Slit	0.3	mm
Soller Slit		°
Glancing Angle		°
Scanning Speed	2	°/min.
Chart Speed	20	mm/min.
Date	53. 12. 13	
Operator		

APX. I-6 CHEMICAL ANALYSES AND X-RAY DIFFRACTION DATA OF NATROJAROSITE

1) Chemical analyses and atomic ratio

SLM-2.

	wt.%	Atomic No.		Atomic ratio*	
Fe_2O_3	49.42	Fe^{3+}	6189	3.000	3.000
Na_2O	5.87	Na	1894	0.918 }	1.004
K_2O	0.84	K	178	0.086	
SO_3	32.37	S	4043	1.960	1.960
H_2O+	11.04	H	12267	5.946	5.946
Total	99.71**				

* Fe^{3+}=3.000. ** Includes H_2O- 0.17, SiO_2 tr., Al_2O_3 tr., TiO_2 tr., FeO tr., MnO tr., MgO tr., CaO tr.

2) X-ray powder diffraction

SLM-2		ASTM 11-302 $NaFe_3(SO_4)_2(OH)_6$	
I_{obs}	d_{obs}	$d_{(ASTM)}$	I/I_0 (ASTM)
M	5.91	5.94	40
W	5.60	5.57	50
M	5.52		
S	5.03	5.06	100
W	4.46		
M	3.65	3.67	20
M	3.47	3.49	20
W	3.175		
Vs	3.107	3.12	70
Vs	3.045	3.06	80
W	2.954	2.96	20
M	2.761	2.78	20
M	2.516	2.53	40
M	2.217		
		2.24	66
		2.13	20
S	1.971	1.98	60
W	1.895	1.91	5
S	1.823	1.83	50
W	1.734	1.74	5
W	1.716	1.72	5
W	1.615		

Vs: very strong
S : strong
M : moderate
W : weak

APX. I-7 POTASSIUM-ARGON DATINGS AND WHOLE ROCK CHEMICAL ANALYSES

Sample No.		SLM-2	SLM-4
Coordinates	E	646955	647517
	N	3123553	3123717
Rock name		Natrojarosite	Altered dolerite
Chemical analyses	SiO_2	tr.	42.03
	TiO	tr.	2.05
	Al_2O_3	tr.	14.98
	Fe_2O_3	49.42	4.77
	FeO	tr.	3.43
	MnO	tr.	0.11
	MgO	tr.	1.91
	CaO	tr.	10.44
	Na_2O	5.87	1.60
	K_2O	0.84	6.64
	H_2O+	11.04	4.55
	H_2O-	0.17	1.66
	P_2O_5	n.a.	0.79
	CO_2	n.a.	4.87
	SO_3	32.37	n.a.
	Total	99.71	99.83
Potassium-Argon dating	Mineral	Natrojarosite	Whole
	Sample wt. (g)	1.0724	0.9978
	K (%)	0.56	4.62
	$^{40}Ar^R/^{40}K$	– *	0.00910
	Air cont. (%)	–	38.73
	Age (m.y.)	–	20
Remarks		$\lambda_e=0.581\times10^{-10}yr^{-1}$ $\lambda_\beta=4.962\times10^{-10}yr^{-1}$ $^{40}K/K=1.167\times10^{-4}$ $^{40}Ar^R$: Radiogenic argon 40	

* Not extracted because of sample dispersion at heating

PART III

DIAMOND DRILLING

APX. III-1 CHEMICAL ANALYSES OF DRILL CORE SAMPLES

APX. III-1 CHEMICAL ANALYSES OF DRILL CORE SAMPLES

1). DDH-M1

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Co (%)	As (%)	Cd (%)	Hg (g/t)	Remarks
1	1	12.05 ~ 13.35	1.30	0.4	36.8				tr.				Calcite-iron oxide-(fluorite-
					9.5	0.14	0.02	0.07					quartz) vein.
2	2	13.35 ~ 13.70	0.35	8.7	121.9	4.08	0.02	0.34	tr.	2.39	0.03	1.6	Iron oxide-green copper
					7.8	4.66	0.01	0.44					mineral-calcite-quartz vein.
3	3	13.70 ~ 14.60	0.90	4.8	70.3	0.97	0.01	0.17	tr.	1.40	0.01	1.1	ditto.
					8.5	1.02	0.01	0.15					
4	4	14.60 ~ 15.50	0.90	0.7	234.4	1.36	0.02	0.19	tr.	1.52	0.02	2.9	ditto.
					11.2	1.40	0.004	0.17					
5	5	15.50 ~ 16.65	1.15	1.4	328.1	6.80	tr.	0.20	tr.	2.62	0.001	2.7	ditto.
					29.3	6.48	0.02	0.16					
6	6	16.95 ~ 17.55	0.60	1.4	210.9	4.99	0.01	0.11	tr.	0.20	0.03	0.72	Green copper mineral-quartz-calcite-iron oxide vein.
					10.9	4.77	0.01	0.11					wd : 5 cm incl : 75°
7	7	19.40 ~ 19.75	0.35	tr.	17.0				tr.				ditto.
					6.5	0.25	0.01	0.11					wd : 3 cm incl : 90°
8	8	26.25 ~ 27.75	1.50	3.9	46.9	0.97	tr.	4.20	tr.	1.47	0.04	0.85	ditto
					13.7	0.19	0.01	3.88					
9	9	44.30 ~ 44.90	0.60	0.8	12.7				tr.				Green copper minerals along cracks.
					8.0	0.36	0.02	0.03					wd : 1 cm incl . 90°
10	10	72.60 ~ 73.20	0.60	tr.	11.3				tr.				Green copper mineral-quartz-calcite-iron oxide vein.
					8.5	0.24	0.01	0.07					wd : 0.5cm incl : 80°
11	11	106.75 ~ 107.20	0.45	tr.	2.8				tr.				Calcite-iron oxide-green copper mineral vein.
					6.0	0.11	0.02	0.04					wd . 1 cm incl : 75°

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Co (%)	As (%)	Cd (%)	Hg (%)	Remarks
12	12	158.50 ~ 158.90	0.40	0.4	76.4 7.0	0.20	0.01	0.05	tr.				Fractured zone; strongly iron oxide-stained, weakly silicified, penetrated by calcite veinlets.
13	13	159.45 - 160.35	0.90	tr.	2.8 5.0	0.11	0.01	0.04	tr.				ditto.
14	14	164.25 - 165.70	1.45	tr.	2.8 5.6	0.06	0.01	0.07	tr.				Iron oxide-green copper mineral vein. incl : 85 - 90°
15	15	170.90 - 172.00	1.10	tr.	2.3 5.6	0.14	0.01	0.11	tr.				Brecciated zone; strongly stained by iron oxide.
16	16	208.50 - 209.50	1.00	tr.	2.3 4.3	0.29	0.01	0.05	tr.				Iron oxide-green copper mineral quartz-calcite-veinlets. wd . 0.5cm incl : 65°
17	17	209.50 - 211.45	1.95	0.4	1.6 4.2	0.05	0.01	0.03	tr.				ditto.

2). DDH-M2

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Co (%)	As (%)	Cd (%)	Hg (%)	Remarks
18	1	1.10 - 1.45	0.35	tr.	65.1 12.7	0.37	0.01	0.01					Iron oxide-green copper mineral-calcite vein. wd : 0.5cm incl : 70°
19	2	2.20 - 2.35	0.15	tr.	20.6 16.3	0.18	0.01	0.01					Iron oxide-green copper mineral-calcite-chalcopyrite vein. wd . 1.0cm incl : 85°
20	3	5.00 ~ 5.25	0.25	tr.	tr. 3.7	0.25	0.01	0.01					Iron oxide-green copper mineral-calcite vein. wd . 0.5cm incl : 85°
21	4	5.90 ~ 6.25	0.35	tr.	1.2 5.4	0.15	0.01	0.01					ditto. wd : 1.0cm incl . 85°
22	5	10.54 10.70	0.16	tr.	1.2 6.2	0.18	0.01	0.01					ditto. wd : 2.0cm incl : 60°
23	6	10.80 - 11.10	0.30	tr.	26.6 15.0	0.21	0.003	0.01					ditto. wd · 1.0cm incl · 60°
24	7	27.75 - 27.92	0.17	tr.	15.7 12.8	0.55	0.01	0.39					Calcite-iron oxide vein.

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Co (%)	As (%)	Cd (%)	Hg (%)	Remarks
25	8	32.85 ~ 33.25	0.40	tr.	60.5 13.2	0.05	0.02	0.03					Iron oxide-quartz-calcite vein. wd : 20 cm incl : 45°
26	9	35.08 ~ 35.45	0.37	tr.	1.2 6.3	0.06	0.01	0.01					ditto. wd : 3-5cm incl : 70°
27	10	37.90 ~ 38.05	0.15	1.4	4.7 12.1	0.09 0.08	0.03 0.06	0.03 0.01		0.17	0.001	1.6	ditto. wd : 15 cm
28	11	45.45 ~ 45.80	0.35	0.7	168.7 18.6	6.18 6.97	0.04 0.02	0.12 0.05		0.98	0.002	20.0	Iron oxide-green copper mineral-quartz-calcite vein.
29	12	64.25 ~ 64.65	0.40	tr.	2.4 4.6	0.11	0.02	0.13					Iron oxide-calcite-quartz-vein. wd : 30 cm incl : 50°
30	13	76.40 ~ 77.10	0.70	0.4	70.0 10.9	0.14 0.15	0.02 0.01	3.14 3.13	tr.	1.14	0.07	2.3	Iron oxide-green copper mineral vein ; very low core recovery.
31	14	120.50 ~ 121.60	1.10	1.3	147.6 14.3	1.78 1.93	0.03 0.01	0.10 0.13	tr.	0.36	0.003	30.0	Iron oxide-green copper mineral-quartz-calcite-fluorite veinlets (networks).
32	15	121.60 ~ 124.80	3.20	tr.	76.2 23.7	0.36	0.02	0.05	tr.				Calcite-iron oxide vein; very low core recovery.
33	16	124.95 ~ 127.75	2.80	2.6	274.1 18.7	9.45 10.68	0.03 0.02	0.11 0.11	tr.	1.19	0.001	44.9	Iron oxide-green copper mineral-quartz-calcite vein ; very low core recovery.
34	17	127.75 ~ 128.50	0.75	tr.	20.0 10.6	1.82 2.57	0.002 0.01	0.07 0.06	tr.	0.05	0 002	2.2	Iron oxide-green copper mineral-calcite veinlets (networks).
35	18	130.80 ~ 131.45	0.65	tr.	9.7 7.0	0.37	0.004	0.04	tr.				Calcite-green copper mineral veinlets (networks).
36	19	139.50 ~ 140.20	0.70	tr.	50.0 6.2	0.65 0.91	0.02 0.01	0.05 0.04	tr.	0.12	0.001	2.4	Iron oxide-green copper mineral-fluorite-quartz-calcite vein. wd : 8 cm incl : 80°
37	20	146.45 ~ 146.80	0.35	tr.	83.3 11.2	0.36	0.01	0.11					Quartz-calcite-gypsum-pyrite vein. wd . 40 cm incl : 20°
38	21	148.70 ~ 149.90	1.20	tr.	15.7 11.2	0.18	0.01	0.03	tr.				Quartz-calcite-gypsum-pyrite (-kobellite) vein.wd :60cm,incl:60°

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Co (%)	As (%)	Cd (%)	Hg (%)	Remarks
39	22	152.65 ~ 152.85	0.20	tr.	55.0	1.46	0.02	0.05		0.17	0.001	0.63	*Quartz-calcite-gypsum-(garnet)-pyrite-(kobellite) vein.*
					13.7	1.76	0.004	0.04					wd : 5 cm, incl : 70°
40	23	154.00 ~ 154.30	0.30	0.9	90.0	1.78	0.02	0.07		0.20	0.0004	0.84	Quartz-calcite-gypsum-pyrite vein.
					15.3	2.05	0.01	0.06					wd : 15 cm, incl . 45-70°
41	24	160.50 ~ 160.90	0.40	tr.	33.3								Quartz-calcite-gypsum-pyrite-
					12.5	0.67	0.01	0.05					(kobellite) veins.
42	25	161.65 ~ 162.70	1.05	tr.	100.0				tr.				ditto.
					14.8	0.42	0.01	0.06					wd : 107 cm, incl : 60°
43	26	162.70 ~ 163.80	1.10	tr.	27.8				tr.				ditto.
					18.7	0.77	0.003	0.11					
44	27	164.20 ~ 165.75	1.55	0.7	55.0	0.97	0.02	0.08	tr.	0.19	0.001	6.7	ditto.
					11.2	1.11	0.01	0.11					wd : 80 cm, incl : 60°
45	28	167.80 ~ 168.20	0.40	0.7	30.0	0.32	0.02	2.81	tr.	1.43	0.005	0.09	Quartz-calcite-gypsum-pyrite-(*green copper mineral*) vein.
					7.0	0.42	0.004	2.56					wd : 17 cm, incl : 60°
46	29	169.30 ~ 170.00	0.70	tr.	1.0				tr.				Quartz-calcite-gypsum-pyrite vein, partly oxidized to
					2.3	0.02	0.01*	0.16					hematite. wd:45cm, incl:75°
47	30	170.65 ~ 171.25	0.60	tr.	1.0				tr.				Quartz-calcite-gypsum-pyrite vein.
					3.1	0.01	0.01	0.05					wd : 55 cm, incl : 70°
48	31	172.15 ~ 172.80	0.65	0.5	70.8				tr.				Quartz-calcite-gypsum-pyrite veins (two, parallel).
					13	0.02	0.01	0.04					wd : 4 cm, incl : 70°
49	32	183.90 ~ 184.30	0.40	1.0	6.2								Quartz-calcite-pyrite vein.
					2.8	0.07	0.01	0.02					wd · 1 cm, incl . 50°
50	33	185.77 ~ 185.97	0.20	tr.	1.2								*Pyrite-calcite vein cut by*
					3.1	0.02	0.003	0.02					calcite-gypsum veinlets.
51	34	187.85 ~ 188.10	0.25	tr.	12.5								Quartz-calcite-gypsum-pyrite-(kobellite) vein.
					3.4	0.03	0.01	0.002					wd : 5 cm
52	35	195.05 ~ 195.22	0.17	tr.	6.2								Pyrite-calcite-quartz-gypsum-(kobellite) veinlets.
					5.4	0.04	0.01	0.02					wd : 1.8 cm, incl : 70°

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Co (%)	As (%)	Cd (%)	Hg (%)	Remarks
53	36	207.95 ~ 208.20	0.25	0.7	15.0 16.5	0.07 0.05	0.02 0.01	0.90 0.94		0.02	0.01	0.46	Pyrite-calcite-gypsum veinlets. wd : 2 cm, incl : 70°
54	37	214.30 ~ 214.80	0.50	tr.	3.0 4.3	0.06	0.01	0.13	tr.				Pyrite-quartz-calcite vein cut by calcite-gypsum vein. wd : 5 cm, incl : 85°
55	38	219.60 ~ 220.00	0.40	tr.	8.9 9.6	0.05	0.01	0.02					Pyrite-gypsum-fluorite-calcite -quartz vein. wd : 3 cm, incl : 85-90°
56	39	240.20 ~ 240.40	0.20	1.1	53.2 29.6	0.18	0.02	0.23					Strongly oxidized pyrite-calcite vein.
57	40	247.00 ~ 249.00	2.00	tr.	4.1 5.4	0.03	0.01	0.01	tr.				Strongly fractured and brecciated zone filld with calcite veinlets; hematite after pyrite is disseminated.
58	41	249.00 ~ 251.00	2.00	tr.	2.8 4.6	0.01	0.01	0.01	tr.				ditto.
59	42	251.00 ~ 253.60	2.60	tr.	6.9 4.6	0.01	0.01	0.01	tr.				ditto.
60	43	257.20 ~ 257.70	0.50	tr.	2.0 3.9	0.02	0.01	0.02					Strongly fractured zone filled with calcite vein; hematite after pyrite is disseminated.
61	44	267.00 ~ 268.35	1.35	tr.	4.5 5.4	0.05	0.02	0.04	tr.				Strongly fractured zone filled with hematite-(pyrite)-calcite veinlets.
62	45	279.40 ~ 281.30	1.90	tr.	263.2 3.1	0.02	0.02	0.04	tr.				Moderately-to-strongly fractured zone filled with calcite veinlets; hematitized pyrite is disseminated.
63	46	284.00 ~ 284.30	0.30	tr.	6.5 4.6	0.02	0.03	0.05					ditto.
64	47	286.45 ~ 288.05	1.60	tr.	4.3 4.5	0.03	0.03	0.05	tr.				Fractured zone filled with calcite veinlets.
65	48	289.10 ~ 294.25	5.15	tr.	3.4 3.4	0.14	0.03	0.16	tr.				Strongly oxidized porous calcite-iron oxide vein, low core recovery.

3) DDH-M3

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	As (%)	Cd (%)	Hg (g/t)	Remarks
66	1	140.50 ~ 141.45	0.95	0.9	20.0 11.2	1.14 1.02	0.01 0.004	10.10 9.69	4.22	0.08	0.17	Strongly brecciated zone filled with pyrite-calcite-(green copper mineral) vein.
67	2	181.30 ~ 182.50	1.20	0.7	2.4 5.6	0.01	0.01	0.15				Sturongly oxidized zone.
68	3	185.70 ~ 188.20	2.50	tr	2.9 11.7	0.02	0.004	0.16				Strongly fractured and brecciated zone filled with calcite-iron oxide-(green copper mineral)vein.
69	4	190.80 ~ 191.80	1.00	tr.	0.6 3.4	0.05	0.003	0.11				Strongly fractured and brecciated zone; strongly oxidized.
70	5	191.80 ~ 192.80	1.00	1.0	2.9 5.9	0.05	0.01	0.12				ditto.
71	6	192.80 ~ 193.40	0.60	0.7	15.0 8.1	0.49 0.55	0.02 0.004	0.90 0.88	0.80	0.01	0.17	Strongly fractured and brecciated zone filled with iron oxide-calcite-(green copper mineral)vein.

4) DDH-M4

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	As (%)	Cd (%)	Hg (g/t)	Remarks
72	1	41.40 ~ 41.95	0.55	tr.	0.8 11.2	0.004	0.01	0.01				Slightly brecciated and bleached marly limestone; weakly 1oxidized.
73	2	47.85 ~ 48.20	0.35	tr.	3.3 5.0	0.01	0.01	0.03				Fractured (brecciated) and bleached limestone, oxidized, penetrated by calcite veinlets.
74	3	48.20 ~ 50.00	1.80	tr.	1.2 3.1	0.01	0.01	0.02				ditto.
75	4	50.00 ~ 51.50	1.50	tr.	0.8 5.9	0.01	0.01	0.04				ditto.
76	5	51.50 ~ 53.00	1.50	tr.	0.5 3.1	0.01	0.01	0.02				ditto.
77	6	53.00 ~ 54.50	1.50	tr.	3.8 2.0	0.003	0.01	0.01				ditto.

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	As (%)	Cd (%)	Hg (g/t)	Remarks
78	7	54.50 ~ 56.00	1.50	tr.	5.4							ditto.
					7.0	0.002	0.02	0.01				
79	8	56.00 ~ 57.50	1.50	0.5	2.1							ditto.
					4.3	0.002	0.01	0.02				

5) DDH-M5

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	As (%)	Cd (%)	Hg (g/t)	Remarks
80	1	95.25 ~ 95.85	0.60	tr.	22.2							Calcite-iron oxide-quartz-
					11.0	0.14	0.03	0.04				fluorite vein.
81	2	99.30 ~ 99.60	0.30	tr.	18.1							Quartz-calcite-iron oxide
					13.0	0.03	0.01	0.03				vein. wd : 20 cm
82	3	100.70 ~ 101.10	0.40	tr.	50.8							Calcite-iron oxide vein.
					8.9	0.03	0.004	0.03				wd : 20 cm, incl : 45°
83	4	125.55 ~ 126.05	0.60	tr.	9.0							Pyrite-quartz-calcite-vein penetrating garnet porphyroblast
					8.1	0.12	0.01	0.02				through *recrystallized limestone*.
84	5	144.05 ~ 144.22	0.17	tr.	18.1							Pyrite-quartz-calcite-(kobellite) vein.
					11.9	0.13	0.004	0.02				wd . 2.5 cm incl 60°
85	6	146.85 ~ 147.00	0.15	tr.	62.5	0.92	0.01	0.16	0.13	0.002	6.6	Pyrite-(iron oxide)-quartz-calcite-gypsum vein.
					10.2	0.82	0.01	0.06				wd : 5-7 cm incl : 60°
86	7	147.25 ~ 147.85	0.60	tr.	93.7	0.89	0.02	0.07	0.20	0.001	6 8	Quartz-pyrite-calcite-(iron oxide)-(green copper mineral)vein.
					12.8	0.82	0.01	0.02				wd : 2 cm, incl : 60°
87	8	150.90 ~ 151.20	0.30	tr.	214.8	1.60	0.02	0.11	0.13	0.001	5.8	Quartz-calcite-gypsum-pyrite vein.
					26.7	1.46	0.01	0.03				wd : 20cm, incl : 60°
88	9	152.55 ~ 153.10	0.55	tr.	14.1							Pyrite-(kobellite)-quartz-*fluorite-gypsum-calcite* vein.
					13.9	0.06	0.01	0.04				wd . 30 cm, incl . 60°
89	10	156.45 ~ 157.05	0.70	tr.	8.1							Fluorite-quartz-calcite-pyrite-(kobellite) vein.
					9.2	0.05	0.01	0.02				wd : 60cm, incl : 60°

No.	Sample No.	Depth (m)	Core length (m)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	As (%)	Cd (%)	Hg (g/t)	Remarks
90	11	157.20 ~ 157.35	0.15	tr.	12.1							ditto.
					12.8	0.06	0.01	0.05				
91	12	159.20 ~ 161.60	2.40	tr.	24.2							Quartz-fluorite-calcite-gypsum-hematite vein; strongly oxidized. wd:60cm, incl:45°
					12.9	0.29	0.02	0.04				
92	13	162.80 ~ 163.10	0.30	tr.	34.0	2.70	0.01	0.07	0.22	0.003	29.5	Quartz-fluorite-calcite-gypsum-iron oxide vein. wd : 7 cm, incl : 70°
					10.3	2.13	0.01	0.02				
93	14	163.50 ~ 163.80	0.30	tr.								Green copper mineral networks.
					8.9	0.37	0.01	0.04				
94	15	209.80 ~ 210.25	0.45	tr.								Quartz-calcite-iron oxide veinlets. wd : 1.5cm, incl : 70°
					8.5	0.06	0.05	0.03				

Remarks : Assays in the upper row were obtained in Japan, and the lower in Mexico, using same samples.

APX. III-2-(1)

MICROSCOPIC OBSERVATIONS
OF THIN SECTIONS
OF DRILL CORE SAMPLES

1) DDH-M1

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
1	12.30 m TPE	Calcite-hematite-(fluorite)-(quartz) vein penetrating recrystallized limestone.	Black-to-dark reddish brown, strongly oxidized, porous.	Hematite and goethite generally show a network texture filled with gangue minerals. Concentrically colloform-textured hematite and goethite are often observed. ° EPMA(spot analysis) A secondary electron image of a concentrically colloform-textured hematite and goethite does not show its texture. A spot analysis of hematite detected Fe and traces of Ca and Si. Ca and Si are impurities admixed with hematite.
2	13.55 m TPE	Conichalcite-iron oxide-quartz-calcite-(fluorite) vein penetrating recrystallized limestone.	Greenish brown, oxidized. Cavities and interstices are filled with green copper mineral (conichalcite) and rare chrysocolla?.	Aggregates of hematite and goethite show an irregular network filled with gangue minerals. Probable copper-bearing transparent minerals are observed adjoinning hematite and goethite. Subhedral pyrite (<0.1mm) and subhedral chalcopyrite (<0.15mm) are very rarely included in gangue minerals (probably quartz). ° EPMA(spot analyses) Fe and S from pyrite, Cu, Fe and S from chalcopyrite were detected, confirming that each one is pyrite and chalcopyrite.
3	14.85 m TP	Quartz-hematite vein.	Brown-to-black, porous limonite jasper with small amounts of cavity-filling green copper minerals.	Fairly abundant hematite is recognized as concentrically colloform-textured aggregates, irregular-shaped aggregates admixed with goethite, or isolated aciculae. EPMA ... Nil.
4	16.55 m TPE	Conichalcite-quartz-calcite-hematite-vein penetrating recrystallized limestone.	Brown-to-dark brown, green copper minerals-spotted.	Although primary sulfides are mostly oxidized to hematite and goethite which show a concentric liesegang or an atoll texture, pyrite and chalcopyrite are recognized as small dots or as cores. Secondary sulfides (chalcocite, covellite, acanthite), as well as copper oxides (cuprite and tenorite),are commonly observed. Finely parted pyrite cores (<0.25mm) are recognized showing an atoll texture with surrounding colloform hematite. Chalcopyrite small dots (<0.02mm) are recognized in a finely crushed goethite

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
5	60.55 m T	Marly limestone (recrystallized).	White gray, very fine-grained, weakly recrystallized, compact rare hematite(after pyrite)-spotted, slightly siliceous.	Equi-granular fine-grained calcite (0.02-0.06mm) predominates. Small amounts of anhedral chalcedonic quartz is spotted as pools or lenses. Hematite pseudomorphs after cubic or anhedral pyrite (0.2-0.4mm) are scattered with chalcedonic quartz. Chalcedonic quartz pools and lenses are arranged parallel to the original sedimentary structure (lamination). Calcite-quartz(-barite') veinlets and calcite-fluorite veinlets penetrate the host rock.
6	86.60 m T	Limestone (recrystallized).	Pinkish white, fine-grained, recrystallized. Pinkish color is due to oxidized iron stains. A quartz-calcite-pyrite (hematitized) vein (4mm) penetrates. Light green and pale bluish copper stains are observed along iron oxide-calcite veinlets (1mm).	Equi-granular anhedral calcite (0.2mm) shows a granoblastic texture. Acicular or sheaf-like hedenbergite? is almost replaced by calcite, actinolite-tremolite, quartz and sericite. Quartz-calcite-pyrite (hematitized)-conichalcite veinlets (<4mm) penetrate the host rock. Conichalcite fills not only quartz in veinlets,but also calcite of the host rock. Around a hematite and quartz pool, well-crystallized fibrous conichalcite (pleochlorism; light green to green, strong birefringense, straight extinction, high interference color) is observed. Pale green weakly pleochroic copper minerals (chrysocolla? or turquoise') are also scattered in the interstices of calcite near veinlets, showing a chalcedonic extinction.

2) DDH-M2

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
7	18.55 m T	Marl? (recrystallized).	White gray, very fine-grained, compact, massive, weakly recrystallized, rarely pyrite-spotted, penetrated by calcite-pyrite veinlets (<1mm).	Fine-grained equi-granular anhedral calcite (0.04-0.1mm) shows a microgranoblastic texture. Rare quartz is scattered as pools (<0.1mm) with calcite. Euhedral cubic pyrite (0.1m) and anhedral pyrite small dots (<0.01mm) are scattered. Calcite grains are weakly orientated showing a sedimentary structure (lamination). Calcite-quartz-pyrite veinlets (<0.5mm) penetrate the host rock.

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
8	43.95 m T	Limestone (recrystallized).	Pale brownish gray, fine-grained, compact, recrystallized, hematite (after pyrite)-spotted, penetrated by calcite-hematite veinlets (<3mm).	Equi-granular anhedral calcite (<0.1mm) shows a granoblastic texture. Larger calcite (<0.6mm) aggregates (<3mm) are dotted, accompanied by hematite. Hematite(after pyrite) (0.02mm) is scattered in fine-grained calcite.
9	50.15 m T	Calcite-gypsum-fluorite quartz-mimetite-zoicite-siderite-(barite?) vein penetrating recrystallized limestone.	Vein is banded as a fluorite-mimetite-rich part and a gypsum-quartz-calcite-rich part. Fluorite is cubic (<3mm). Mimetite is pale yellow powdery mineral filling fluorite or other minerals. Limestone is white, fine-grained, and is recrystallized.	Abundant polygonal calcite (0.05-5mm) and minor euhedral fluorite (<0.2mm) are filled with anhedral quartz (<0.05mm). Gypsum is very rare in the examined thin section. Memetite is recognized as isolated granules or as aggregates (0.2-1mm). Zoicite is observed as lenticular aggregates filling the interstices of calcite. Siderite is granules or aggregates (0.2-1mm), showing rather high indices and strong birefringence. An aggregate of barite? (low retardation, moderate indices (some 1.6), almost straight extinction, positive elongation, biaxial positive, colorless in thin section,turbid) is recognized with zoicite. Rare conichalcite (<0.3mm) is observed. Limestone consists mainly of equi-granular calcite (0.05-0.2mm). Small amounts of iron oxide and hexagonal psismatic quartz (<0.05mm) fill calcite. Rare irregular-shaped garnet and zoicite (<0.1mm) are formed.
10	125.40 m TPX	Hematite (after pyrite)-quartz-conichalcite-crysocalla?- chlorite-sericite vein (strongly oxidized).	The specimen is strongly oxidized and is porous. *Hematite* pseudomorphs after cubic pyrite (<7mm) are cemented with earthy materials. Abundant pale bluish-to-bluish green earthy copper minerals are recognized as druse-fillings,pools,and as networks.	Hematite(after euhedral pyrite, <7mm) and anhedral quartz (<1mm) are cemented with abundant conichalcite, crysocolla?, sericite,and minor chlorite. Conichalcite is mostly recognized around hematite as green-to-dark green radiating fibrous aggregates. Crysocolla? is found as pale bluish green cryptocrystalline colloform aggregates. Sericite is observed as aggregates of very fine-grained flakes (<0.01mm), and is stained to pale yellowish brown around hematite. Sericite small aggregates are also found in hematite. Chlorite is rather rare. Calcite is very rarely observed as an inclusion in quartz. Spherulitic or amorphous silicates are often observed.

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
11	156.50 m T	Garnet porphyroblast in recrystallized limestone.	Brown, euhedral single crystal (50mm) with a zonal structure. Limestone is white, recrystallized, and is penetrated by hematitized pyrite veinlets.	A garnet large single crystal shows a fine-banded zonal texture, showing its crystal growth. Calcite and quartz are included in garnet poikiloblastically. Cracks are remarkedly developed in garnet. Calcite and iron oxides replace garnet along the cracks. Limestone comprises predominant equigranular anhedral calcite (0.2mm) and small amounts of carbonitized pyroxene (or amphibole), rare quartz and chalcedony. Pyroxene is completely replaced by calcite, chlorite and iron oxides.
12	164.80 m TPE	Pyrite-gypsum-calcite-quartz vein (partly oxidized).	Crushed pyrite is hematitized along its cracks. Quartz, calcite and gypsum fill the cracks of pyrite, as small veinlets or networks.	Crushed pyrite (1-20mm) is oxidized to hematite from its margin, showing a crustified form. Small amounts of quartz (<1mm), gypsum (<1mm), euhedral fluorite (<1mm) and calcite (various size) fill the interstices of pyrite. Some calcite is light brown-colored by oxidized iron stains. Rare actinolite is observed in a quartz-gypsum-rich part.
13	195.10 m TP	Pyrite-gypsum-quartz-calcite-barite? vein (partly oxidized) penetrating recrystallized limestone.	Crushed pyrite is oxidized to hematite. Small cubic pyrite is rich in the marginal part of the vein. Larger pyrite is rich in the inner part, showing a weak-banded structure. Limestone is white, fine-grained, and is recrystallized.	The vein consists of pyrite (<4mm), gypsum (1-2mm), quartz (<0.5mm), calcite (<1mm) and anhedral barite? (<1mm). Pyrite is crushed and oxidized to hematite along its margin or cracks. Fragments of pyrite are orientated parallel to the banding of the vein. Gypsum, quartz and calcite fill pyrite. Barite? is recognized with quartz and calcite. Limestone is composed mainly of equi-granular calcite (0.1-0.2mm), showing a granoblastic texture. Minor quartz and iron oxides fill calcite.
14	214.40 m TP	Pyrite-gypsum-quartz-calcite-fluorite vein penetrating recrystallized limestone.	Cubic pyrite (<1cm) is almost fresh. Gypsum fills a cavity of the vein. Limestone is white, fine-grained, and is recrystallized.	The vein is zoned as a pyrite-rich part, a fine-grained calcite-quartz-gypsum-fluorite aggregates part, and a large gypsum part from its margin. Euhedral pyrite (<10mm) is scarcely altered to hematite along its margin or cracks. Quartz is anhedral (<2mm) and mortaric. Calcite varies its size. Fluorite is euhedral-to-subhedral (<0.4mm), and is rarely recognized. Gypsum is as large as 10 to 20mm in the gypsum part. Limestone is composed of predominant equi-granular calcite (0.2-0.5mm), minor quartz (<0.3mm) and minor iron oxides (<0.2mm), representing a granoblastic texture.

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
15	219.65 m TPE	Pyrite-gypsum-fluorite-calcite-quartz vein penetrating recrystallized limestone.	Cubic pyrite (<8mm) is dotted in the vein. A calcite- (pyrite) veinlet (5mm) cuts the vein through pinkish white, fine-grained recrystallized limestone.	The vein consists of coarse-grained anhedral calcite (1-4mm) and euhedral pyrite (1-4mm, partly hematitized), and filling fine-grained anhedral quartz (1mm), anhedral gypsum (<1mm), calcite (<1mm), fluorite (<1mm) and iron oxides (<1mm), forming lenses or pools (3-10mm). A oxidized-iron-stained pale brown calcite- (pyrite) veinlet (5mm) penetrates the vein through limestone. Limestone shows a granoblastic texture of equi-granular anhedral calcite (0.2-1mm) and rare iron oxide pigments.
16	222.40 m TPE	Pyrite-fluorite-gypsum-quartz-calcite vein penetrating white recrystallized limestone.	Pyrite is disseminated as dots and as lenses. Dark gray very fine-grained soft mineral (kobellite) is recognized around pyrite. Limestone is white, fine-grained, and is recrystallized. Reddish brown very small iron oxides are dotted in limestone.	The vein consists mainly of subhedral quartz (1-2mm), cubic pyrite (0.4-2mm) and calcite (1-2mm). Small amounts of arrowhead-formed euhedral gypsum (0.4-2mm) and rare euhedral fluorite (0.2mm) are also recognized. Limestone shows a equi-granular granoblastic texture of anhedral calcite (0.2-1mm). Reddish brown small dots (<0.5mm) are acicular-to-sheaf-like pyroxene (or amphibole) which are completely decomposed to calcite, siderite, quartz and iron oxides. Quartz-calcite veinlests (4mm) penetrate limestone.

3) DDH-M3

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
17	141.00 m TPX	Hematite (after pyrite)-willemite-austinite-conichalcite-calcite-quartz vein (strongly oxidized).	The specimen is remarkedly porous and drusy. Reddish brown fine-grained, compact, recrystallized limestone relicts (<2cm) are included. Hematite pseudomorphs after pyrite (<1cm) are dotted, filled by conichalcite, calcite, quartz and porous aggregates of hematite and goethite. Conichalcite is concentrated as pools or irregular-shaped bands around hematite pseudomorphs, as well as around limestone breccias. Calcite is formed in a druse.	Pyrite is strongly crushed and completely altered to hematite (limonite). Quartz (<1mm) is also crushed and shows an ameba-like configuration. Calcite (0.2-4mm) is anhedral or granular. Replacing original sphalerite (or pyrite?), a willemite-austinite-calcite mesh texture is developed. Cells of the mesh texture are filled with limonite (hematite and goethite), fibrous radiating conichalcite and pale green cryptocrystalline copper minerals (conichalcite or chrysocolla, etc). Willemite (<0.1mm) is granular or hexagonal-prismatic. Some willemite forms radiating aggregates. Austinite (<0.1mm) is granular, and shows anomalous interference colors. Conichalcite and light green cryptocrystalline copper minerals also fill hematite, quartz and calcite.

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
18	197.25 m T	Marl penetrated by a medium-grained lenticular calcite vein, weakly recrystallized?	Marl is grayish white, very-fine grained, and is thinly laminated. Limonite fine bands are clear. A lenticular calcite vein includes iron-stained marl breccias (<15mm).	Marl is composed of predominant very fine-grained calcite (0.01mm), minor larger calcite (0.2mm), quartz, hematite(after pyrite)and black carbonaceous matters. Larger calcite, quartz and hematite(after pyrite)form dots or lenticular pools elongated parallel to the original lamination. Carbonaceous matters are also foliated. Recrystallization is very weak. Calcite vein consists of equi-granular calcite (3mm). Marl brreccias in the calcite vein are recrystallized and are stained by oxidized iron.

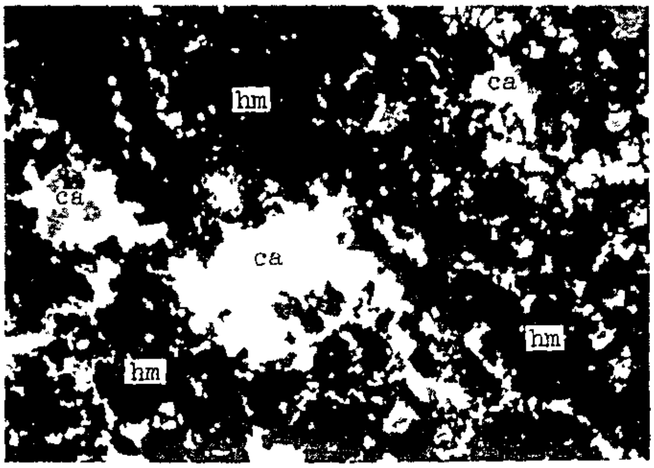
4) DDH-M5

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
19	125.75 m T	Pyrite-quartz-calcite-fluorite-gypsum vein penetrating garnet porphyroblast through recrystallized limestone.	Cubic pyrite (<1.5cm) is fresh. Quartz and calcite partly replace a garnet porphyroblast (50mm). Garnet is strongly oxidized to form limonite. A gypsum veinlet penetrates limestone through pyrite-quartz-calcite vein. Limestone is white, fine-grained, and is recrystallized.	Garnet porphyroblast is strongly crushed and parted. Tabular alkali-feldspar (<0.5mm) are included in garnet. Half of alkali-feldspar is completely replaced by calcite. Sericitization is also recognized. Calcite, quartz, iron oxides and rare gypsum fill the cracks of garnet. Iron-montmorillonite, calcite and quartz are observed at the contact of garnet and quartz-calcite vein. A fluorite-gypsum-quartz-calcite veinlet (0.3mm) penetrates garnet.
20	147.50 m TPE	Pyrite-quartz-gypsum-fluorite vein.	Crushed cubic large pyrite (30mm) is invaded or penetrated by quartz. A gypsum veinlet (4mm) penetrates quartz through pyrite. Dark gray,fine-grained,pyritized igneous rock breccias (10mm) are included.	Pyrite is crushed, and quartz, calcite, gypsum and hematite fill the small cracks. Subhedral quartz (<10mm), gypsum (3-10mm) and fluorite (3-10mm) show a wedge texture. Flaky sericite (<0.1mm) and sericite aggregates often fill pyrite and other minerals. Quartz is also crushed and stained by iron oxides, showing a wavy extinction. The igneous rock breccia consists of quartz and sericitized alkali-feldspar, representing a mosaic texture. Quartz is turbid with iron oxides.

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
21	147.50 m b T	Fine-grained altered igneous rock breccia included in a pyrite-quartz-gypsum-fluorite vein.	Dark gray, fine-grained, altered, pyrite-unidentified black mineral-disseminated.	The rock consists mainly of irregular-shaped quartz (<0.2mm) and lath-shaped sericite-pyrite *pseudomorph* after plagioclase? (<0.1mm). Subhedral pyrite (<2mm), anhedral unidentified opaque mineral (<2mm) and granular fluorite (<0.1mm) are scattered. Anhedral alkali-feldspar (adularia?, <0.1mm) fills quartz and other minerals. Original plagioclase? lath is completely replaced by sericite, calcite and pyrite. Quartz is corroded showing an irregular boundary, and includes sericite. Some quartz is halfly replaced by sericite. Sericite elongated flakes are also recognized interstitially. Very fine-grained hexagonal-to-prismatic or granular rutile (<0.05mm) is sparsely scattered.
22	151.05 m TPE	Quartz-pyrite-gypsum vein penetrating a strongly argillized and pyritized igneous rock?.	Pyrite large crystal (30mm) is crushed. Small cubic pyrite (<8mm) is completely altered to hematite. Quartz and gypsum fill pyrite. The igneous rock? is completely argillized and strongly pyritized, and unidentified black minerals are disseminated. Yellowish brown-to-brown oxidized iron stains the altered igneous rock?.	Abundant aggregates of fine-grained flaky sericite (<0.02mm), as well as anhedral gypsum, fill irregular-shaped quartz (0.4-0.8mm). Slightly oxidized euhedral-to-subhedral pyrite (1-1.5mm), black anhedral opaque mineral (<1mm), and fine-grained granular fluorite (<0.1mm) are sparsely disseminated among sericite-gypsum aggregates. Pyrite and quartz often include sericite and granular calcite. Some sericite is stained to pale yellowish brown by oxidized iron around pyrite. Rare hexagonal-to-prismatic or granular rutile (<0.02mm) are scattered. Igneous rock texture is completely destructed by sericite and gypsum.
23	152.85 m TP	Pyrite-(kobellite)-quartz-fluorite-gypsum-calcite vein (slightly oxidized).	Cubic or anhedral pyrite aggregates (2-20mm) are filled with quartz, gypsum and fluorite. Pyrite is weakly crushed, and is slightly oxidized to hematite from its margin and along cracks. Kobellite is dark gray and is recognized as lenses (<2x10mm) among quartz and gypsum.	Cubic or anhedral fragmental pyrite (0.2-5mm) is filled with interlocking aggregates (0.5-5mm) of polygonal quartz, gypsum, calcite and fluorite (0.8mm). Crushing is developed in larger pyrite, and hematite replaces pyrite along the cracks or the rim.

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
24	156.75 m TP	Pyrite-quartz-calcite-gypsum-fluorite-sericite vein.	Pyrite is strongly crushed, and is slightly oxidized from its margin. Turbid quartz, calcite, and gypsum fill pyrite. White pulverulent minerals (sericite?) are recognized among quartz, calcite and gypsum.	Abundant euhedral or fragmental pyrite (1-7mm), subhedral quartz (1mm) and subhedral granular fluorite (0.8-1.5mm) are filled with subhedral calcite (4mm) and subhedral gypsum (0.8-1.3mm). Irregular-shaped mirmekitic calcite-gypsum aggregates are often observed. Pyrite is strongly crushed, and the partings are filled with calcite and gypsum. Pyrite includes quartz rarely. Quartz is commonly corroded, and shows an irregular configulation. Half of quartz is replaced by sericite and calcite along its crystal planes. Some altered quartz shows a fine-intergrowth similar to an albite twinning. Hexagonal-to-cubic small pyrite dots (0.2mm) are abundant in altered quartz. A banded calcite-fluorite-gypsum veinlet (0.5mm) penetrates sericitized, carbonitized and pyritized quartz through pyrite.
25	183.80 m TP	Hematite (after pyrite)-quartz-conichalcite vein.	Cubic-to-subhedral hematite pseudomorphs(after pyrite, <5mm) are filled with fine-grained quartz. Conichalcite is recognized in pores of leached hematite, as well as in druses.	Cubic hematite pseudomorphs (after pyrite, 1-10mm) are filled with abundant interlocking subhedral quartz (2-4mm). Radiating fibrous or sheaf-like conichalcite (<1.3mm) fills pores of leached hematite, interstices of quartz, and druses. Conichalcite is commonly concentrated around hematite. Light yellowish green chlorite is recognized with hematite, forming an atoll texture or a liesegang texture. Acicular sericite is recognized with chlorite and conichalcite. Some sericite is included in quartz. Rare calcite is also included in quartz.

APX. III-2-(2) PHOTOMICROGRAPHS OF THIN SECTION OF DRILL CORE SAMPLES



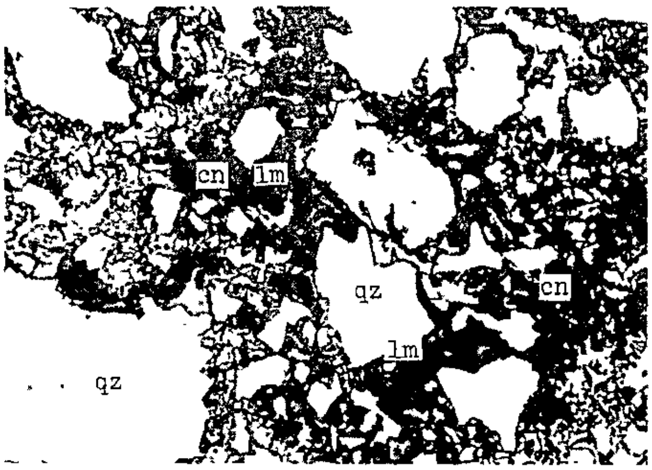
crossed nicols   0 1 2mm

1) DDH-M1 12.30m

Calcite-hematite-(fluorite)-(quartz) vein.

Calcite fill pores of hematite.

ca: calcite, hm: hematite.



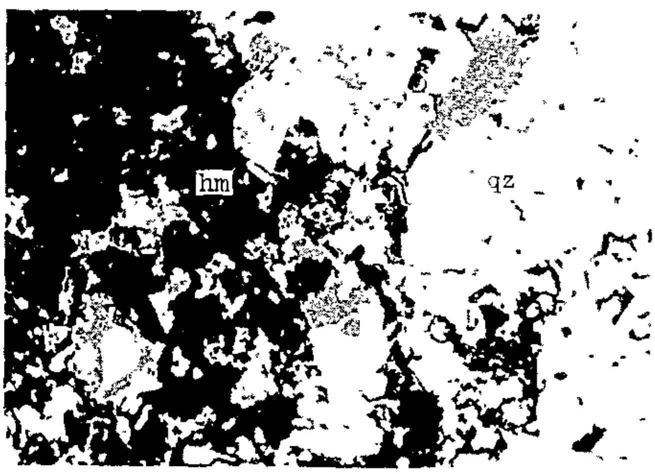
open nicol   0 1 2mm

2) DDH-M1 13.55m

Conichalcite-iron oxide-quartz-calcite-(fluorite) vein.

Fragmental quartz is filled with colloform conichalcite and limonite.

cn: conichalcite, lm: limonite
qz: quartz.



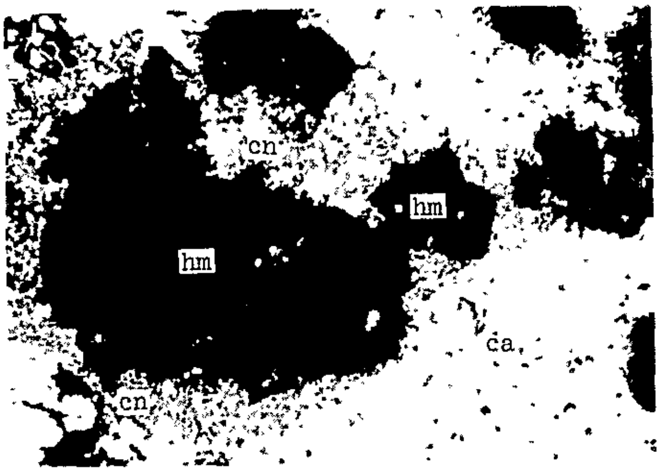
open nicol   0 1 2mm

3) DDH-M1 14.85m

Quartz-hematite vein.

Quartz and interstitial colloform hematite.

hm: hematite, qz: quartz.



open nicol 0 1 2mm

4) DDH-M1 16.55m

Conichalcite-quartz-calcite-hematite vein.

Flaming conichalcite surrounds hematite pseudomorphs after pyrite.

ca: calcite, cn: conichalcite, hm: hematite.

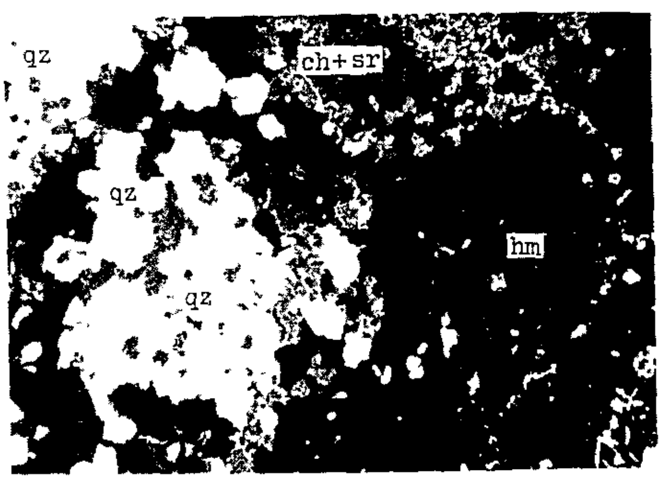
open nicol 0 1 2mm

5) DDH-M2 50.15m

Calcite-gypsum-fluorite-quartz-mimetite-zoicite-garnet-siderite-(barite) vein.

Zoicite is formed in the vein.

ca: calcite, cn: conichalcite, fl: fluorite, zc: zoicite.



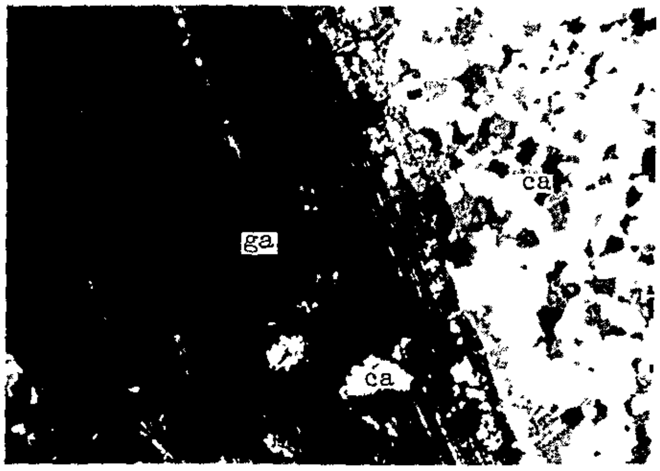
crossed nicols 0 1 2mm

6) DDH-M2 125.40m

Hematite (after pyrite)-quartz-conichalcite-chrysocolla?-chlorite-sericite vein.

Euhedral-to-subhedral quartz and intersticial hematite. Sericite-chlorite aggregates are common.

ch: chlorite, hm: hematite, qz: quartz, sr: sericite



crossed nicols 0 1 2mm

7) DDH-M2 156.50m

Zonal-structured garnet porphyroblast and recrystallized limestone.

ca: calcite, ga: garnet.

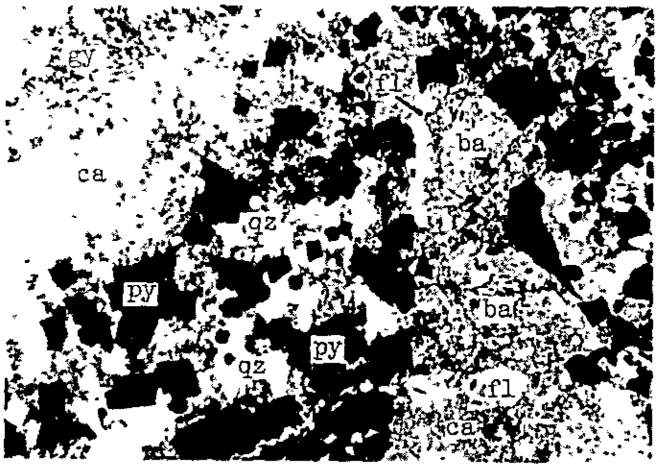
crossed nicols 0 1 2mm

8) DDH-M2 164.80m

Pyrite-gypsum-calcite-quartz vein.

Fragmental pyrite is oxidized from its margin. Gypsum and calcite fill pyrite, quartz and fluorite.

ca: calcite, fl: fluorite,
gy: gypsum, qz: quartz
py: pyrite.



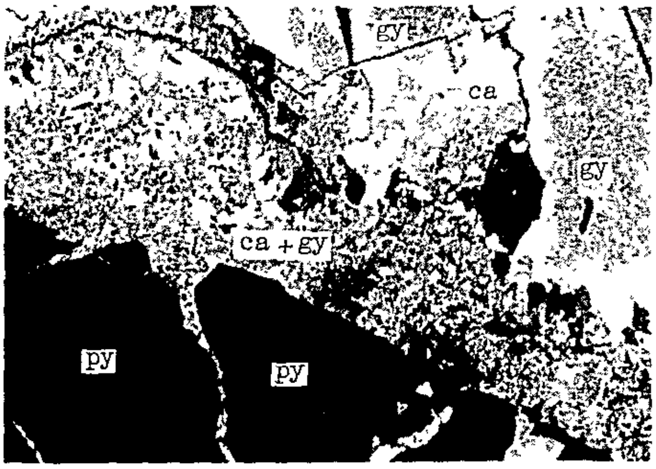
open nicols 0 1 2mm

9) DDH-M2 195.10m

Pyrite-gypsum-quartz-calcite-barite vein.

Pyrite is partly oxidized to hematite. Quartz, calcite, gypsum and barite fill pyrite.

ba: barite, ca: calcite,
gy: gypsum, qz: quartz,
py: pyrite.



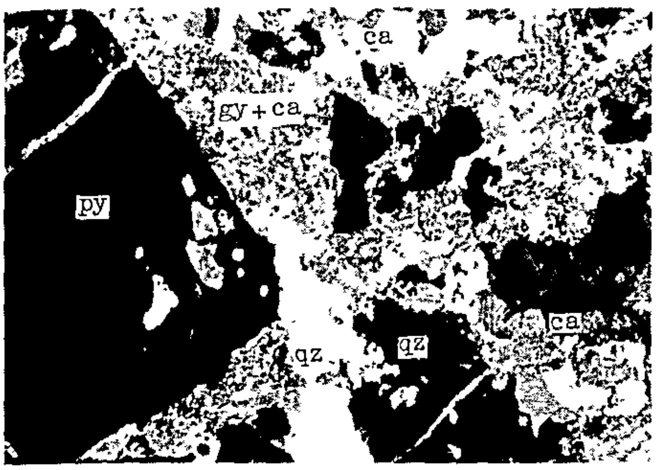
crossed nicols 0 1 2mm

10) DDH-M2 214.40m

Pyrite-gypsum-quartz-calcite-fluorite vein.

Pyrite is filled with calcite and gypsum. Larger calcite and gypsum develop in outer part.

ca: calcite, gy: gypsum, py: pyrite.



crossed nicols 0 1 2mm

11) DDH-M2 219.65m

Pyrite-gypsum-fluorite-calcite-quartz vein.

Well-crystallized pyrite, quartz and calcite are filled with aggregates of gypsum and calcite.

ca: calcite, gy: gypsum, qz: quartz, py: pyrite.

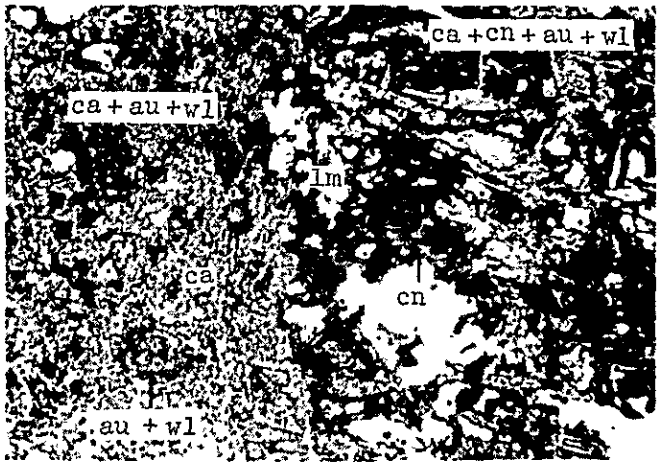
open nicol 0 1 2mm

12) DDH-M2 222.40m

Pyrite-fluorite-gypsum-quartz-calcite vein.

Euhedral pyrite is filled with calcite, quartz and fluorite.

ca: calcite, fl: fluorite, qz: quartz, py: pyrite.



open nicol 0 1 2mm

13) DDH-M3 141.00m

Hematite (after pyrite)-willemite-austinite-conichalcite-calcite-quartz vein.

Liesegang texture of limonite and very fine-grained willemite austinite, conichalcite, and calcite.

au: austinite, ca: calcite, cn: conichalcite, lm: limonite, wl: willemite.

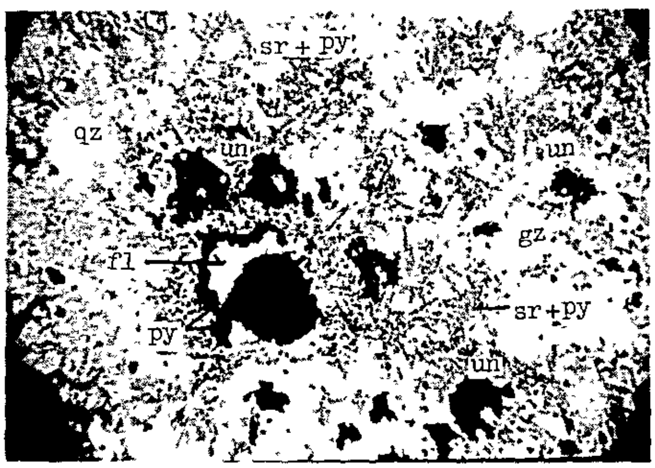
open nicol 0 1 2mm

14) DDH-M5 147.50m (a)

Pyrite-quartz-gypsum-fluorite vein.

Corroded fluorite by quartz. Fluorite and quartz are corrode by gypsum. Rare sericite is recognized as interstitial fillings or as inclusions.

fl: fluorite, gy: gypsum, qz: quartz, sr: sericite.



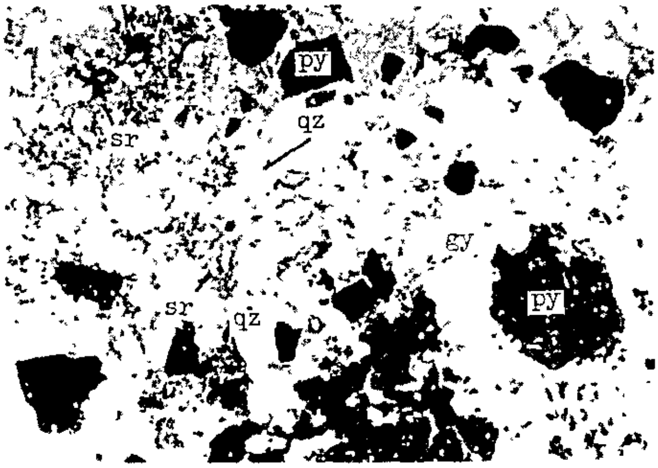
open nicol 0 1 2mm

15) DDH-M5 147.50m (b)

Altered igneous rock brecci

Sericite-pyrite pseudomorphs after lath-shaped plagioclase? show an original igneous rock texture. Pyrite, unidentified black mineral, and fluorite are disseminated. Quartz includes sericite.

fl: fluorite, py: pyrite, qz: quartz, sr: sericite, un: unidentified black mineral.



open nicol 0 1 2mm

16) DDH-M5 151.05m

Quartz-pyrite-gypsum vein penetrating a strongly argillized and pyritized igneous rock.

Gypsum and sericite replace the original igneous rock. Fragmental quartz remains scarcely. Weakly oxidized pyrite is disseminated.

gy: gypsum, qz: quartz,
py: pyrite, sr: sericite.

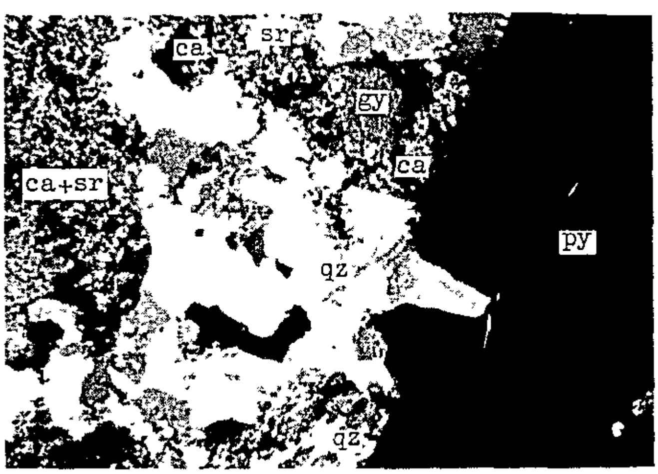
crossed nicol 0 1 2mm

17) DDH-M5 152.85m

Pyrite-(kobellite)-quartz-fluorite-gypsum-calcite vein.

Pyrite is weakly oxidized. Larger quartz is crushed and smaller quartz is formed along cracks. Gypsum and calcite fill pyrite, quartz and fluorite.

ca: calcite, fl: fluorite,
gy: gypsum, qz: quartz,
py: pyrite



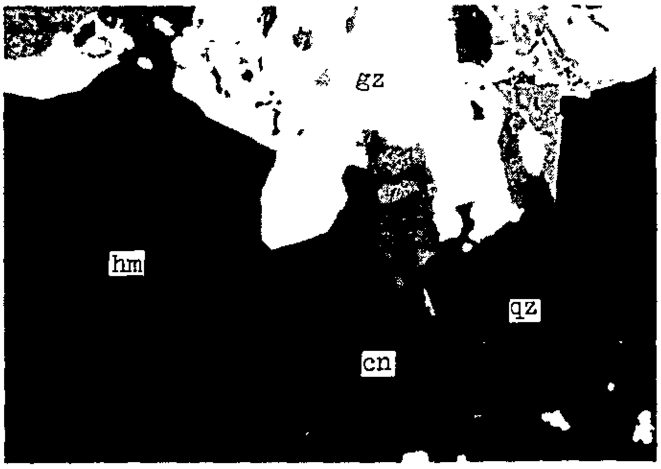
crossed nicol 0 1 2mm

18) DDH-M5 156.75m

Pyrite-quartz-calcite-gypsum-fluorite-sericite vein.

Calcite-sericite aggregates and gypsum fill pyrite, as well as quartz. Quartz is commonly replaced by sericite, calcite and iron oxide.

ca: calcite, gy: gypsum,
qz: quartz, py: pyrite,
sr: sericite.



crossed nicols 0 1 2mm

19) DDH-M5 183.80m

Hematite (after pyrite)-quartz-conichalcite vein.

Radiating fibrous conichalcite fills quartz and hematite after pyrite interstitially.

cn: conichalcite, hm: hematite, qz: quartz.

APX. III-3-(1)

MICROSCOPIC OBSERVATIONS

OF POLISHED SECTIONS

&

ELECTRON PROBE MICROANALYSES

OF DRILL CORE SAMPLES

1) DDH-M1

No.	Depth	Rock name & occurrence	Macroscopic observations	Microscopic observations
1	12.30 m TPE	Cactite-hematite (fluorite)-(quartz) vein penetrating recrystallized limestone.	Black-to-dark reddish brown, strongly oxidized, porous.	Anhedral granular calcite (0.5-1.3mm) and iron oxide (0.05-1mm) show a suture texture. Very rare quartz pools (<0.2mm) and anhedral granular fluorite are recognized. Iron oxide specks are arranged concentrically parallel to the shell of calcite, showing crystal growth lines.
2	13.55 m TPEX	Conichalcite-iron oxide - quartz-calcite-(fluorite) vein penetrating recrystallized limestone.	Greenish brown, oxidized. Cavities and interstices are filled with green copper mineral (conichalcite) and rare chrysocolla?.	Isolated or mortarically aggregated anhedral quartz (2-4mm), fine-grained quartz (0.5mm) and a small amount of anhedral granular fluorite are scattered. Conichalcite, calcite and iron oxides fill quartz and fluorite. Iron oxides are mainly recognized around quartz. The mortaric quartz may be relicts of a primary sulfide-bearing quartz-fluorite vein. Sulfides are completely decomposed by wheathering to form iron oxides and conichalcite.
3	14.85 m TP	Quartz-hematite vein.	Brown-to-black, porous limonite jaspar with small amounts of cavity-filling conichalcite.	An equi-granular texture of euhedral-to-anhedral quartz (0.4-1mm) filled with iron oxides is observed. Very fine-grained quartz and limonite often make a liesegang-to-atoll texture. Quartz is a relict of a primary sulfide-quartz vein, and iron oxides may have precipitated filling quartz after the decomposition of the primary sulfides.
4	16.55 m TPE	Conichalcite-quartz-calcite-hematite vein penetrating recrystallized limestone.	Brown-to-dark brown, green copper mineral - spotted.	Hematite(after iron sulfide, 0.5-1.5mm) and conichalcite (0.2-0.5mm) are spotted in equi-granular anhedral calcite (0.3-1mm). Very fine-grained iron oxides (0.01-0.04mm) are scattered in the interstices of calcite. A small amount of subhedral-to-anhedral quartz (0.2mm) is recognized. Conichalcite coexists with hematite commonly as sheaf-like or radiating fan-shaped aggregates. Some conichalcite shows a ring or an atoll texture with hematite.

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
				pseudomorph representing a boxwork texture. Chalcocite - covellite aggregates (<0.05mm) are commonly observed in pseudomorphs after chalcopyrite. Acanthite (0.1mm) occurs closely associated with chalcocite and covellite. Copper oxides are found as irregular-shaped aggregates (<0.3mm) in gangue minerals. Copper oxides are identified as cuprite (light bluish gray color, red internal reflection, weak anisotropism), tenorite (paratenorite") (pale brown weakly pleochroic, weakly anisotropic), and the intermediate phase of above two (pale brown with orange tint, strongly anisotropic). Probable copper-bearing transparent mineral (dark gray) surrounds copper sulfides or copper oxides. ° EPMA (spot analyses and characterictic X-ray image analysis) From a bright mineral in a secondary electron image, Ag and S are detected confirming that this mineral is acanthite. A characteristic X-ray image of Ag-Lα showed the clear configulation of acanthite. From chalcocite, Cu, S, minor Ag, and trace Fe were detected. Minor Ag is due to admixed acanthite, and trace Fe is an impurity in chalcocite.

2) DDH-M2

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
5	125.40 m TP	Hematite (after pyrite)-quartz-conichalcite-chrysocolla? -chlorite-sericite vein.	The sample is strongly oxidized, and is porous. Hematite pseudomorphs after cubic pyrite (<7mm) are cemented with earthy materials. Abundant pale bluish-to-bluish green earthy copper minerals are recognized as druse-fillings, pools, and networks.	Pyrite relicts (<0.05mm) are recognized in porous colloform hematite - goethite pseudomorphs after pyrite. Irregular-shaped hematite-goethite aggregates are observed in the matrix. Probable copper-bearing fibrous minerals often fill pores (<0.2mm). ° EPMA Nil.

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
6	161.00 m PE	Pyrite-quartz-calcite-gypsum- (kobellite) vein.	Abundant weakly crushed cubic pyrite (<10mm) is filled with quartz, calcite and gypsum. Black, soft, fibrous metallic mineral (<4mm, kobellite) is accompanied.	Fairly abundant cubic pyrite (<10mm) and rare kobellite (<0.6mm) is filled with gangue minerals. Pyrite is weakly crushed,and includes gangue minerals. Kobellite is recognized as granules embayed by pyrite, or aggregates of acicular or columnar crystals, representing whitish-gray color and strong anisotropism. ° EPMA(spot analysis) From a kobellite Bi, S, minor Sb and trace Pb were detected.
7	164.80 m TPE	Pyrite-gypsum-calcite-quartz vein.	Crushed pyrite is hematitized along its cracks. Quartz, calcite and gypsum also fill the cracks of pyrite as small veinlets or networks.	Crushed pyrite is replaced by flaky hematite (0.03mm) and goethite (<0.02mm) along its partings, representing an atoll texture. Pyrite occupies the core (<0.7mm) of the atoll texture. Rare chalcocite flake (<0.03mm) is recognized surrounded by hematite-goethite colloform bands. ° EPMA(spot analysis) From a chalcocite flake, Cu, S and trace Fe were detected. Trace Fe is an impurity.
8	195.10 m TP	Pyrite-gypsum-quartz-calcite-barite vein penetrating recrystallized limestone.	Crushed pyrite is oxidized to hematite. Small cubic pyrite (<1mm) is rich in the marginal part of the vein. Larger pyrite is abundant in the inner part, representing a weak-banded structure.	Fairly abundant cubic or elongated pyrite (<10mm) is slightly crushed, and is filled with gangue minerals. Small cubic pyrite in the marginal part (2mm) is often completely oxidized to hematite. An atoll texture of pyrite core and hematite ring is clearly observed. ° EPMA ... Nil.
9	214.40 m TP	Pyrite-gypsum-quartz-calcite-fluorite vein penetrating recrystallized limestone.	Cubic pyrite (<10mm) is almost fresh. Gypsum fills a cavity of the vein.	Cubic fresh pyrite (<10mm) is filled with gangue minerals. Crushing and parting is strongly observed at the bordering part of each crystal. Small amounts of hematite - goethite aggregates are observed in pyrite. ° EPMA ... Nil.

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
10	219.65 m TPE	Pyrite-gypsum-fluorite-calcite-quartz vein penetrating recrystallized limestone.	Cubic pyrite (<8mm) is dotted in the vein. A calcite- (pyrite) veinlet (5mm) cuts the vein through pinkish white, fine-grained recrystallized limestone.	Cubic or trigonal pyrite (5mm) is weakly crushed, and is wrapped by goethite film (<0.02mm). Chalcopyrite and pyrrohtite (0.03-0.1mm) are sparsely included in pyrite. Some chalcopyrite is completely replaced by chalcocite. Pyrite includes some dark brown unidentified mineral (<0.1mm). ° EPMA(spot analyses) From two pyrrohtites, Fe, S and trace Cu were detected. Trace Cu may be an impurity. Fe, lesser Ca and Si were detected from the dark brown unidentified mineral, suggesting goethite or Fe-bearing silicate.
11	222.40 m TPE	Pyrite-fluorite-gypsum-quartz-calcite vein penetrating white recrystallized limestone.	Pyrite is disseminated as dots and as lenses. Dark gray very fine-grained soft metallic mineral (kobellite) is recognized around pyrite.	Cubic-to-subhedral pyrite (0.5-4mm) is sparsely dotted among gangue minerals. Granular kobellite (<1mm) is occasionally embayed by pyrite. Chalcocite-covellite-(goethite) pseudomorphs after tetrahedrate (0.3mm) are rarely recognized. Some tetrahedrite includes pyrite. Chalcopyrite small dots (<0.03 mm) are included in pyrite. Pyrite is occasionaly wrapped with goethite film. ° EPMA(spot analyses) From a homogeneous spot in a pseudomorph after tetrahedrite, Fe, Cu, S, Ca, trace Bi, trace As,and trace Si were detected. The homogeneous spot is likely to be an alteration product of tetrahedrite.

3) DDH-M3

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
12	141.00 m TPX	Hematite (after pyrite)-willemite-austinite-conichalcite-calcite vein.	The specimen is remarkedly porous and drusy. Hematite pseudomorphs after pyrite (1cm) are dotted, and are filled with conichalcite, calcite, quartz and porous aggregates of hematite and goethite. Conichalcite is concentrated as pools or as irregular-shaped bands around hematite pseudomorphs,as well as around limestone breccias.	Subhedral or rounded granular hematite pseudomorphs after pyrite (<0.2-3mm) are scattered among gangue minerals. Very-fine-grained flaky hematite and goethite commonly fill pores showing a ring texture.Cryptocrystalline irregular-shaped goethite is abundant. Fibrous radiating probable copper-bearing transparent mineral is recognized as pools. ° EPMA Nil.

4) DDH-M5

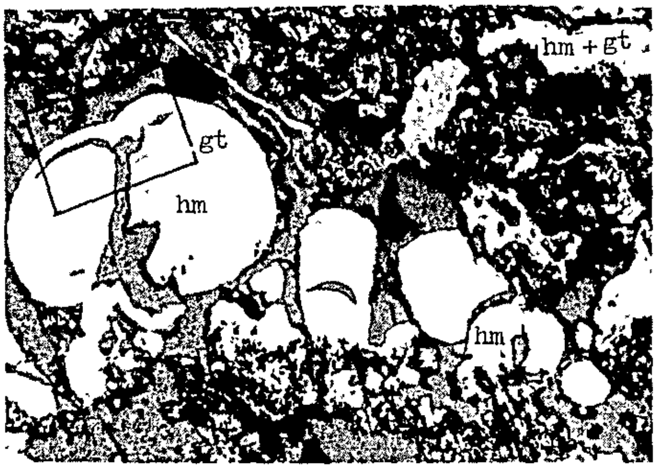
No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
13	147.50 m TPE	Pyrite-quartz-gypsum-fluorite vein including pyritized fine-grained igneous rock breccias.	Crushed cubic large pyrite (30mm) is invaded or penetrated by quartz A gypsum veinlet (4mm) penetrates pyrite through quartz. Dark gray fine-grained pyritized igneous rock breccias (<30mm) are included.	Irregular-shaped pyrite large crystals are weakly crushed, and is hematitized along its cracks. Subhedral kobellite (<0.7mm) and *subhedral-to-rounded* granular acanthite (<3mm) are rarely included in pyrite. Ameba-shaped tetrahedrite is recognized in some acanthite. Microveinlets (<0.02mm) or dots (<0.02mm) of chalcopyrite and tetrahedrite are also found in acanthite. Acanthite often shows wavy crystal growth lines. At the contact of acanthite or tetrahedrite with gangue minerals, flaming chalcocite band (<0.04mm) is often observed. Silver-bearing transparent mineral (cerargyrite?, dark gray, olive green internal reflection) is found adjoining chalcocite. ° EPMA(spot analyses) In the secondary electron images, acanthite is clearly showed as white figure. Lesser white tone indicates some silver-bearing mineral (cerargyrite?). Tetrahedrite is light gray. Chalcopyrite, chalcocite are gray to dark gray, and pyrite is almost black. From a tetrahedrite, Cu, As, Sb, Zn, Sb, trace Fe and trace Bi were detected. From another tetrahedrite, Cu, Bi, S, trace Ag and trace Sb were detected. Cu, S, minor Sb, trace Ag and trace Bi were detected from chalcocite.
14	151.05 m TPE	Quartz-pyrite-gypsum-vein penetrating a strongly argillized and pyritized igneous rock?	Pyrite large crystals(<30mm) are crushed. Small cubic pyrite (<8mm) is completely oxidized to hematite. Quartz and gypsum fill pyrite. The igneous rock? is completely argillized, and pyrite and unidentified black mineral are disseminated. Yellow brown-to-reddish brown oxidized iron stains the igneous rock?.	Crushed cubic-to-subhedral pyrite (0.5-15mm) is densely scattered in *gangue minerals*. *Some* pyrite includes subhedral-to-granular dots (<0.04mm) of chalcopyrite and pyrrhotite, as well as irregular-shaped or granular aggregates (<0.2mm) of *unidentified minerals*. Chalcocite and pyrrhotite often coexist. Unidentified anhedral mineral (<0.1cm) is also scattered in gangue minerals. The unidentified aggregate in pyrite comprises *two phase*; one is pale brown, soft, and strongly anisotropic, occupying the core; the other is bluish gray, soft, and moderately anisotropic. Probale intermediate phase of those two are recognized along the contact. The unidentified mineral in gangue minerals is similar to the former of the unidentified aggregate in pyrite.

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
				° EPMA(spot analyses) From the bluish gray unidentified mineral, Cu, S, minor Ag, minor Sb, and trace Fe were detected. From the pale brown unidentified mineral, Cu, Bi, S, Minor Ag, minor Sb, and minor Cl were detected. From a pale brown unidentified mineral scattered among gangue minerals, Cu, S, lesser Ag and Sb, trace Fe, Bi and Ca were detected. Trace Fe, Ca, Cl are impurities. From those results, the bluish gray mineral might be a variety of emplectite or whittchenite, and the pale brown mineral might be a variety of polybasite.
15	152.85 m TP	Pyrite- (kobellite)-quartz-fluorite-gypsum-calcite vein.	Cubic or anhedral pyrite aggregates (2-20mm) are filled with quartz, gypsum and fluorite. Pyrite is weakly crushed and slightly oxidized to hematite from its margin and along the crakes. Kobellite is dark gray and is recognized as lenses (<2x10mm) among quartz and gypsum.	Crushed cubic-to-subhedral or elongated fragmental pyrite (0.2-5mm) is abundantly observed among gangue minerals. Fine-grained flaky hematite and goethite fill cracks of pyrite. Kobellite was not recognized in the examined section. ° EPMA Nil.
16	156.75 m TP	Pyrite-quartz-calcite-gypsum-fluorite-sericite vein.	Fairly abundant cubic or anhedral pyrite aggregates (3-10mm) are filled with quzrtz, calcite and gypsum. Pyrite is strongly crushed and wrapped by reddish brown hematite film.	Massive pyrite is weaklv crushed, and gangue minerals invade pyrite along the cracks. Hematite-goethite film wraps pyrite fragment. ° EPMA Nil.

No.	Depth	Occurrence	Macroscopic observations	Microscopic observations & EPMA
17	183.80 m TP	Hematite (after pyrite)-quartz-conichalcite vein.	Cubic-to-subhedral hematite pseudomorphs after pyrite (<5mm) are filled with fine-grained quartz. Conichalcite is recognized in pores of leached hematite, as well as in druses.	Strongly crushed and completely oxidized cubic pyrite (0.5-2mm) is scattered in gangue minerals. A concentric colloform texture of hematite and goethite is clearly observed in each cell of a boxwork. Frames are composed of very fine-grained flakes of hematite and goethite. Rare subhedral-to-anhedral chalcopyrite (0.1mm) is recognized in probable quartz. Rare pyrrhotite (0.01mm) is preserved in hematite. Probable copper-bearing transparent mineral fills druses as fibrous radiating aggregates. ° EPMA Nil.

APX. III-3-(2) PHOTOMICROGRAPHS, SECONDARY ELECTRON IMAGES AND CHARACTERISTIC X-RAY IMAGES OF PLISHED SECTIONS OF DRILL CORE SAMPLES

APX.III-3-(2) PHOTOMICROGRAPHS, SECONDARY ELECTRON IMAGES* AND CHARACTERISTIC X-RAY IMAGES OF POLISHED SECTIONS OF DRILL CORE SAMPLES



open nicol 0.5mm

1) DDH-M1 12.30m

Calcite-hematite-(fluorite)-(quartz) vein.

Hematite-goethite concentric colloform texture replacing crushed pyrite.

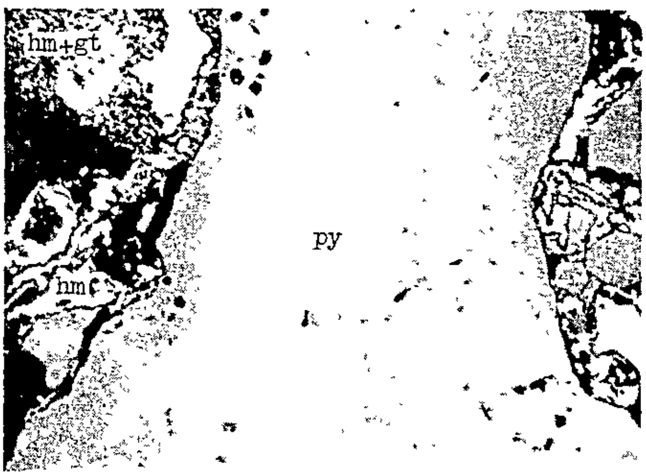
hm: hematite,
gt: goethite.

0.1mm

2) DDH-M1 12.30m

Secondary electron image and analyzed spot by EPMA.

hematite: Fe-((Ca))-((Si)).



open nicol 0.1mm

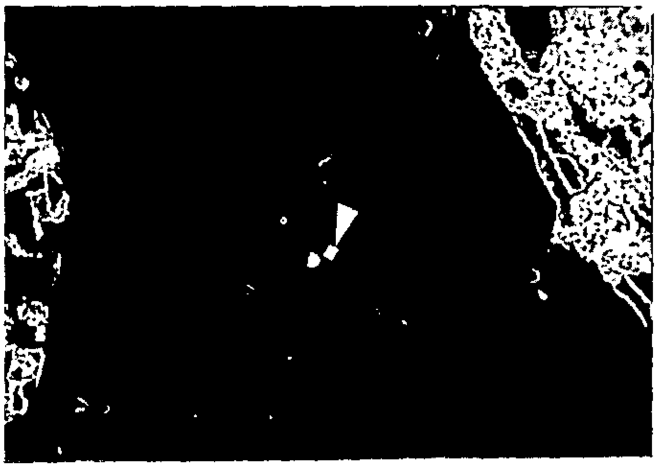
3) DDH-M1 13.55m (a)

Conichalcite-iron oxide-quartz-calcite-(fluorite) vein.

Pyrite inclusion preserved in probable quartz.

py: pyrite,
hm: hematite,
gt: goethite.

* The areas of the secondary electron images are shown on the pair-photomicrographs. Note the left hand is reversed to the right hand comparing the secondary electron image with the pair-photomicrograph.

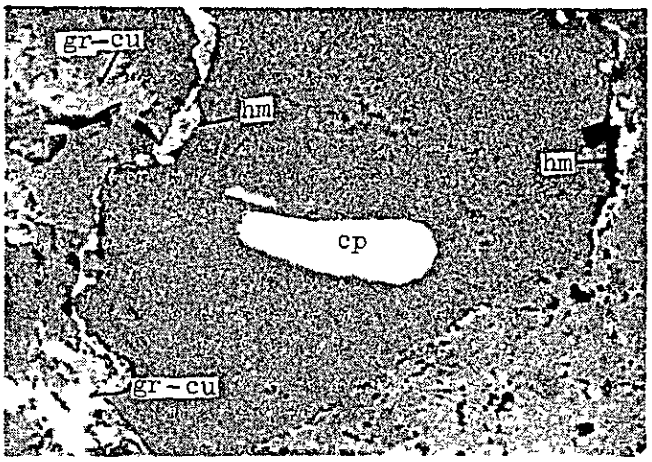


0.1mm

4) DDH-M1 13.55m (a)

Secondary electron image and anlyzed spot by EPMA.

pyrite: Fe-S.



open nicol

0.1mm

5) DDH-M1 13.55m (b)

Chalcopyrite inclusions preserved in probable quartz.

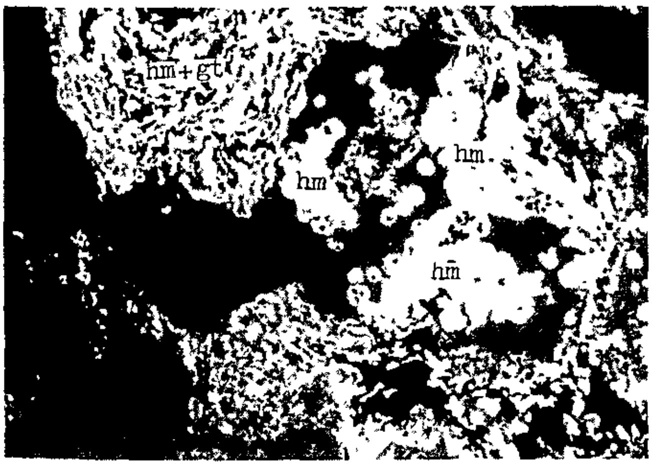
cp: chalcopyrite,
gr-cu: transparent copper mineral,
hm: hematite.

0.1mm

6) DDH-M1 13.55m (b)

Secondary electron image and analyzed spot by EPMA.

chalcopyrite: Fe-Cu-S.



open nicol 0.5mm

7) DDH-M1 14.85m

Quartz-hematite vein.

Concentric colloform texture of hematite and goethite.

hm: hematite,
gt: goethite.

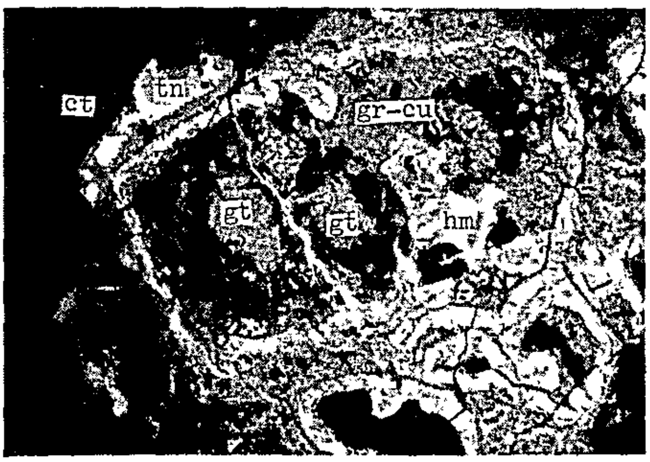
open nicol 0.5mm

8) DDH-M1 16.55m (a)

Conichalcite-quartz-calcite-hematite vein.

Pyrite and chalcocite relicts showing an atoll-to-liesegang texture. Transparent copper mineral surrounds hematite.

cc: chalcocite,
py: pyrite,
gr-cu: transparent copper mineral,
hm: hematite.

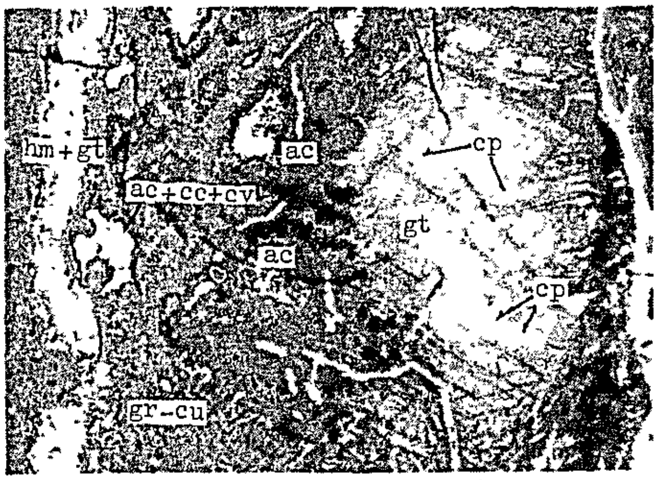


open nicol 0.5mm

9) DDH-M1 16.55m (b)

Destructed chalcopyrite. Secondary copper sulfides and silver sulfide are scattered. Colloform hematite surrounds the shell. Copper oxides and transparent copper mineral occupy outer part of the shell.

ct: cuprite, tn: tenorite,
gr-cu: transparent copper mineral,
hm: hematite, gt: goethite.

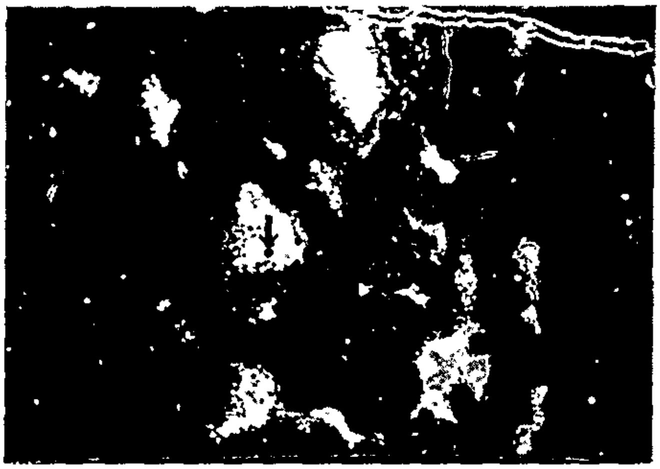


open nicol 0.1mm

10) DDH-M1 16.55m (b)-(1)

Partial enlargement 1.

ac: acanthite,
cp: chalcopyrite,
cc: chalcocite,
cv: covellite,
gr-cu: transparent copper mineral,
hm: hematite,
gt: goethite.

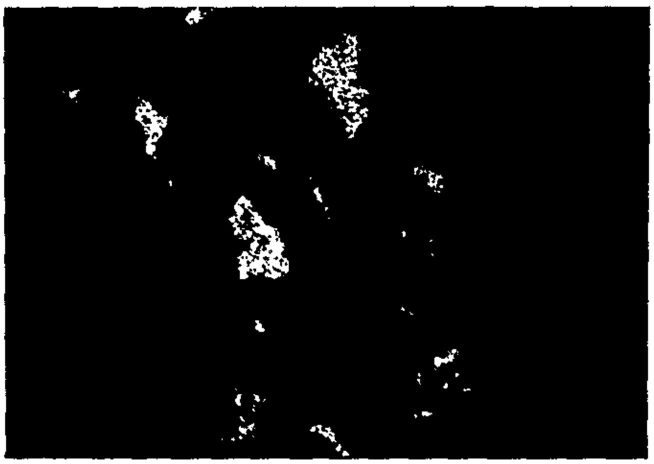


0.1mm

11) DDH-M1 16.55m (b)-(1)

Secondary electron image and analyzed spot by EPMA.

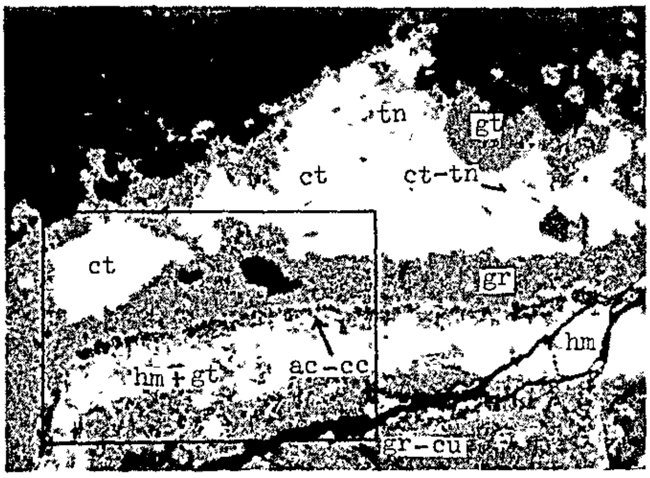
acanthite: Ag-S.



0.1mm

12) DDH-M1 16.55m (b)-(2)

Ag-Lα image of above area.



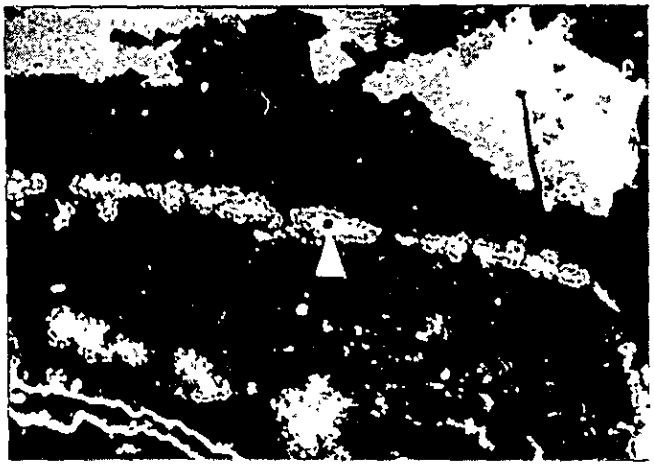
open nicol 0.1mm

13) DDH-M1 16.55m (b)-(2)

Partial enlargement 2.

Chalcocite-acanthite rim along colloform hematite, and copper oxides surrounded by transparent copper mineral.

ac: acanthite, cc: chalcocite,
ct: cuprite, tn: tenorite,
ct-tn: cuprite-tenorite intermediate phase,
gr-cu: transparent copper mineral,
hm: hematite, gt: goethite.

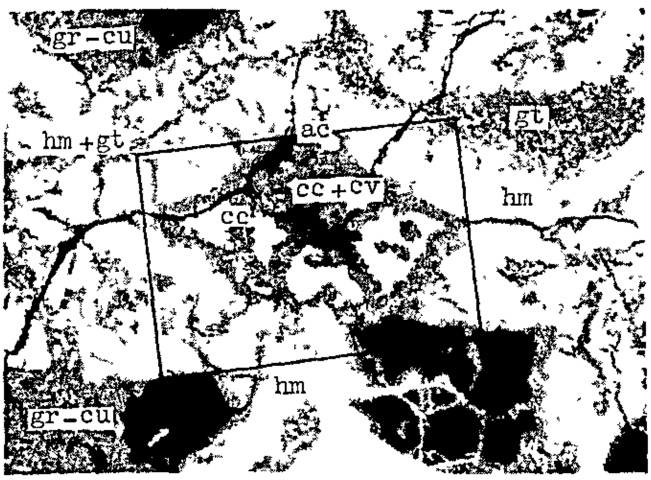


0.05mm

14) DDH-M1 16.55m (b)-(2)

Secondary electron image and analyzed spot by EPMA.

chalcocite: Cu-S-((Fe)).



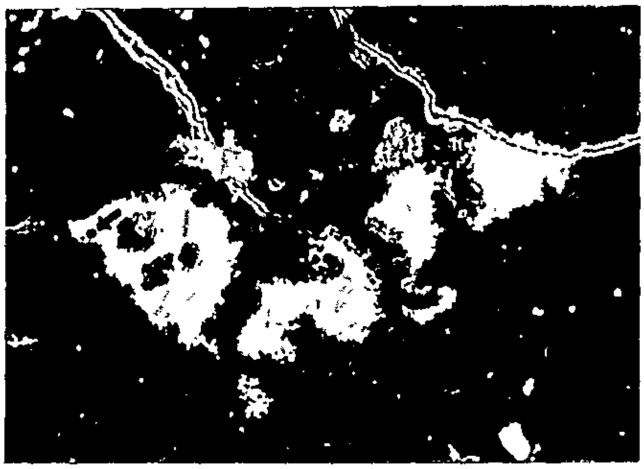
open nicol 0.1mm

15) DDH-M1 16.55m (b)-(3)

Partial enlargement 3.

Chalcocite-covellite aggregates and acanthite are spotted in a pool of transparent copper mineral surrounded by colloform hematite and goethite.

ac: acanthite, cc: chalcocite
cv: covellite, hm: hematite
gt: goethite

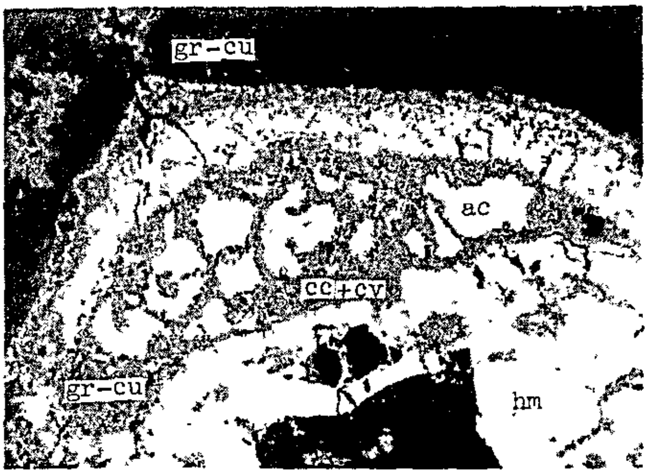


0.05mm

16) DDH-M1 16.55m (b)-(3)

Secondary electron image and analyzed spot.

chalcocite: Cu-S-((Ag)) - ((Fe)).



open nicol

0.1mm

17) DDH-M1 16.55m (c)

Chalcocite-covellite aggregates and acanthite, spotted in a pool of transparent copper mineral surrounded by colloform hematite after pyrite.

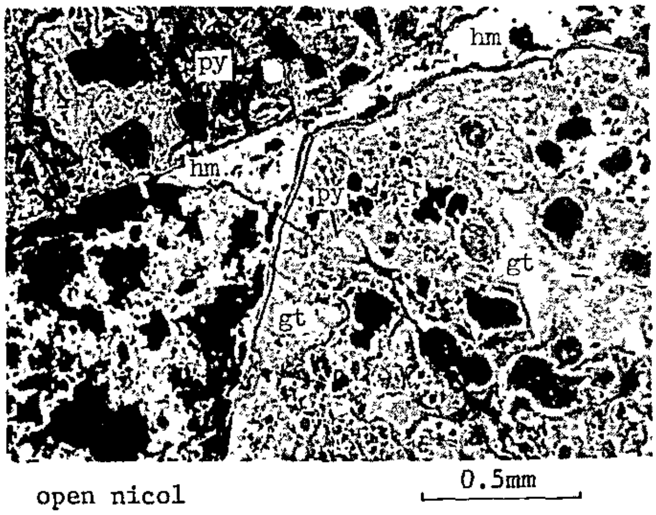
ac: acanthite, cc: chalcocite,
cv: covellite,
gr-cu: transparent copper mineral,
hm: hematite.

crossed nicols

0.1mm

18) DDH-M1 16.55m (c)

Acicular covellite shows a strong reflection anisotropism.



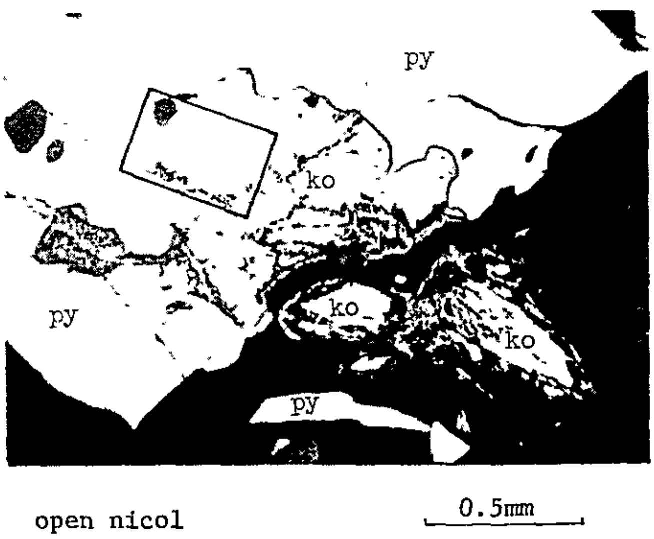
open nicol

19) DDH-M2 125.40m

Hematite (after pyrite)-quartz-conichalcite-chrysocolla?-chlorite-sericite vein.

Pyrite small relict in porous colloform hematite-goethite pseudomorph after pyrite.

py: pyrite,
hm: hematite,
gt: goethite.



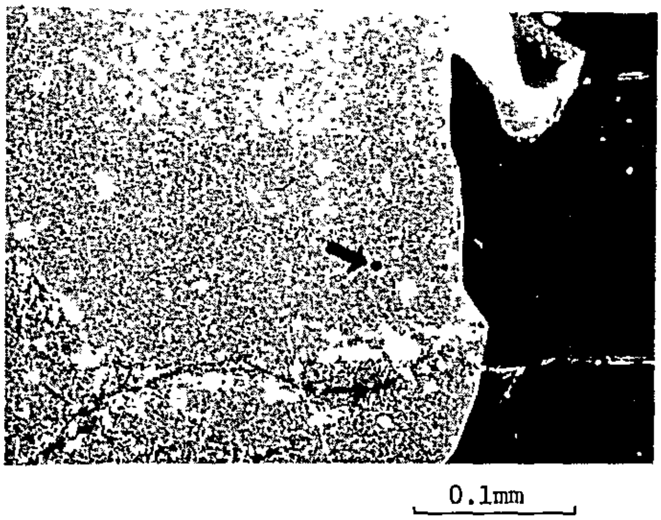
open nicol

20) DDH-M2 161.00m

Pyrite-(kobellite)-quartz-calcite-gypsum vein.

Embayed kobellite by pyrite.

ko: kobellite,
py: pyrite.



21) DDH-M2 161.00m

Secondary electron image and analyzed spot by EPMA.

kobellite: Bi-S-(Sb)-((Pb)).

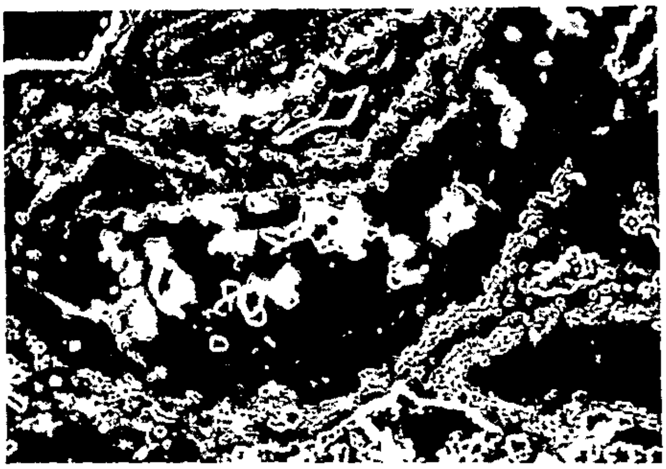
open nicol 0.5mm

22) DDH-M2 164.80m

Pyrite-gypsum-calcite-quartz vein.

Atoll-to-liesegang texture of crushed pyrite. Chalcocite film wraps pyrite. Chalcocite dots are also observed.

py: pyrite,
cc: chalcocite,
hm: hematite,
gt: goethite.

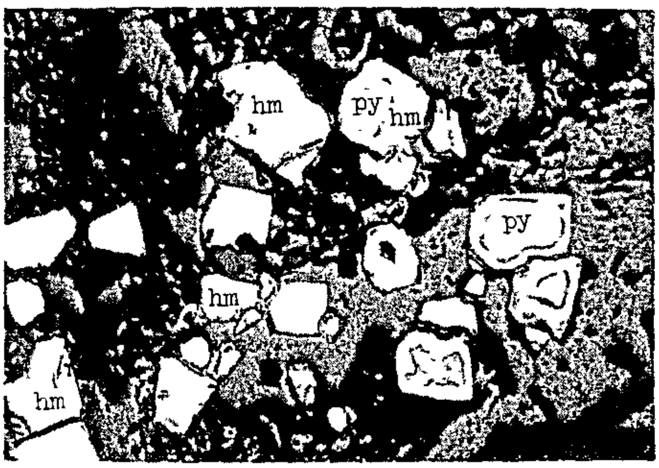


0.1mm

23) DDH-M2 164.80m

Secondary electron image and analyzed spot by EPMA.

chalcocite: Cu-S-((Fe)).



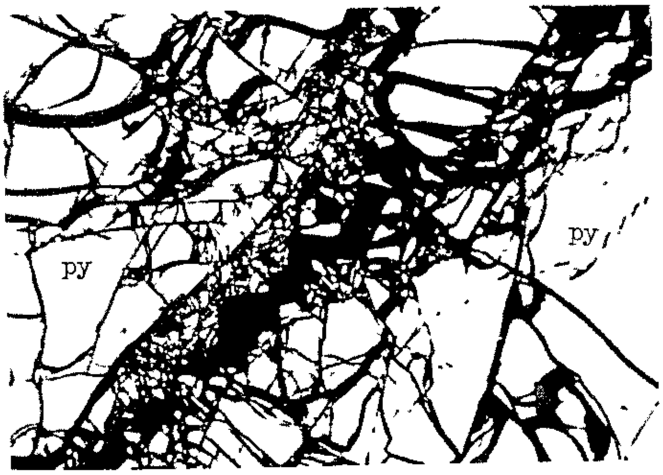
open nicol 0.5mm

24) DDH-M2 195.10m

Pyrite-gypsum-quartz-calcite-barite vein.

Atoll-textured pyrite and hematite pseudomorphs after pyrite.

py: pyrite, hm: hematite.



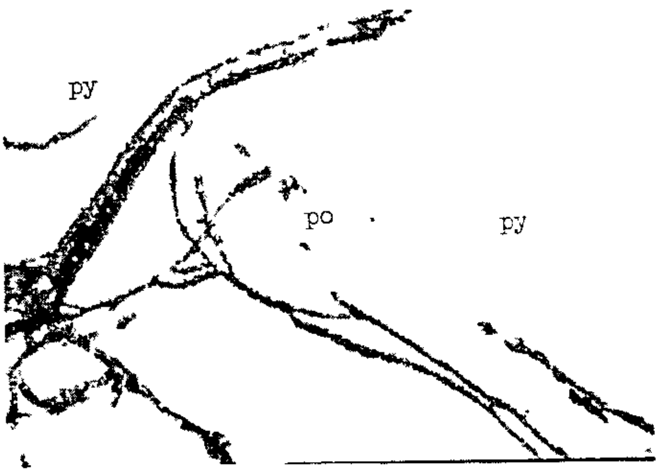
open nicol 0.5mm

25) DDH-M2 214.40m

Pyrite-gypsum-quartz-calcite-fluorite vein.

Strongly crushed pyrite.

py: pyrite.



crossed nicols 0.1mm

26) DDH-M2 219.65m (a)

Pyrite-gypsum-fluorite calcite-quartz vein.

Pyrrhotite inclusion in pyrite.

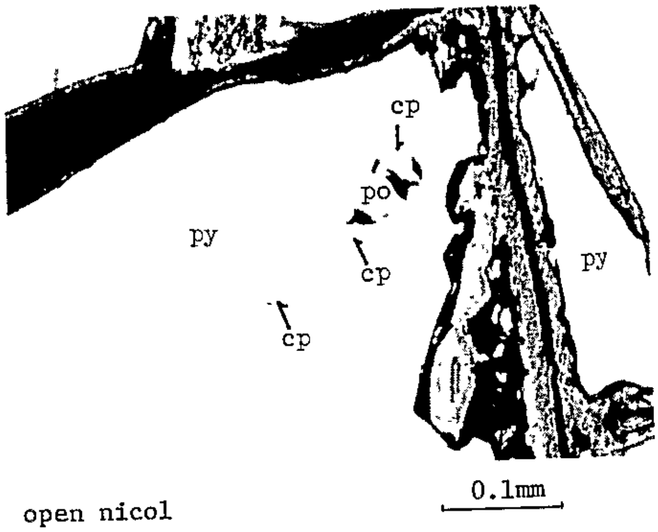
po: pyrrhotite,
py: pyrite.

0.1mm

27) DDH-M2 219.65m (a)

Secondary electron image and analyzed spot by EPMA.

pyrrhotite: Fe-S.

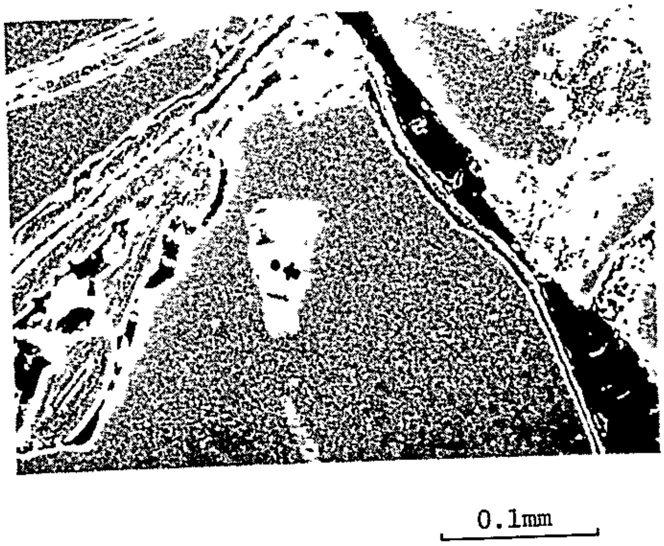


open nicol

28) DDH-M2 219.65m (b)

Pyrrhotite and chalcopyrite inclusions in pyrite.

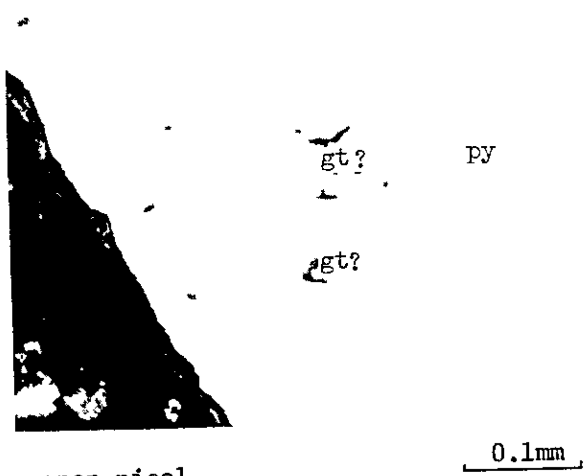
cp: chalcopyrite,
po: pyrrhotite,
py: pyrite.



29) DDH-M2 219.65m (b)

Secondary electron image and analyzed spot by EPMA.

pyrrhotite: Fe-S-《Cu?》.

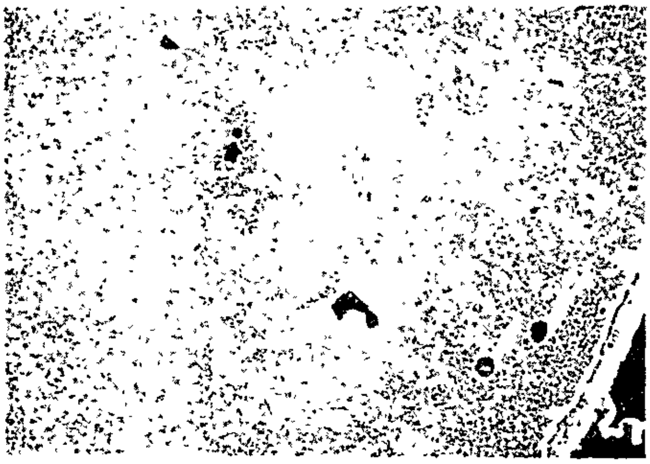


open nicol

30) DDH-M2 219.65m (c)

Goethite? in pyrite.

py: pyrite,
gt?: goethite?.

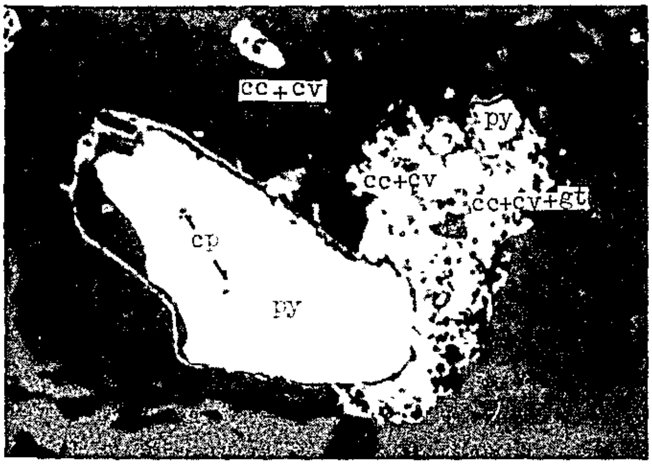


0.1mm

31) DDH-M2 219.65m (c)

Secondary electron image and analyzed spot by EPMA.

goethite?: Fe-(Ca)-(Si).



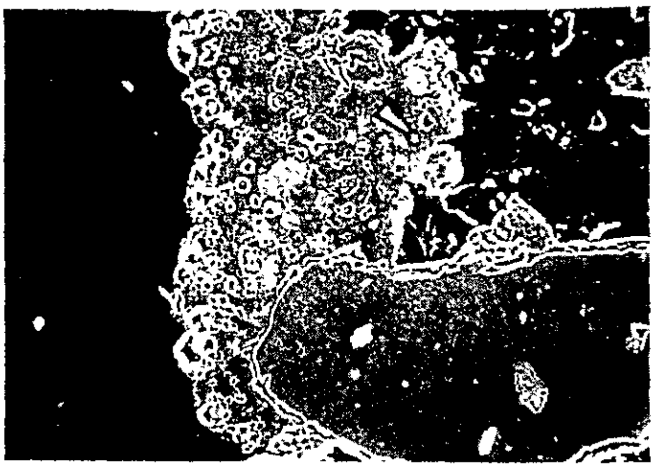
0.1mm

32) DDH-M2 222.40m

Pyrite-fluorite-gypsum-quartz-calcite vein.

Chalcopyrite inclusions in pyrite, and chalcocite-covellite-goethite pseudomorph after tetrahedrite? with pyrite inclusions.

cp: chalcopyrite,
cc: chalcocite,
cv: covellite, py: pyrite,
gt: goethite.

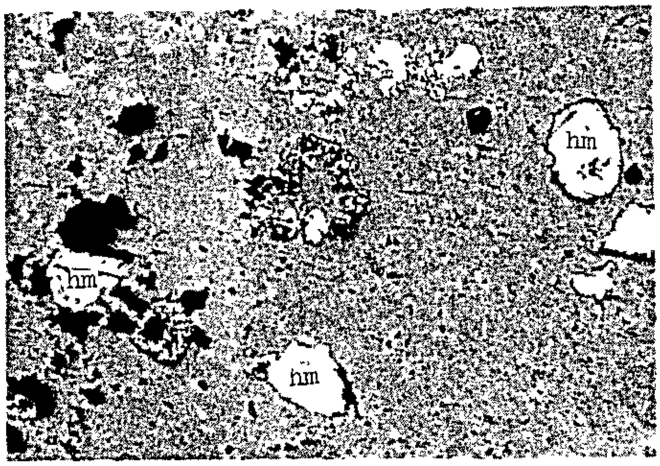


0.1mm

33) DDH-M2 222.40m

Secondary electron image and analyzed spot by EPMA.

unidentified mineral:
Fe-Cu-S-Ca-((Bi?))-((As?))-((Si?)).



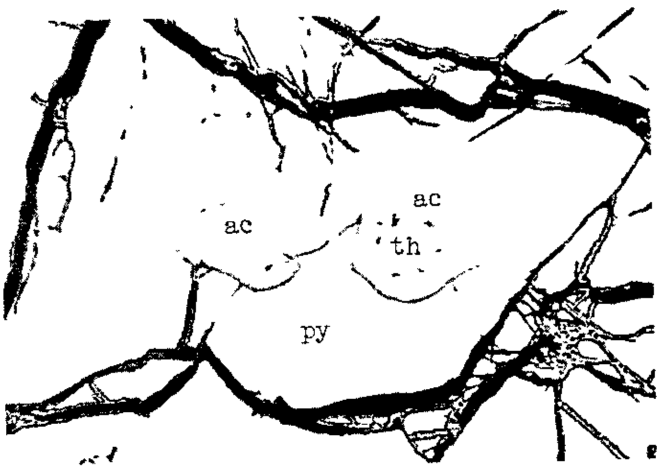
open nicol 0.5mm

34) DDH-M3 141.00m

Hematite (after pyrite)-willemite-austinite-conichalcite-calcite vein.

Hematite pseudomorphs after pyrite.

hm: hematite.



open nicol 0.5mm

35) DDH-M5 147.50m (a)

Pyrite-quartz-gypsum-fluorite vein.

Acanthite incusions in pyrite. Ameba-shaped tetrahedrite is included in acanthite.

ac: acanthite,
py: pyrite,
th: tetrahedrite.

open nicol 0.1mm

36) DDH-M5 147.50m (a)

Enlargement.

Wavy crystal growth lines are cleary observed in acanthite.

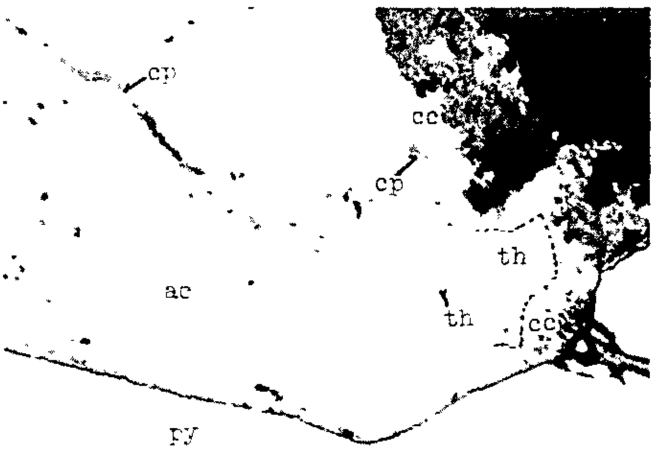
ac: acanthite,
py: pyrite,
th: tetrahedrite.

0.1mm

37) DDH-M5 147.50m (a)

Secondary electron image and analyzed spot by EPMA.

tetrahedrite: Cu-As-(Sb)-(Zn)-((Fe))-((Bi?)).

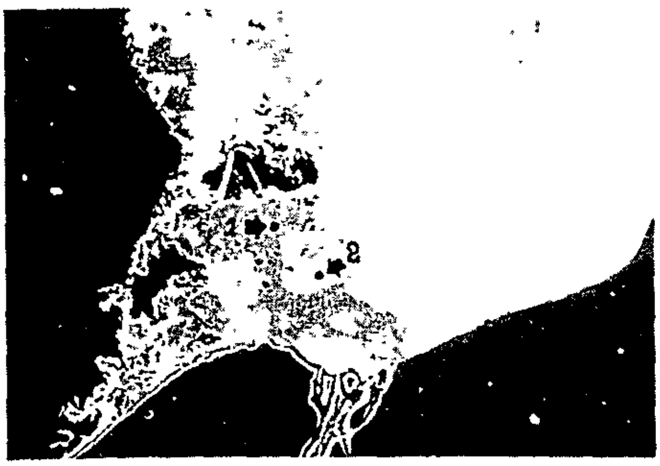


open nicol 0.1mm

38) DDH-M5 147.50m (b)

Embayed acanthite by pyrite.

Chalcopyrite-tetrahedrite spots and lenses are observed in acanthite. Flaming chalcocite band surrounds acanthite. Cerargyrite? is identified by a brighter tone than those of chalcopyrite, chalcocite and tetrahedrite in the secondary electron image.
ac: acanthite, ce?: cerargyrite,
cc: chalcocite,
cp: chalcopyrite, th: tetrahedrite.

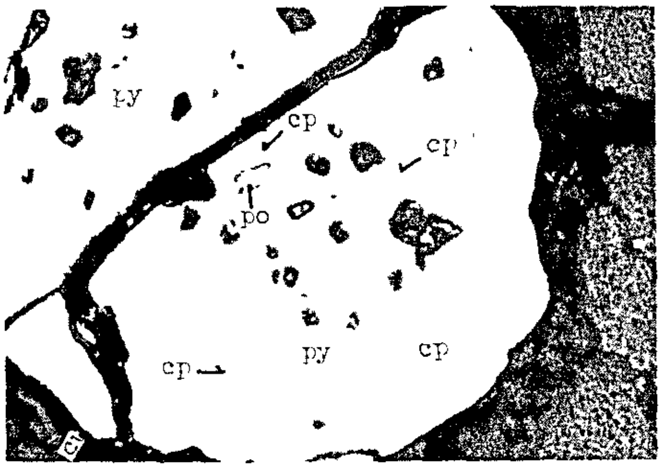


0.1mm

39) DDH-M5 147.50m (b)

Secondary electron image and analyzed spots by EPMA.

1. chalcocite? : Cu-S-(Sb)-((Ag))-((Bi?)).
2. tetrahedrite : Cu-Bi-S-((Ag))-((Sb)).



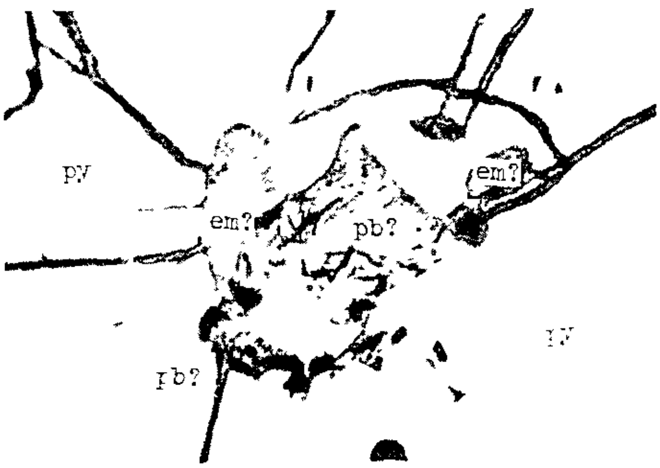
open nicol 0.1mm

40) DDH-M5 151.05m (a)

Quartz-pyrite-gypsum vein.

Chalcopyrite and pyrrhotite inclusions in pyrite.

cp: chalcopyrite,
po: pyrrhotite,
py: pyrite.

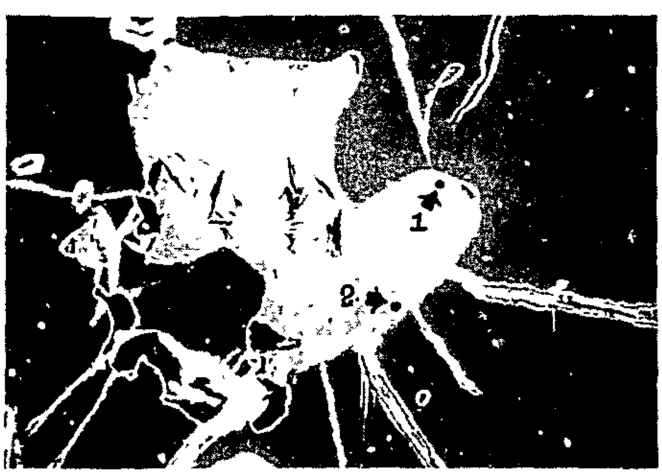


open nicol 0.1mm

41) DDH-M5 151.05m (b)

Polybasite? and emplectite? inclusions in pyrite.

em?: emplectite?,
pb?: polybasite?,
py: pyrite.



0.1mm

42) DDH-M5 151.05m (b)

Secondary electron image and analyzed spots by EPMA.

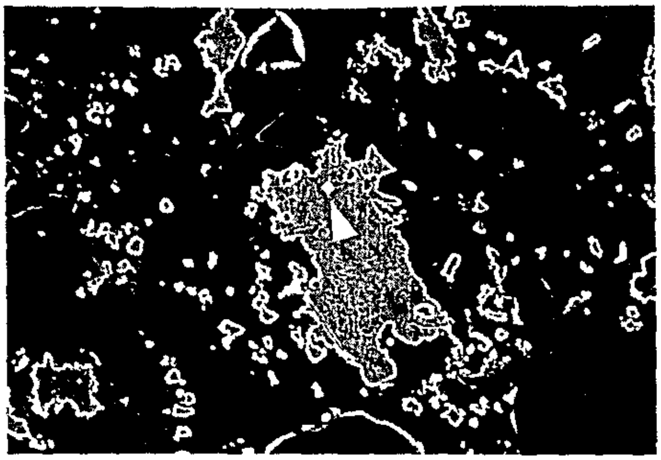
1. polybasite? : Cu-Bi-S-(Ag)-(Sb).
2. emplectite? : Cu-S-(Ag)-(Sb)-((Fe)).

open nicol 0.5mm

43) DDH-M5 151.05 (c)

Disseminated polybasite? and pyrite.

pb?: polybasite?,
py: pyrite.

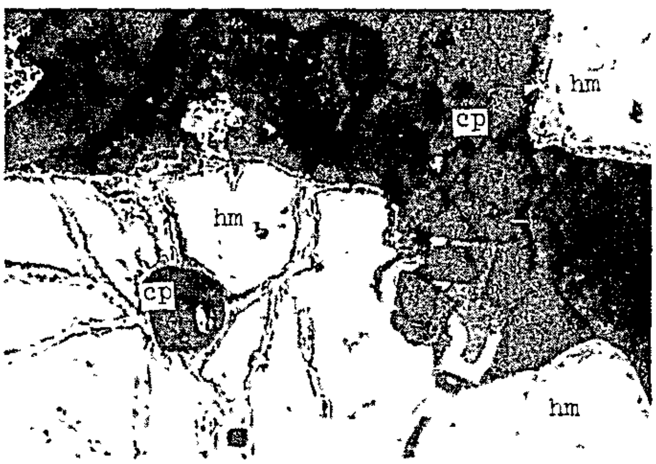


0.1mm

44) DDH-M5 151.05m (c)

Secondary electron image and analyzed spot by EPMA.

polybasite?: Cu-S-Ag-Sb-((Bi))-((Fe)).



open nicol 0.5mm

45) DDH-M5 183.80m

Hematite (after pyrite)-quartz-conichalcite vein.

Colloform hematite pseudomorphs after crushed pyrite, and chalcopyrite inclusions in probable quartz.

cp: chalcopyrite,
hm: hematite.

APX.III-3-(3) QUALITATIVE ANALYSES OF ORE MINERALS OF DRILL CORE SAMPLES BY ELECTRON PROBE MICROANALYZER

No.	Sample No.			Examined mineral	Fe	Cu	Pb	Zn	Ag	Bi	Sb	As	S	Ca	Si	Cl
1	DDH-M1	12.30m	TPE	hematite	S									VW	VW	
2		13.55m	TPE	pyrite	S								S			
3				chalcopyrite	S	S							S			
4		16.55m	TPE	acanthite					VS				S			
5				chalcocite	VW	S							S			
6				chalcocite	VW	S			W				S			
7	DDH-M2	161.00m	PE	kobellite			VW			VS	W		S			
8		164.80m	TPE	chalcocite	VW	S							S			
9		219.65m	TPE	pyrohtite	S								S			
10				pyrohtite	S	T							S			
11				unidentified mineral	S									W	W	
12		222.40m	TPE	altered tetrahedrite	S	S				T		T	S	S	T	
13	DDH-M5	147.50m	TPE	tetrahedrite		S			VW	S	VW		S			
14				chalcocite		S			VW	T	W		S			
15				chalcocite?	VW	S		W		T	W	M				
16		151.05m	TPE	emplectite? (wittchenite?)	VW	S			W		W		S			
17				polybasite?		S			W	S	W		S			W
18				polybasite?	VW	S			M	VW	M		S	VW		

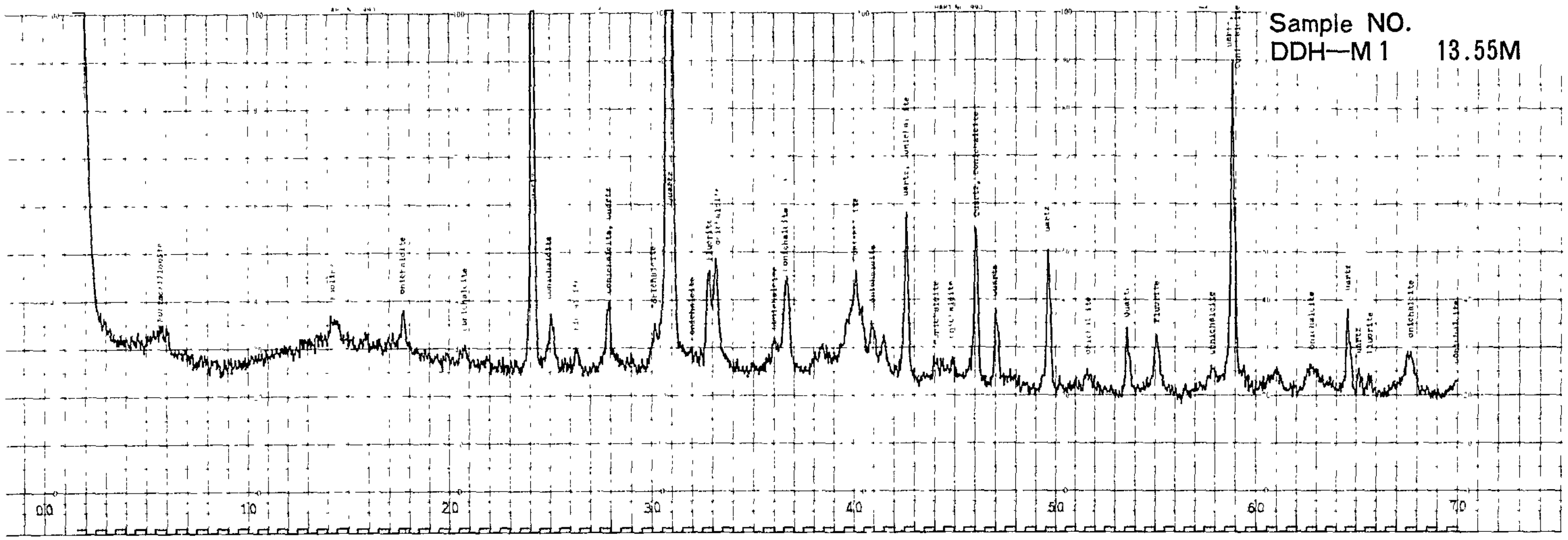
VS: very strong M: moderate VW: very weak
S : strong W: weak T : trace

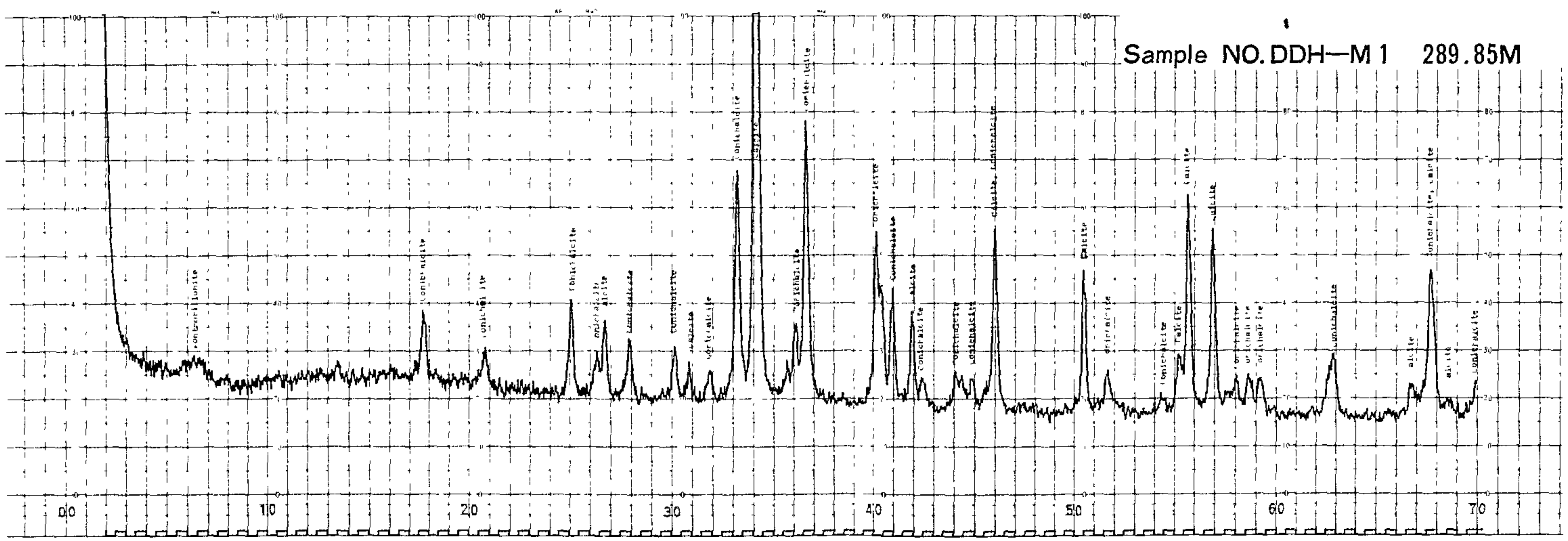
APX. III-1-(1) DETECTED MINERALS BY X-RAY DIFFRACTIONS

No.	Drill hole	Depth	Occurrence	Conichalcite	Mimetite	Willemite	Austinite	Fluorite	Barite	Quartz	Calcite	Montmorillonite	Hydrated halloysite	Mica	Kaolin
1	DDH-M1	13.55 m	Strongly oxidized Cu-Fe-fluorite-quartz-calcite vein	++				++		++++		+			+
2	DDH-M1	289.85 m	Pale greenish white earthy mineral filling druses of a calcite vein	+++							++++	+			
3	DDH-M2	50.15 m	Pale yellow-to-pale yellowish brown minerals accompanied by a fluorite-calcite-quartz vein		+++			++++		(+)	++	+	(+)		
4	DDH-M2	115.10 m	Pale bluish green chrysocolla? banded with brownish limonite? and olive green clayey minerals					++++		+			++		
5	DDH-M2	125.40 m	Pale bluish colloform chrysocolla? patch of a strongly oxidized Fe-Cu vein							+		+++		+	
6	DDH-M3	80.85 m a	White pulverulent radiating sheaf-like mineral accompanied with a calcite vein						++		+++		(+)		
7	DDH-M3	80.85 m b	White pulverulent mineral accompanied with a calcite vein						++		++		(+)		
8	DDH-M3	141.00 m	Strongly oxidized zinc-rich (10.10% Zn) Cu-Fe-quartz-calcite vein			++	++			(+)	+++				

++++: very abundant ++++ abundant +++ common ++ rare (+), very rare

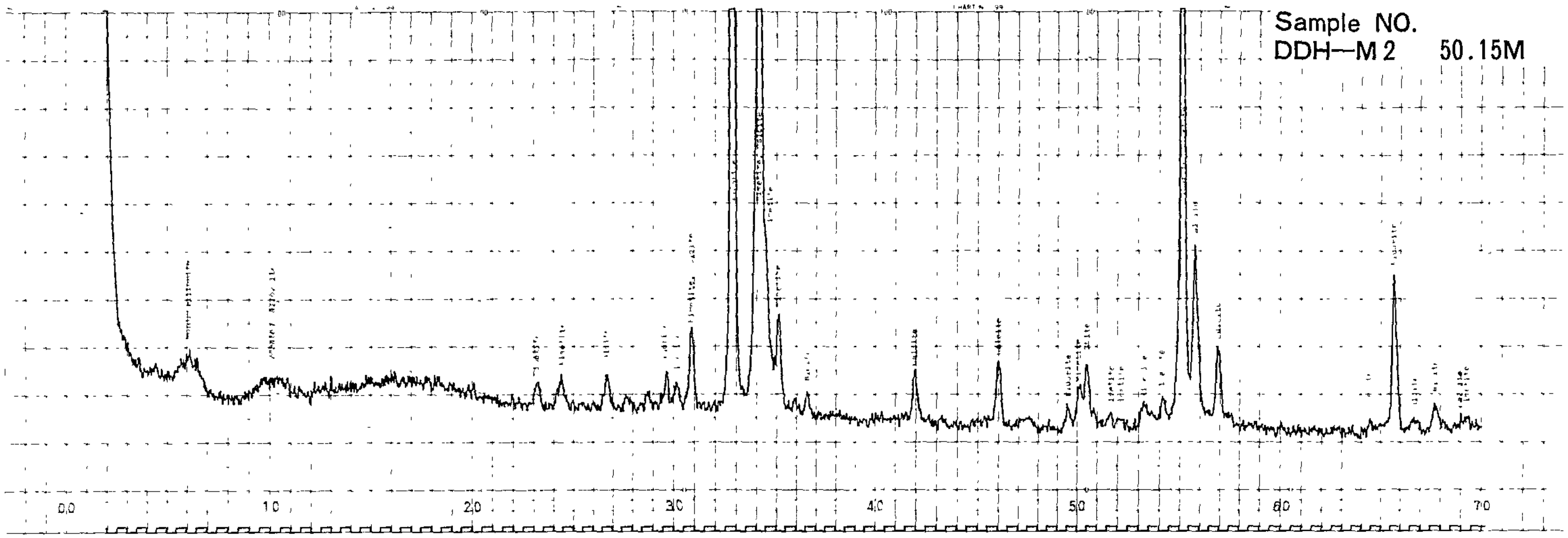
APX. III-4-(2) CHARTS OF X-RAY DIFFRACTIONS

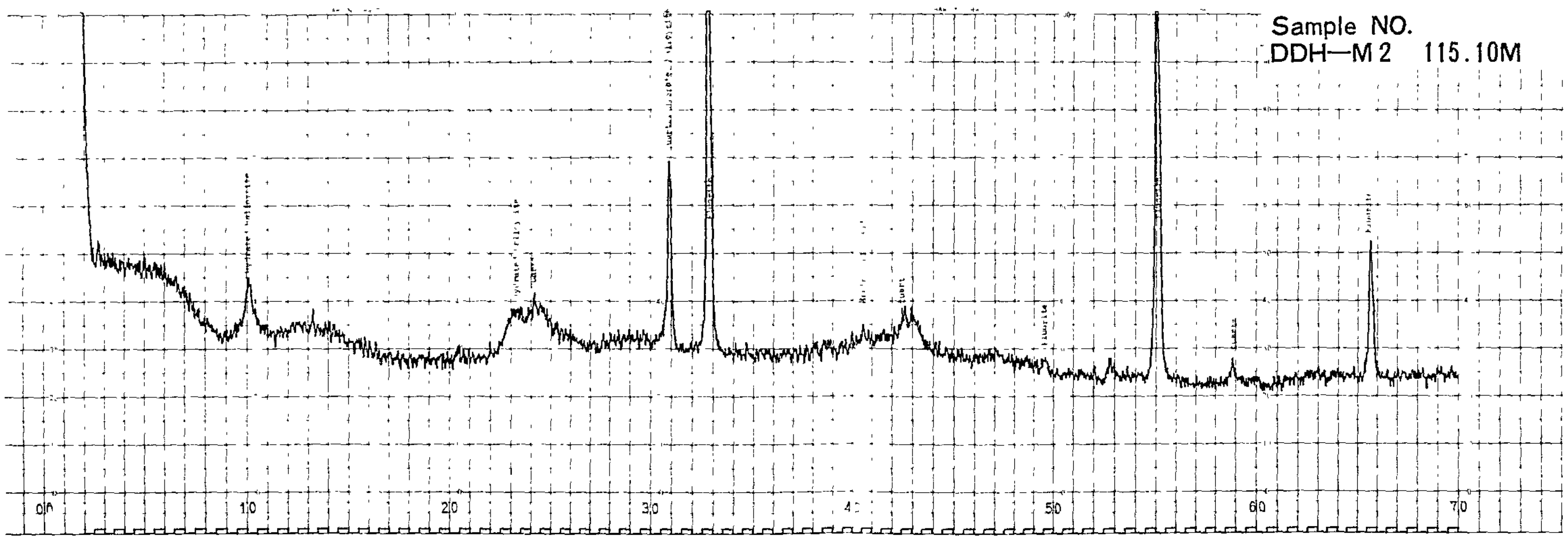




CONDITION

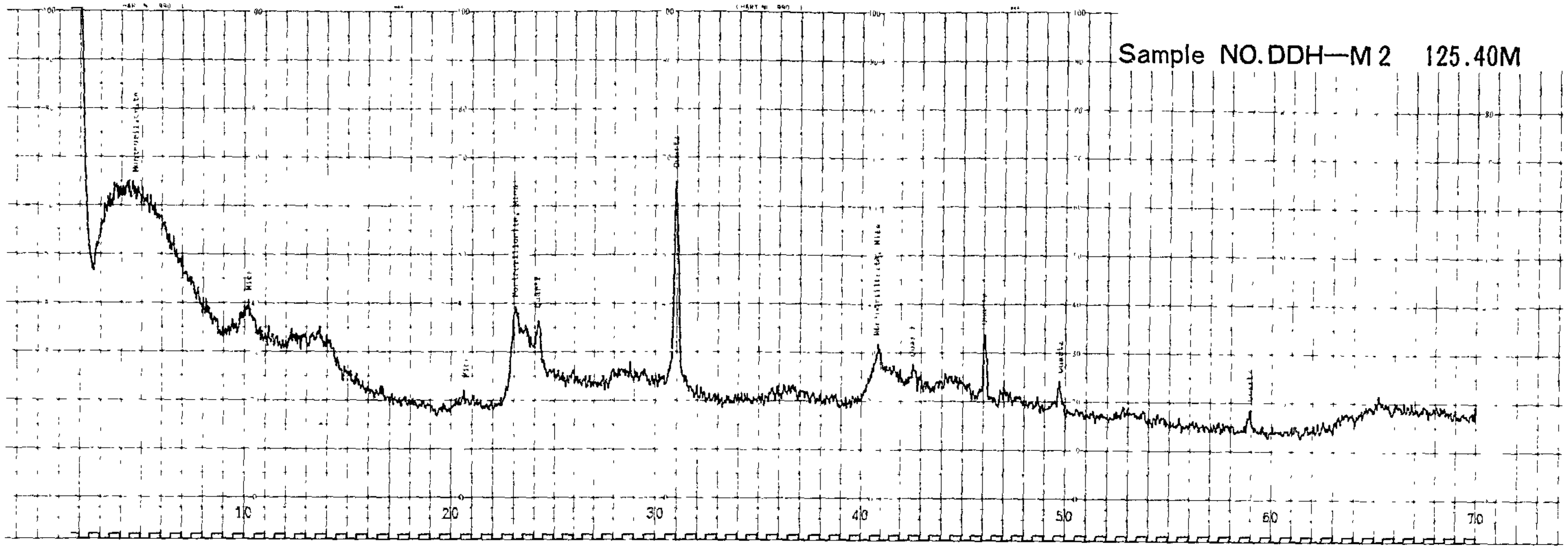
Target	Co	
Filter	Fe	
Voltage	40	KV
Current	20	mA
Ratemeter	200	
Multiplier	10	
Count Full Scale	2000	c/s
Time Constant	1	sec
P.H.A	3-080-300	
Divergent Slit	1	°
Receiving Slit	0.3	mm
Soller Slit		
Glancing Angle		
Scanning Speed	2	°/min
Chart Speed	20	mm/min
Date	53. 12. 13	
Operator		

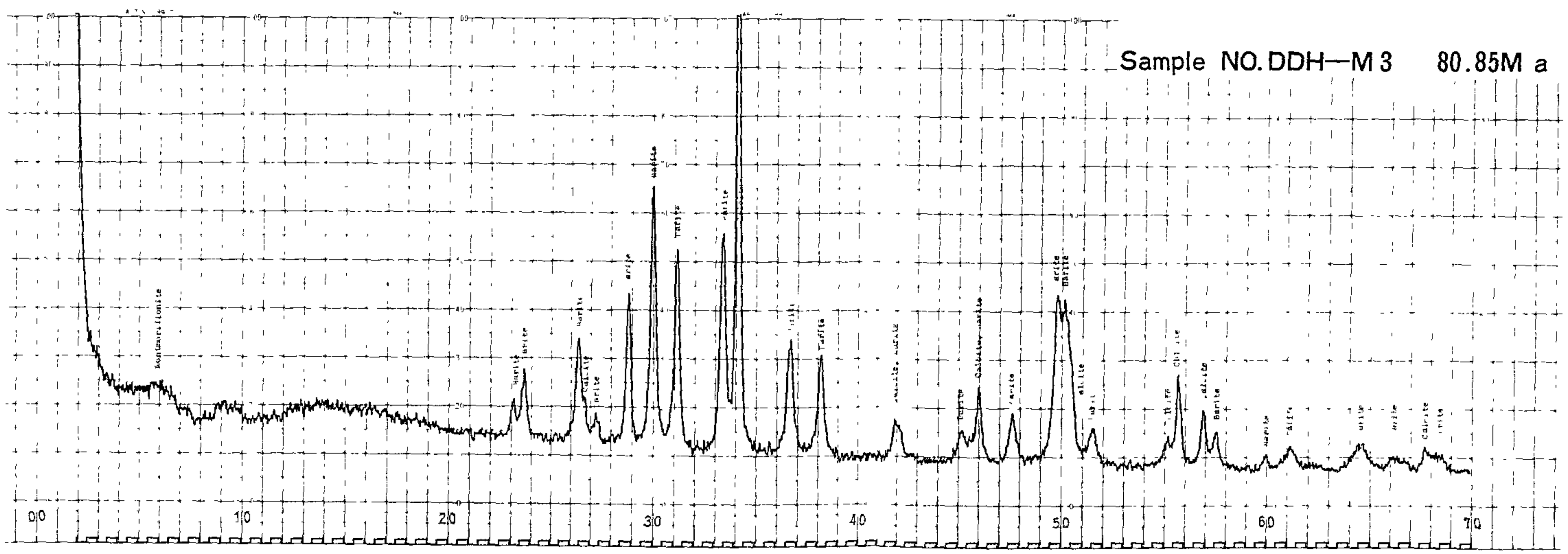




CONDITION

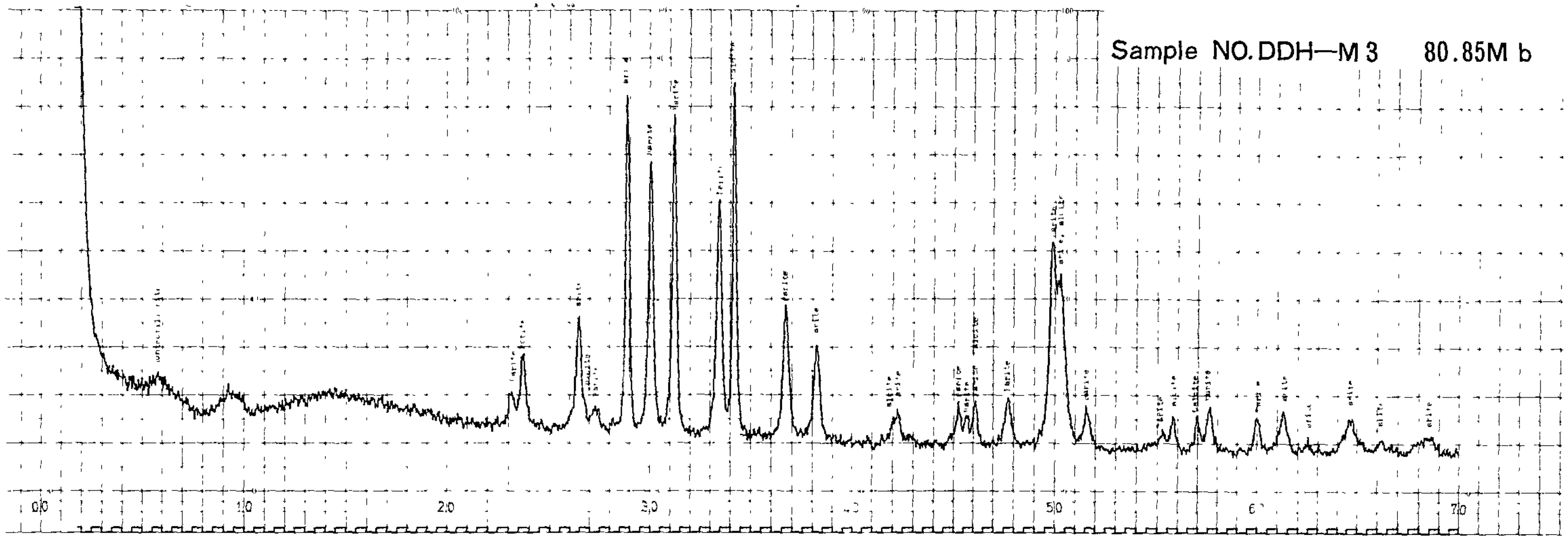
Target	Co	
Filter	Fe	
Voltage	40	KV
Current	20	mA
Ratemeter	200	
Multiplier	10	
Count Full Scale	2000	c/s
Time Constant	1	sec.
P H.A.	3-080-300	
Divergent Slit	I	°
Receiving Slit	0.3	mm
Soller Slit		°
Glancing Angle		°
Scanning Speed	2	°/min.
Chart Speed	20	mm/min.
Date	53. 12. 13	
Operator		





CONDITION

Target	Co	
Filter	Fe	
Voltage	40	KV
Current	20	mA
Ratemeter	200	
Multiplier	10	
Count Full Scale	2000	c/s
Time Constant	1	sec.
P.H A.	3-080-300	
Divergent Slit	1	°
Receiving Slit	0 3	mm
Soller Slit		°
Glancing Angle		°
Scanning Speed	2	°/min.
Chart Speed	20	mm/min.
Date	53 12. 13	
Operator		



CONDITION

Target	Co	
Filter	Fe	
Voltage	40	V
Current	20	mA
Ratemeter	200	
Multiplier	10	
Count Full Scale	2000	c/s
Time Constant	1	sec
P H A	3-080-350	
Divergent Slit	1	
Receiving Slit	0.3	mm
Soller Slit		
Glancing Angle		
Scanning Speed	2	°/min
Chart Speed	20	mm/min
Date	53. 12. 23	
Operator