2-2 Drilling operation

(1) Drilling method

The drilling was conducted by wireline method from the surface soil with an NX single bit, an NQ coring bit and a BQ coring bit.

The drilling and casing profile is as shown in Ap.Fig.4.

Mainly bentonite mud water was used as the drilling fluid. Use was also made of mud oil (lubricant oil) mixed with this drilling fluid.

For the prevention of mud water loss, use was made, among other things, of Telstop (squeezed cottonseeds).

(2) Rig and Materials

The rig employed was a OE-8B1 (with a capacity of 300m) from Koken Boring Co., Ltd., Japan. The types and specifications of the machinery used and the quantities of diamond bits and other expendables are tabulated in Ap.Tables 4 to 7 classified by drill hole.

Of the expendable materials, the drilling fluids were brought from Japan, but the light oil, gasoline, oil and greases as well as the cement were purchased locally.

(3) Operation

The preparation of the drill sites, installation, the moving and dismantling of the machinery were carried principally in one shift a day with the drilling operation in 3 shifts a day, each shift lasting 8 hours.

The drilling crew for each shift consisted of a total of 4 persons: one Japanese technician and three local workers. Employed in addition to these were 1 to 2 persons for the first shift and 1 to 2 persons for the second shift for various purposes including the supplying of drilling water. The number of persons employed for moving the machinery from site to site was 4 to 5 persons.

The operation hours and the overall list of operations are as shown in Ap.Table 8.

The results of the drilling performance were as follows: the average rate of drilling for all drill holes 10.19 (11.14)m per shift; the actual core recovery rate 96.4 (99.4)%.

Note: The figures in parentheses refer to the vertical drilling.

(4) Results of drilling progress

The results of the drilling progress classified by drill hole are shown in Tables 2 to 5, the overall results of the drilling operations in Tables 6 to 9, and the drilling work schedule in Figs.18 to 21.

2-3 Geology and mineralization by the drill holes

The geological logs for MJZ-7, MJZ-8, MJZ-11 and MJZ-12 are shown in Figs.22 to 25. The results of a chemical analysis of ores, a microscopic observation of polished section and X-ray diffractive analysis of the minerals are tabulated in Ap.Table 9 to Ap.Table 11.

2-3-1 MJZ-7 Hole

Depth	0 - 10.40m	Laterite
"	10.40 - 159.30m	Mainly arenaceous rock (sandstone) with intercalated thin layer of limestone and shale
"	159.30 - 300.50m	Mainly black shale with intercalated limestone and arenaceous rock (fine-grained

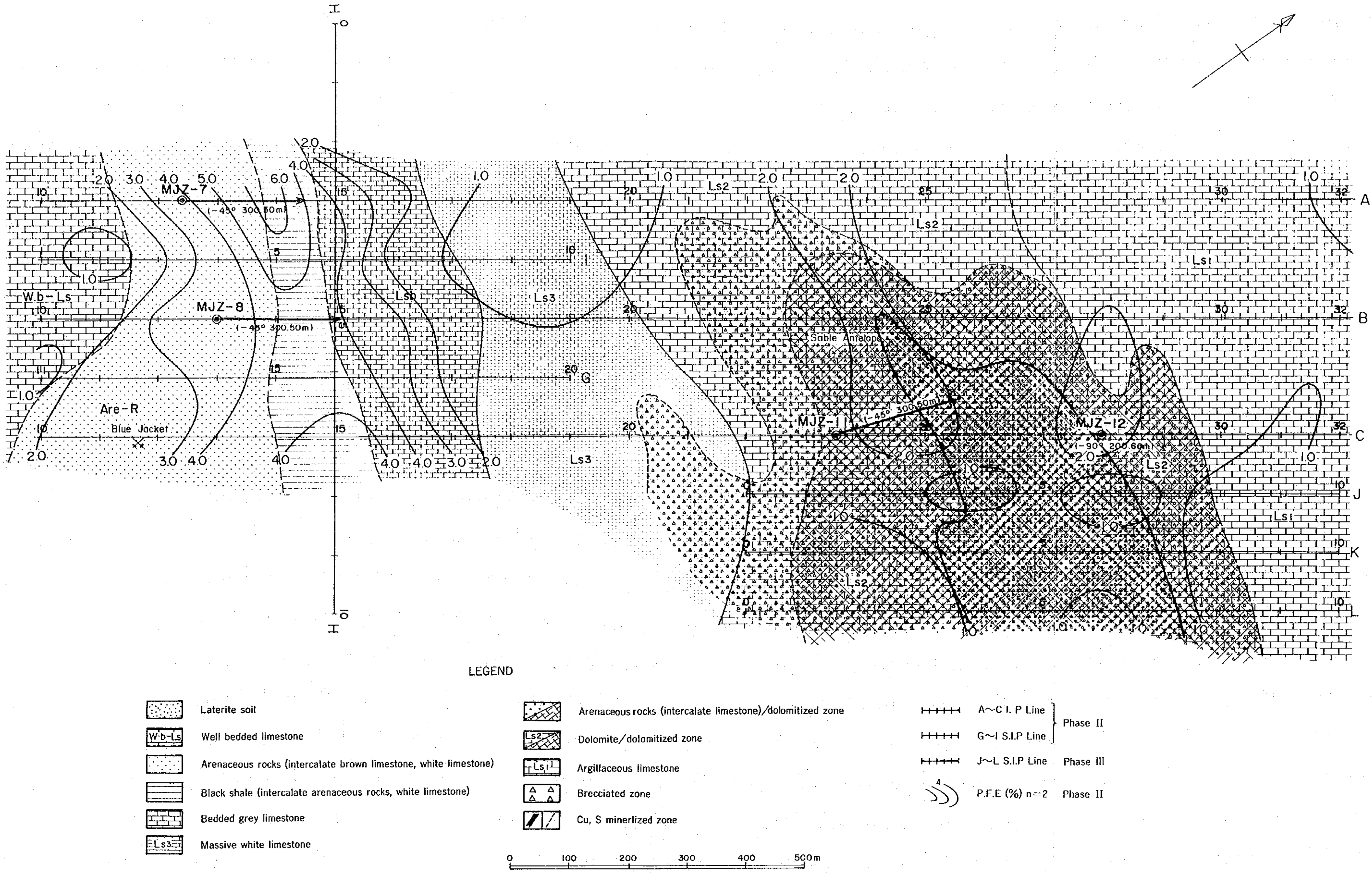


Fig. 16 Location Map of Drillings in Sable Antelope Area

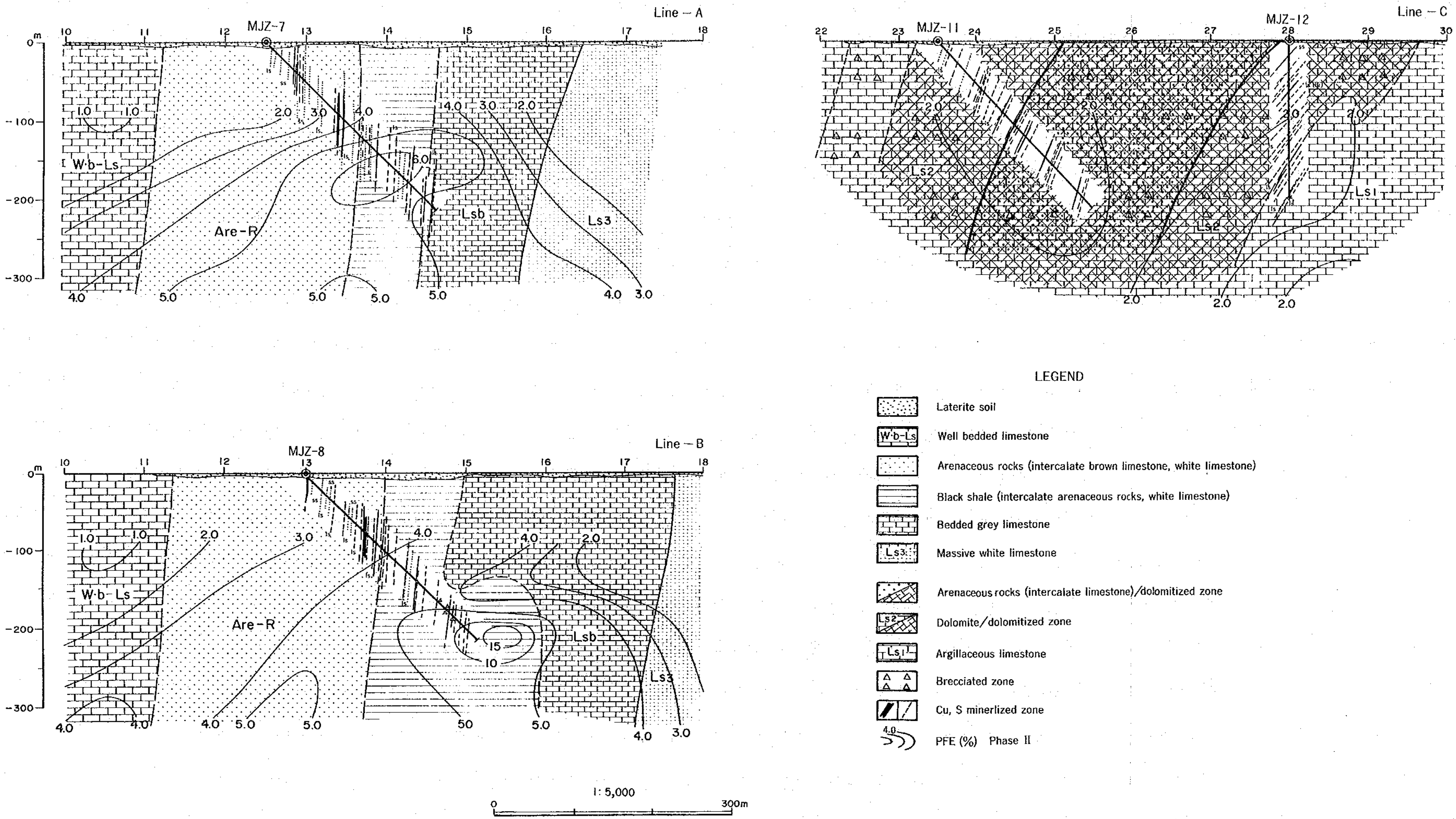


Fig. 17 Geological Section in Sable Antelope Area

Table 2 Record of the Drijling Operation on MJZ-7

	Drilling length			Total		Shift		Working man	
	Shift. 1	Shift. 2	Shift. 3	Drilling	Core length	Drilling	Total	Engineer	Worker
July	m	m	m	m	m	shift	shift	man	man
27	Pds.								
28	Pds.								
29	Pds.								
30	Reassemb.								
31	Reassemb.								
August									
1	5.00			5.00	-				
2	5.50	7.40	10.10	23.00	14.20	4	9	28	81
3	2.40	15.30	12.20	29.90	27.40				
4	8.10	15.30	10.00	33.40	33.40				
5	13.00	14.00	12.00	39.00	39.00				
6	12.60	14.60	9.00	36.20	36.20				
7	10.80	1.80	8.40	21.00	21.00				
8	12.00	12.00	12.00	36.00	36.00				
9	9.40	11.60	12.00	33.00	33.00	21	21	28	102
10	9.60	5.30	9.00	23.90	23.50				
11	12.00	8.10	Out-C.P.	20.10	20.10				
12	Dismant.								
13	Waiting.								
14	Waiting.								
15	Waiting.								
16	Day off								
Total	100.40	105.40	94.70	300.50	283.80	30	40	79	263

Abbreviation

Pds. : Preparation for driling site
Transpor. : Transportation
Reassemb. : Reassemblage
Ins-C.P. : Inserting casing pipe
Out-C.P. : Taking out casing pipe
Dismant. : Dismantlement
Waiting. : Waiting period
Packing. : Packing for mashine and equipment

Table 3 Record of the Drilling Operation on MJZ-8

	Drilling length			Total		Shift		Working man	
	Shift. 1	Shift. 2	Shift. 3	Drilling	Core length	Drilling	Total	Engineer	Worker
July	m	m	m	m	m	shift	shift	man	man
2	Pds.								
3	Pds.								
4	Transpor.								
5	Transpor.						4	16	48
6	Transpor.								
7	Transpor.								
8	Transpor.								
9	Reassemb.								
10	Reassemb.								
11	Reassemb.								
12	9.60			9.60	4.10	1	7	28	104
13	6.30	9.10	9.00	24.40	12.90				
14	6.00	6.40	9.00	21.40	19.80				
15	5.00	11.60	8.20	24.80	24.80				
16	8.00	10.90	7.20	26.10	26.10				
17	9.50	14.60	9.00	33.10	32.80				
18	12.00	9.00	8.00	29.00	29.00				
19	3.70	7.40	Int-C.P	11.10	11.10	20	21	28	98
20	6.00	15.50	10.40	31.90	31.60				
21	8.40	7.60	8.00	24.00	24.00				
22	9.00	6.00	6.00	21.00	21.00				
23	7.70	6.10	3.40	17.20	17.20				
24	7.40	8.10	7.70	23.20	23.20				
25	3.70	Out-C.P.		3.70	3.70				
26	Dismant					16	18	28	95
Total	102.30	112.30	85.90	300.50	281.30	37	50	100	345

Table 4 Recoard of the Drilling Operation on MJZ-11

	Drilling length			Total		Shift		Working man	
	Shift. 1	Shift. 2	Shift. 3	Drilling	Core length	Drilling	Total	Engineer	Worker
September	m	m	m	m	m	shift	shift	man	man
15	Day off								
16	Day off								
17	Transpor.								
18	Transpor.								
19	Reassemb.								
20	Reassemb.						4	16	72
21	5.50	11.00	9.00	25.50	17.10				
22	9.00	12.00	12.00	33.00	26.00				
23	12.00	9.00	15.00	36.00	36.00				
24	12.00	12.00	12.00	36.00	36.00				
25	2.20	9.70	12.00	23.90	23.90				
26	12.00	12.00	9.00	33.00	33.00				
27	15.00	15.00	12.00	42.00	42.00	21	21	28	101
28	12.00	12.00	12.00	36.00	36.00				
29	12.00	12.00	11.10	35.10	35.10				
30	Out-C.P. Dismant.					6	7	11	45
Total	91.70	104.70	104.10	300.50	285.10	27	32	55	218

Table 5 Record of the Drilling Operation on MJZ-12

	Drilling length			Total		Shift		Working man	
	Shift. 1	Shift. 2	Shift. 3	Drilling	Core length	Drilling	Total	Engineer	Worker
October	m	m	m	m	m	shift	shift	man	man
1	Transpor.								
2	Reassemb.								
3	Reassemb.								
4	8.10	9.20	15.50	32.80	30.70	3	6	16	61
5	11.40	12.20	15.40	39.00	39.00				
6	12.30	14.10	10.50	36.90	36.90				
7	13.50	12.00	12.00	37.50	37.50				
8	12.00	9.00	11.00	32:00	32.00				
9	10.00	9.30	3.10	22.40	22.40				
10	Dismant.								
11	Dismant.					15	17	27	107
12	Transpor.								
13	Transpor.								
14	Transpor.								
15	Packing								
16	Packing								
17	Packing								
18	Packing						7	28	98
19	Packing								
20	Packing								
21	Packing								
22	Packing								
23	Transpor.						5	20	70
Total	67.30	65.80	67.50	200.60	198.50	18	35	91	336

Table 6 Summary of the Drilling Operation on MJZ-7

		Survey Period				Total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	27.7.1986∿31.7.1986	5	days 5	days 0	man 20	man 60
	Drilling	1.8.1986∿11.8.1986	11	drilling 11	0	44	157
				recovering 0	0	0	0
	Removing	12.8.1986∿16.8.1986	5	4	1	15	46
	Total	27.7.1986∿16.8.1986	21	20	1	79	263

Drilling length	Length planned	m 300.00	Surface soil Overburden Quaternary	m 10.40
	Increase or Decrease in length	m –	Core length	m 283.80
	Length drilled	m 300.50	Core recovery	% 97.8

Core recovery of 100 m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ∿ 100	93.4	93.4
100 ∿ 200	100.0	96.8
200 ∿ 300.5	99.6	97.8

Working hours	Drilling	h 157°30'	% 63.0	% 48.5
	Other working	92°30'	37.0	28.4
	Recovering			
	Total	250°00'	100	76.9
	Reassemblage	43°00'		13.2
	Dismantlement	8°00'		2.5
	Water transportation	(174°00')		
	Road construction and others	24°00'		7.4
	G. Total	325°00'		100

Efficiency of Drilling

Total m/work period(m/day)	300.50m/11days (27.31m/day)
Total m/total shift(m/shift)	300.50m/30shifts (10.01m/shifts)

Drilling length/bit (each sized bit)

Bit size	HX	NQ	BQ
Drilled length	5.00	174.10	121.40
Core length	–	162.80	121.00

Casing pipe inserted	Size	meterage (m)	$\frac{\text{meterage}}{\text{drilling length}} \times 100$ (%)	Recovery (%)
	HX	5.00	1.7	100
	NX	30.00	10.0	100
	BX	179.10	59.6	63.1

Table 7 Summary of the Drilling Operation on MJZ-8

		Survey Period				Total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	2.7.1986∿11.7.1986	10	days 10	days 0	man 40	man 140
	Drilling	12.7.1986∿25.7.1986	14	drilling 14	0	56	190
				recovering 0	0	0	0
	Removing	26.7.1986∿26.7.1986	1	1	0	4	15
	Total	2.7.1986∿26.7.1986	25	25	0	100	345

Drilling length	Length planned	300.00 m	Surface soil Overburden Quaternary	2.70 m
	Increase or Decrease in length	300.00 m	Core length	281.30 m
	Length drilled	300.50 m	Core recovery	94.4 %

Core recovery of 100 m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ∿ 100	83.6	83.6
100 ∿ 200	99.4	91.6
200 ∿ 300.5	100	94.4

		h	%	%
Working hours	Drilling	174°20'	55.7	42.7
	Other working	138°10'	44.1	33.9
	Recovering	0°30'	0.2	0.1
	Total	313°00'	100	76.7
	Reassemblage	78°00'		19.1
	Dismantlement	8°00'		2.0
	Water transportation	(102°00')		
	Road construction and others	9°00'		2.2
	G. Total	408°00'		100

Efficiency of Drilling

Total m/work period(m/day)	300.50m/14days (21.46m/day)
Total m/total shift(m/shift)	300.50m/37shifts (8.12m/shift)

Drilling length/bit (each sized bit)

Bit size	HX	NQ	BQ
Drilled length	4.00	175.50	121.00
Core length	1.10	159.50	120.70

	Size	meterage (m)	$\frac{\text{meterage}}{\text{drilling length}} \times 100$ (%)	Recovery (%)
Casing pipe inserted	HX	4.00	1.3	100
	NX	33.00	11.0	100
	BX	179.50	59.8	100

Table 8 Summary of the Drilling Operation on MJZ-11

		Survey Period				Total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	15.9.1986∿20.9.1986	6	days 4	days 2	man 16	man 72
	Drilling	21.9.1986∿29.9.1986	9	drilling 9	0	36	134
				recovering 0	0	0	0
	Removing	30.9.1986∿30.9.1986	1	1	0	3	12
	Total	15.9.1986∿30.9.1986	16	14	2	55	218

Drilling length	Length planned	300.00 m	Surface soil Overburden Quaternary	1.50 m
	Increase or Decrease in length	– m	Core length	285.10 m
	Length drilled	300.50 m	Core recovery	95.3 %

Core recovery of 100 m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ∿ 100	85.8	85.8
100 ∿ 200	100	92.9
200 ∿ 300.5	100	95.3

		h	%	%
Working hours	Drilling	150°00'	68.3	57.0
	Other working	69°30'	31.7	26.4
	Recovering			
	Total	219°30'	100	83.4
	Reassemblage	37°00'		14.1
	Dismantlement	6°30'		2.5
	Water transportation	(126°00')		
	Road construction and others			
	G. Total	263°00'		100

Efficiency of Drilling

Total m/work period(m/day)	300.50m/9 days (33.38 m/day)
Total m/total shift(m/shift)	300.50m/27shifts (11.12m/shift)

Drilling length/bit (each sized bit)

Bit size	HX	NQ	BQ
Drilled length	5.50	127.20	167.80
Core length	–	117.30	167.80

	Size	meterage (m)	$\frac{\text{meterage}}{\text{drilling length}} \times 100$ (%)	Recovery (%)
Casing pipe inserted	HX	5.50	1.8	100
	NX	27.00	9.0	100
	BX	132.70	44.2	100

Table 9 Summary of the Drillilng Operation on MJZ-12

		Survey Period				Total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	1.10.1986∿3.10.1986	3	days 3	days 0	man 12	man 45
	Drilling	4.10.1986∿9.10.1986	6	drilling 6	0	24	97
				recovering 0	0	0	0
	Removing	10.10.1986∿23.10.1986	14	14	0	55	194
	Total	1.10.1986∿23.10.1986	23	23	0	91	336

Drilling length	Length planned	200.00 m	Surface soil Overburden Quaternary	1.00 m
	Increase or Decrease in length	– m	Core length	198.50 m
	Length drilled	200.60 m	Core recovery	99.4 %

Core recovery of 100 m hole		
Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ∿ 100	98.8	98.8
100 ∿ 200.6	100	99.4

		h	%	%
Working hours	Drilling	101°40'	70.6	35.9
	Other working	42°20'	29.4	15.0
	Recovering			
	Total	144°00'	100	50.9
	Reassemblage	27°00'		9.5
	Dismantlement	40°00'		14.1
	Water transportation	(16°00')		
	Road construction and others	72°00'		25.5
	G. Total	283°00'		100

Efficiency of Drilling	
Total m/work period (m/day)	200.60m/6 days (33.43m/day)
Total m/total shift (m/shift)	200.60m/18shifts (11.14m/shift)

Drilling length/bit (each sized bit)			
Bit size	HX	NQ	BQ
Drilled length	3.60	197.00	
Core length	2.60	195.90	

Casing pipe inserted	Size	meterage (m)	$\frac{\text{meterage}}{\text{drilling length}} \times 100$ (%)	Recovery (%)
	HX	1.00	0.5	100
	NX	11.00	5.5	100
	BX			

LEGEND

░		Surface soil	△	Br	Breccia
▤	Sh	Shale	⋰	V, Nw	Vein & Network
▒	Ss	Sandstone	▩	Mass Ore	Massive Ore
○	Cong	Conglomerate	∴	Diss Ore	Dissemination
▦	Ls	Limestone	P-01		Polished section
▧	Do	Dolomite	X-01		X-ray Difraction
▨	Do-Are	Dolomitic arenaceous rock	∼		Shear zone
▨	Ch	Chert			

Abbreviation

Cp	Chalcopyrite	Dol	Dolomite
Bo	Bornite	Sid	Siderite and/or Sideritic Dolomite
Cc	Chalcocite	Ank	Ankerite
Di	Digenite	Qtz	Quartz
Mal	Malachite	Fe-Ox	Iron Oxides (mainly hematite)
Gal	Galena	Lim	Limonite
Ten	Tennantite	Altn	Alternation
Py	Pyrite	Drs	Druse
Cal	Calcite and/or Calcitic Dolomite		

C. R	Core Recovery

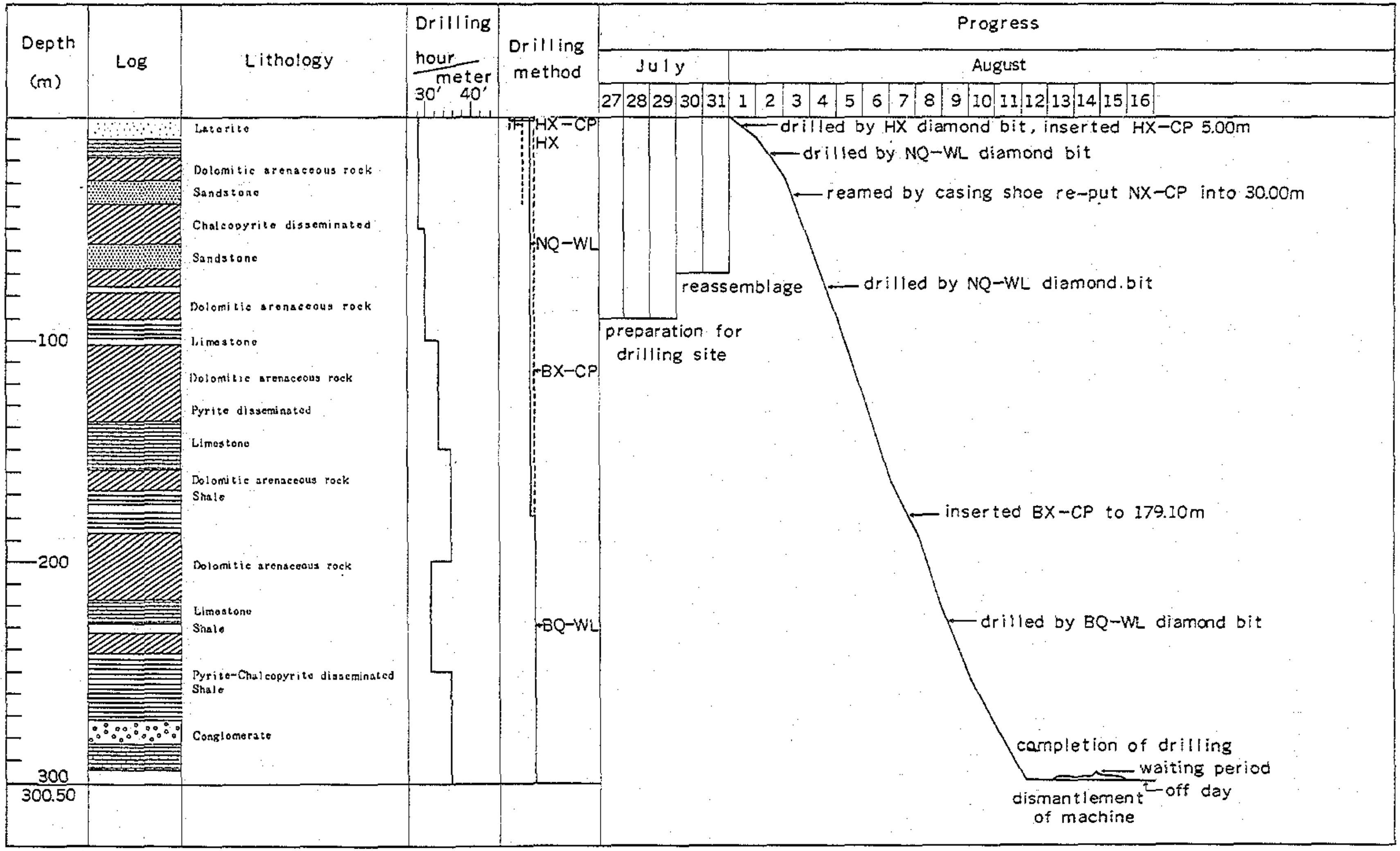


Fig. 18 Drilling Progress on M J Z-7

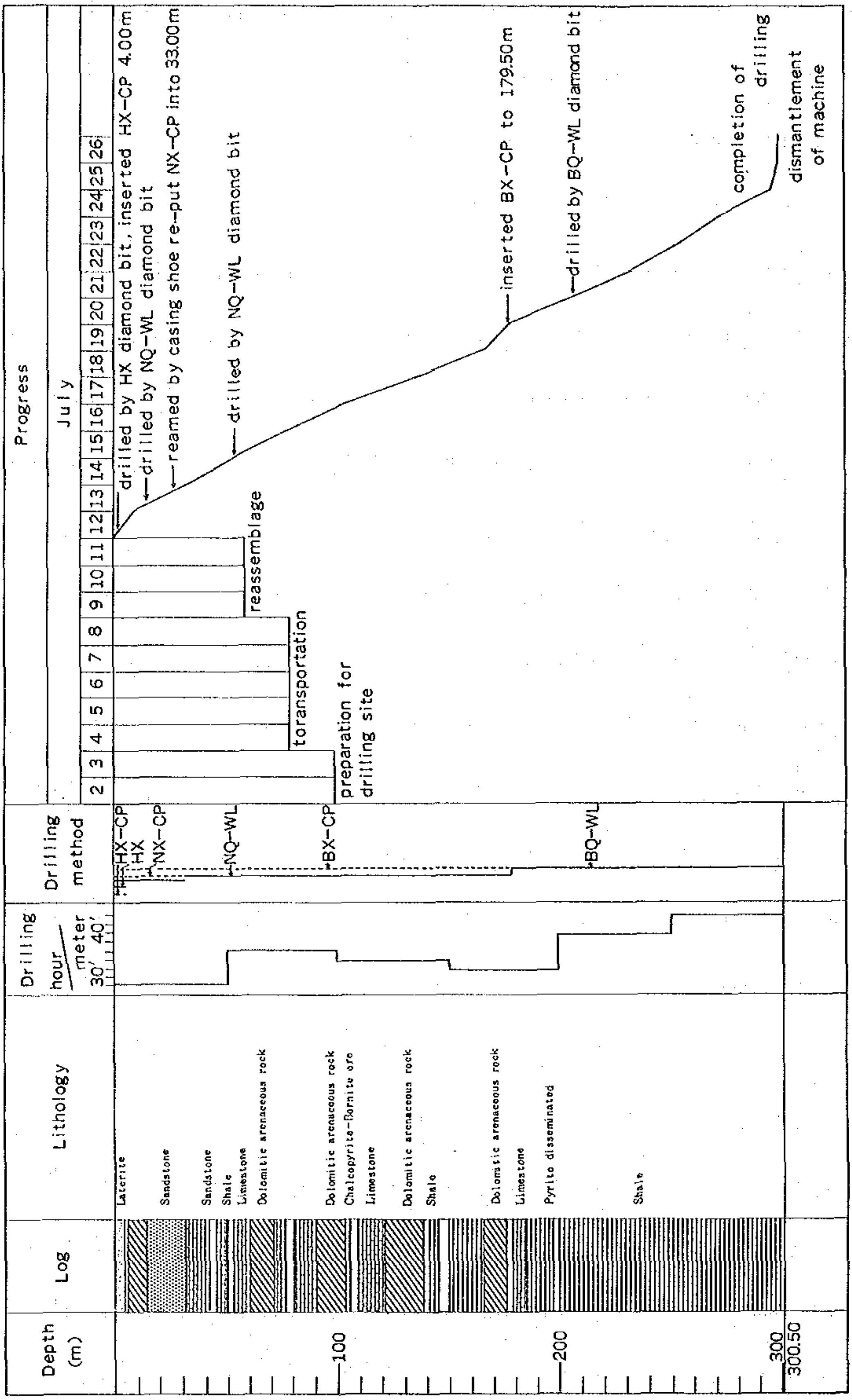


Fig. 19 Drilling Progress on MJZ-8

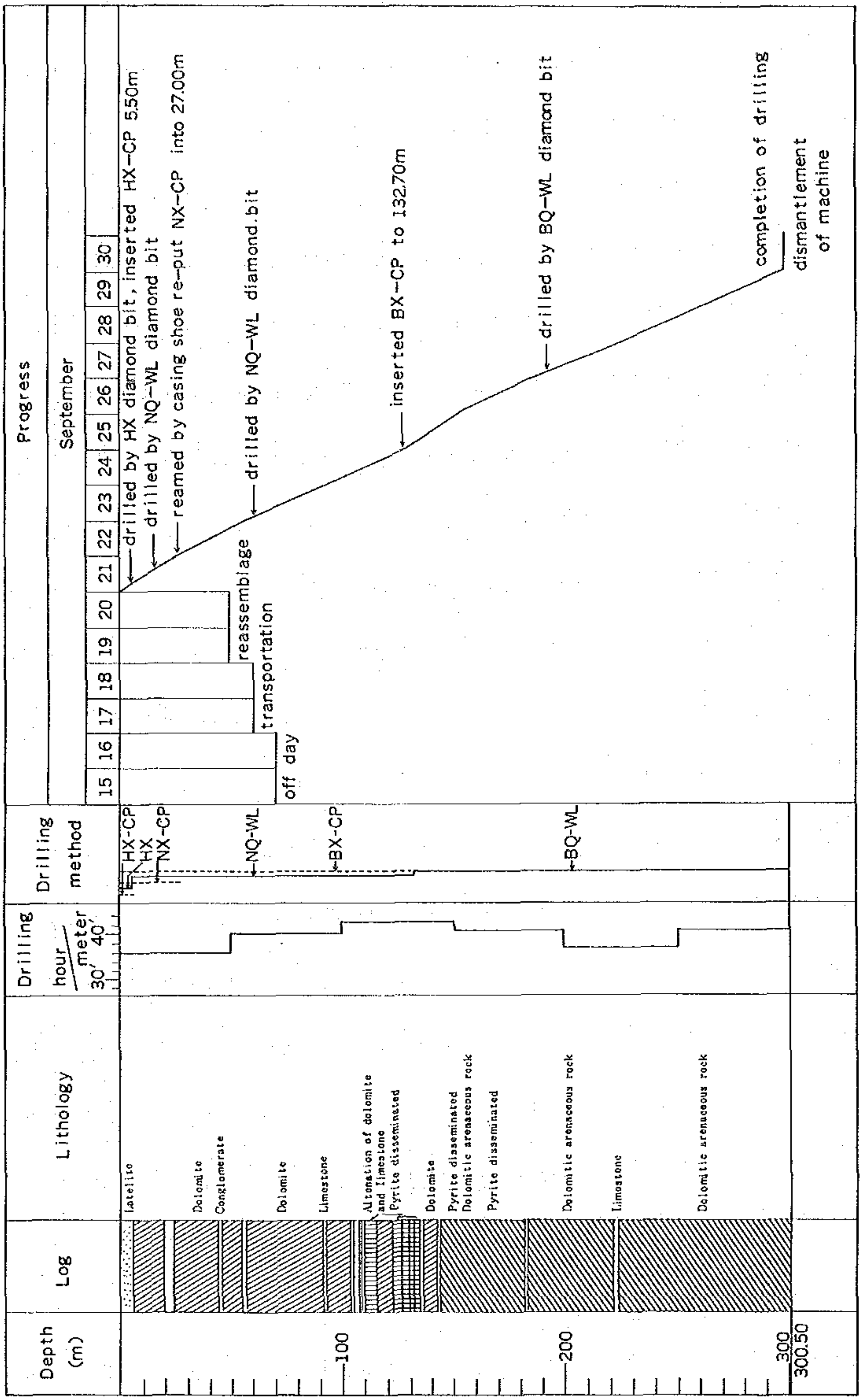


Fig. 20 Drilling Progress on MJZ-11

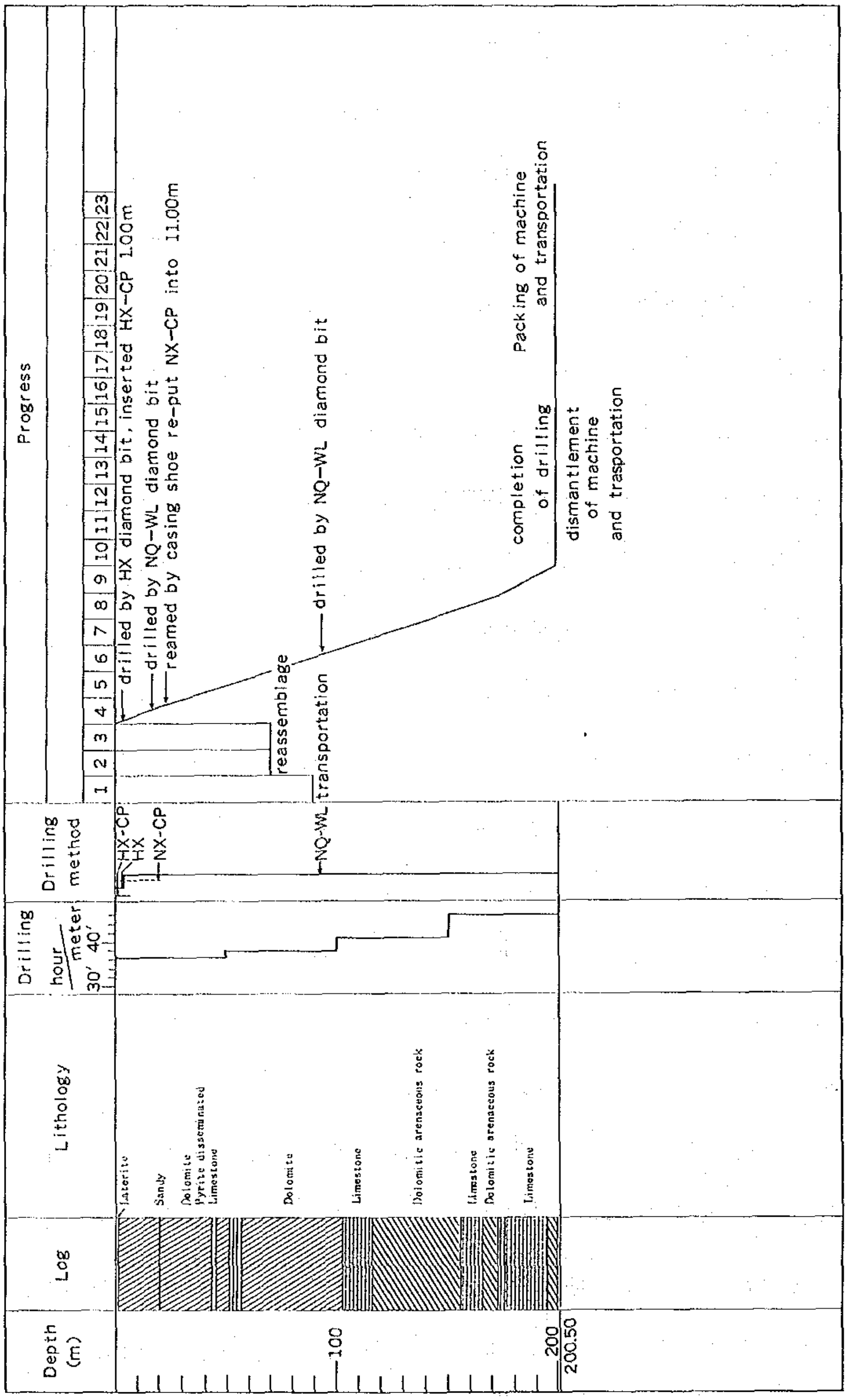
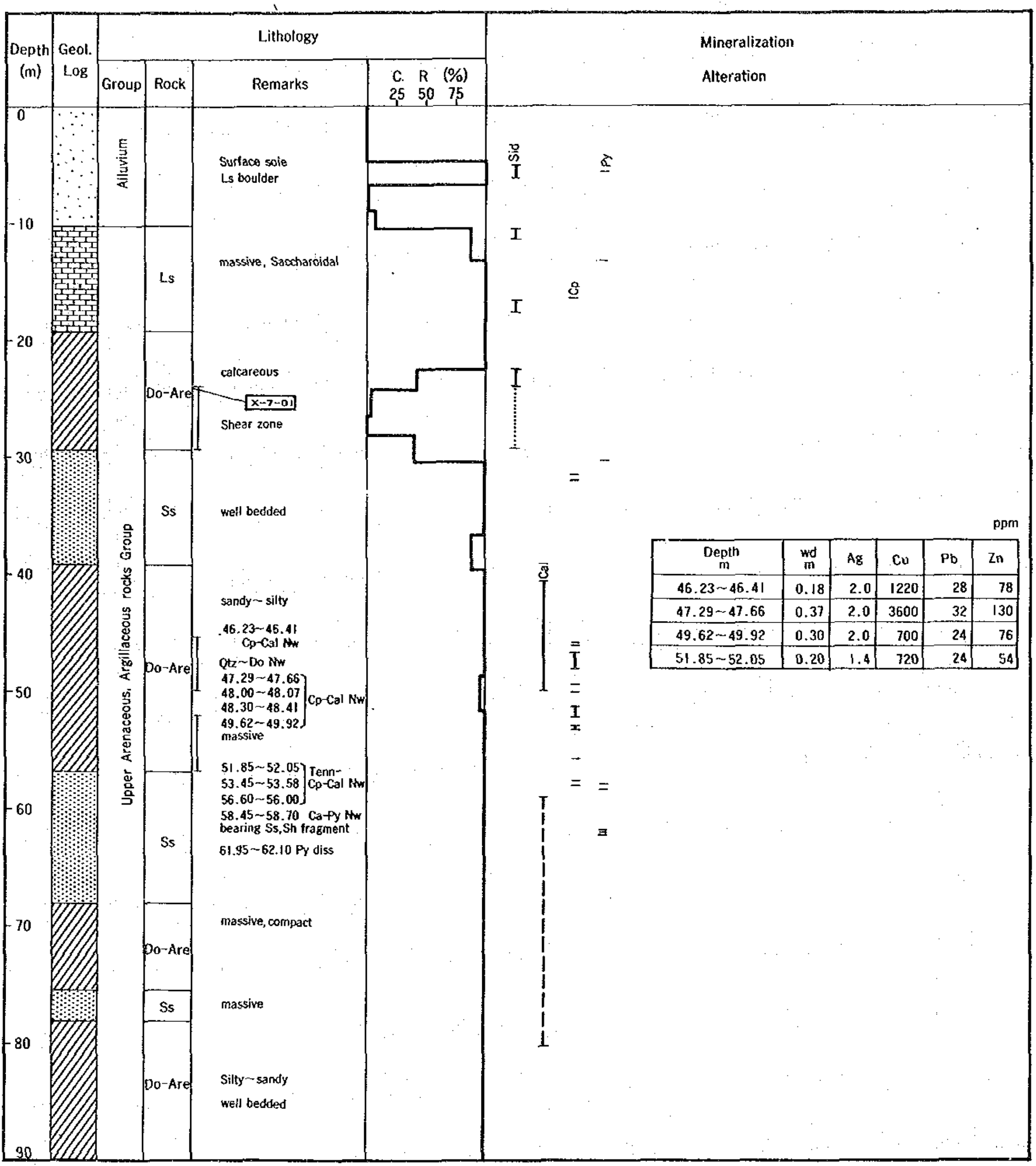


Fig. 21 Drilling Progress on MJZ-12

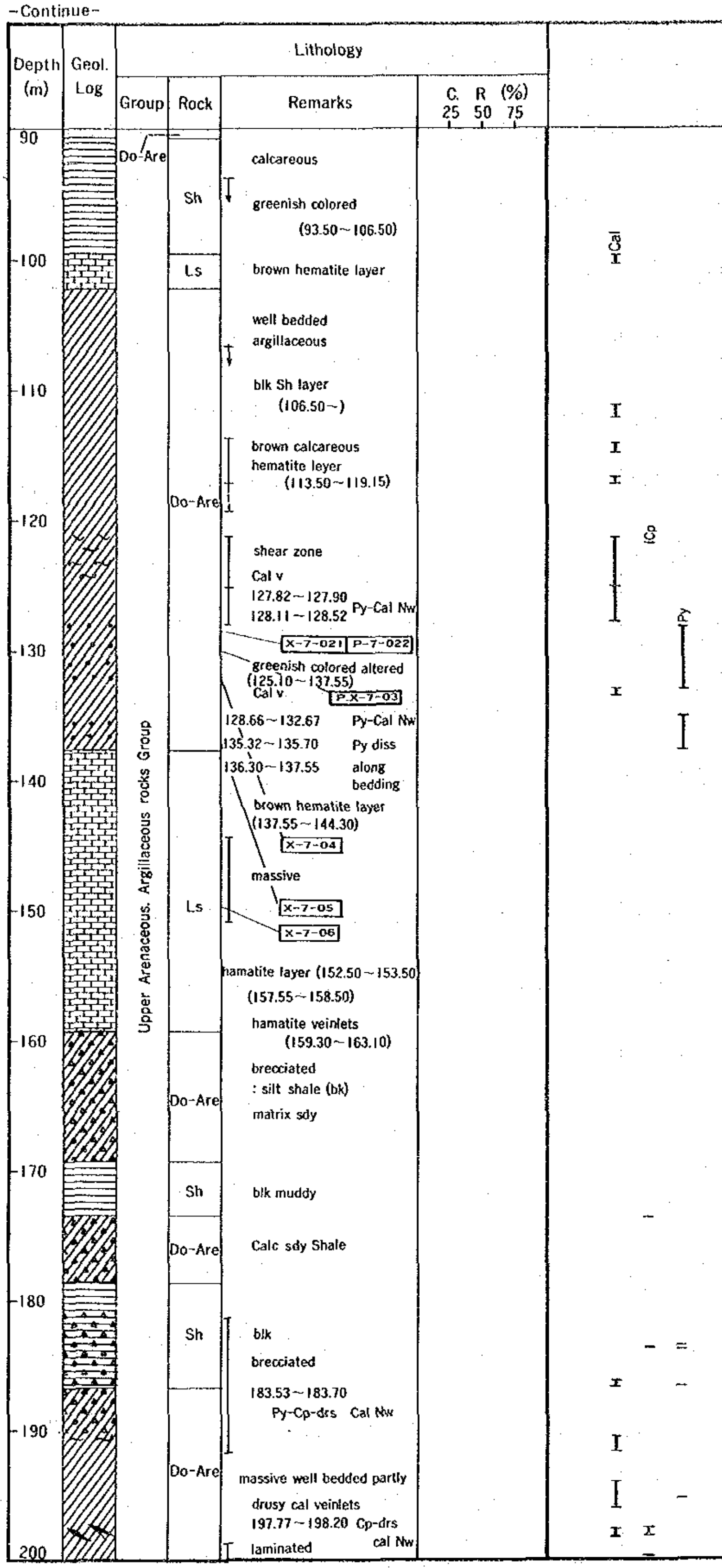
Drill Hole No.	MJZ-7	Inclination	−45°
Location	Sable Antelope	Bearing	36°
Elevation	Approx 1200m	Term	Aug. 1 ~ 11 '86
Depth	300.50m	Core Recovery	97.8%



Depth m	wd m	Ag	Cu	Pb	Zn
46.23~46.41	0.18	2.0	1220	28	78
47.29~47.66	0.37	2.0	3600	32	130
49.62~49.92	0.30	2.0	700	24	76
51.85~52.05	0.20	1.4	720	24	54

Fig. 22 Geological Log MJZ−7 (1)

-Continue-

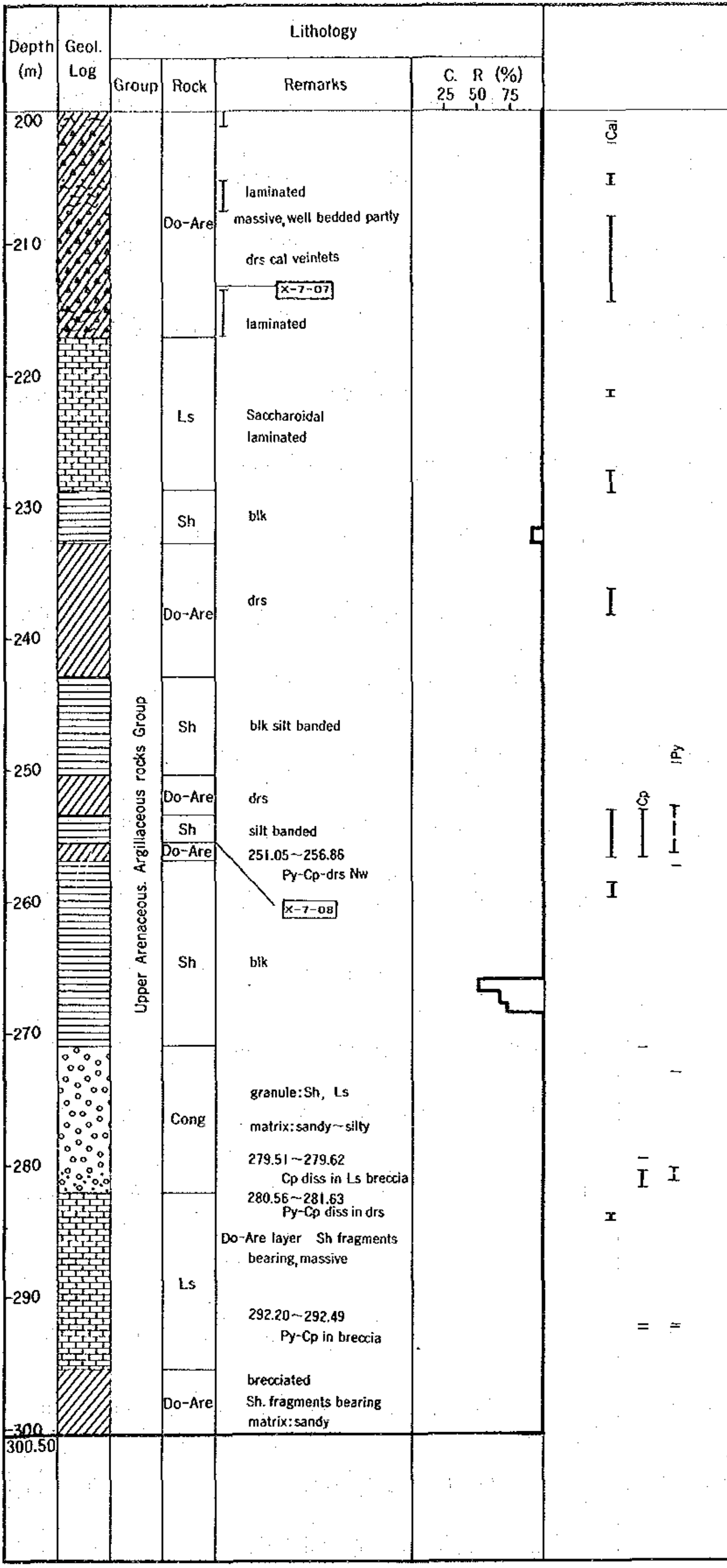


ppm

Depth m	wd m	Ag	Cu	Pb	Zn
128.11~128.52	0.41	0.1	98	24	36
128.66~129.00	0.34	0.4	136	24	78
129.00~129.60	0.60	0.6	580	28	118
129.60~130.30	0.70	<0.10	98	30	82
130.30~130.70	0.40	<0.10	76	28	70
130.70~132.67	1.97	<0.10	50	24	34
135.32~135.70	0.38	<0.10	70	20	66
136.30~136.50	0.20	0.4	84	28	34
136.50~137.55	1.05	0.4	76	32	54
197.77~198.20	0.43	1.0	180	32	118

M J Z − 7 (Ⅱ)

-Continue-

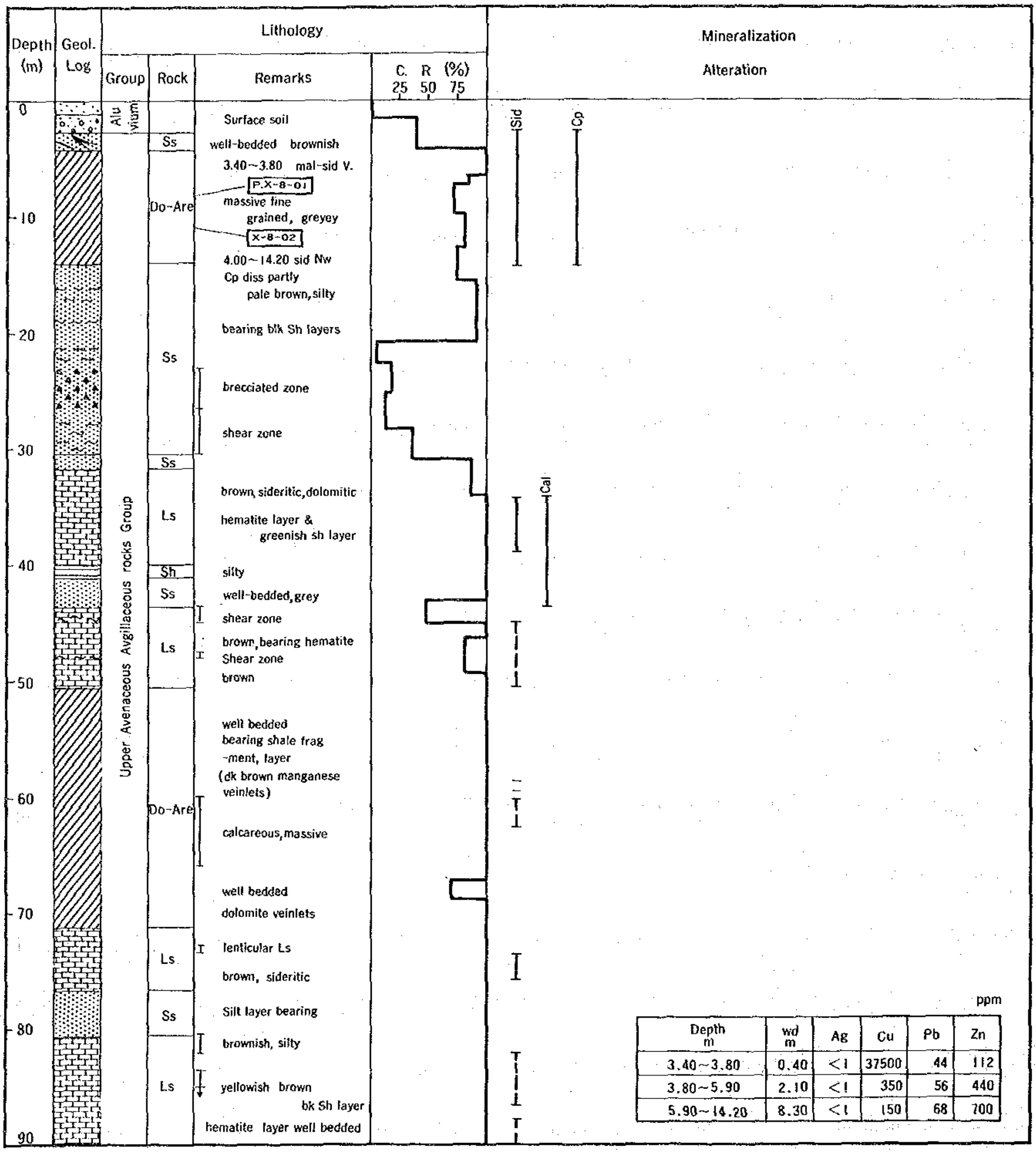


ppm

Depth m	wd m	Ag	Cu	Pb	Zn
256.50~256.86	0.36	1.0	1900	44	940
280.56~280.76	0.20	2.0	660	52	440
280.76~281.63	0.87	1.0	300	56	640
292.20~292.49	0.29	1.4	320	124	700

M J Z − 7 (Ⅲ)

Drill Hole No.	MJZ-8	Inclination	−45°
Location	Sable Antelope	Bearing	36°
Elevation	Approx 1200m	Term	July. 12~25 '86
Depth	300.50m	Core Recovery	94.4%

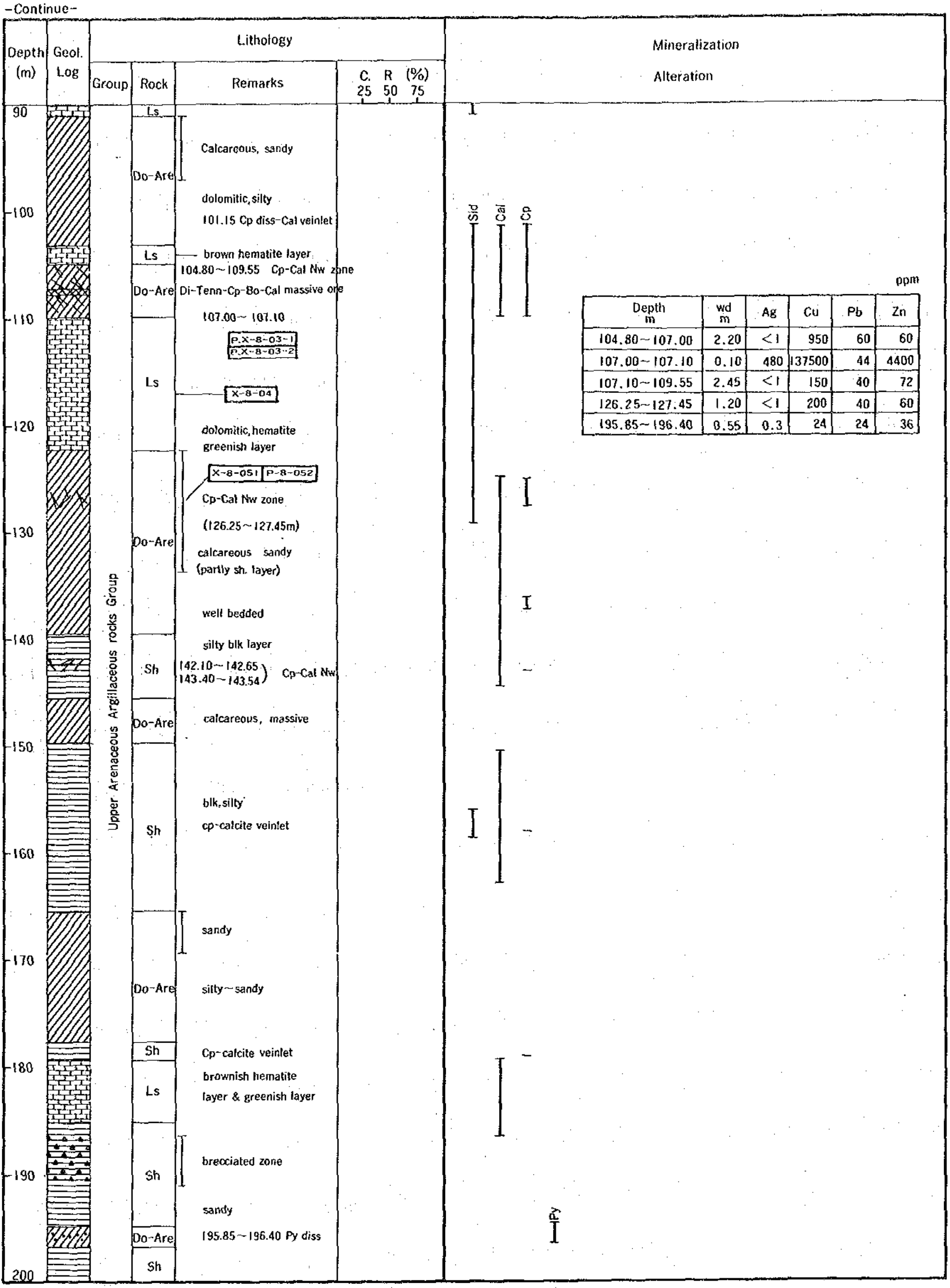


ppm

Depth m	wd m	Ag	Cu	Pb	Zn
3.40~3.80	0.40	<1	37500	44	112
3.80~5.90	2.10	<1	350	56	440
5.90~14.20	8.30	<1	150	68	700

Fig. 23 Geological Log MJZ−8(I)

-Continue-



ppm

Depth m	wd m	Ag	Cu	Pb	Zn
104.80~107.00	2.20	<1	950	60	60
107.00~107.10	0.10	480	137500	44	4400
107.10~109.55	2.45	<1	150	40	72
126.25~127.45	1.20	<1	200	40	60
195.85~196.40	0.55	0.3	24	24	36

MJZ-8 (II)

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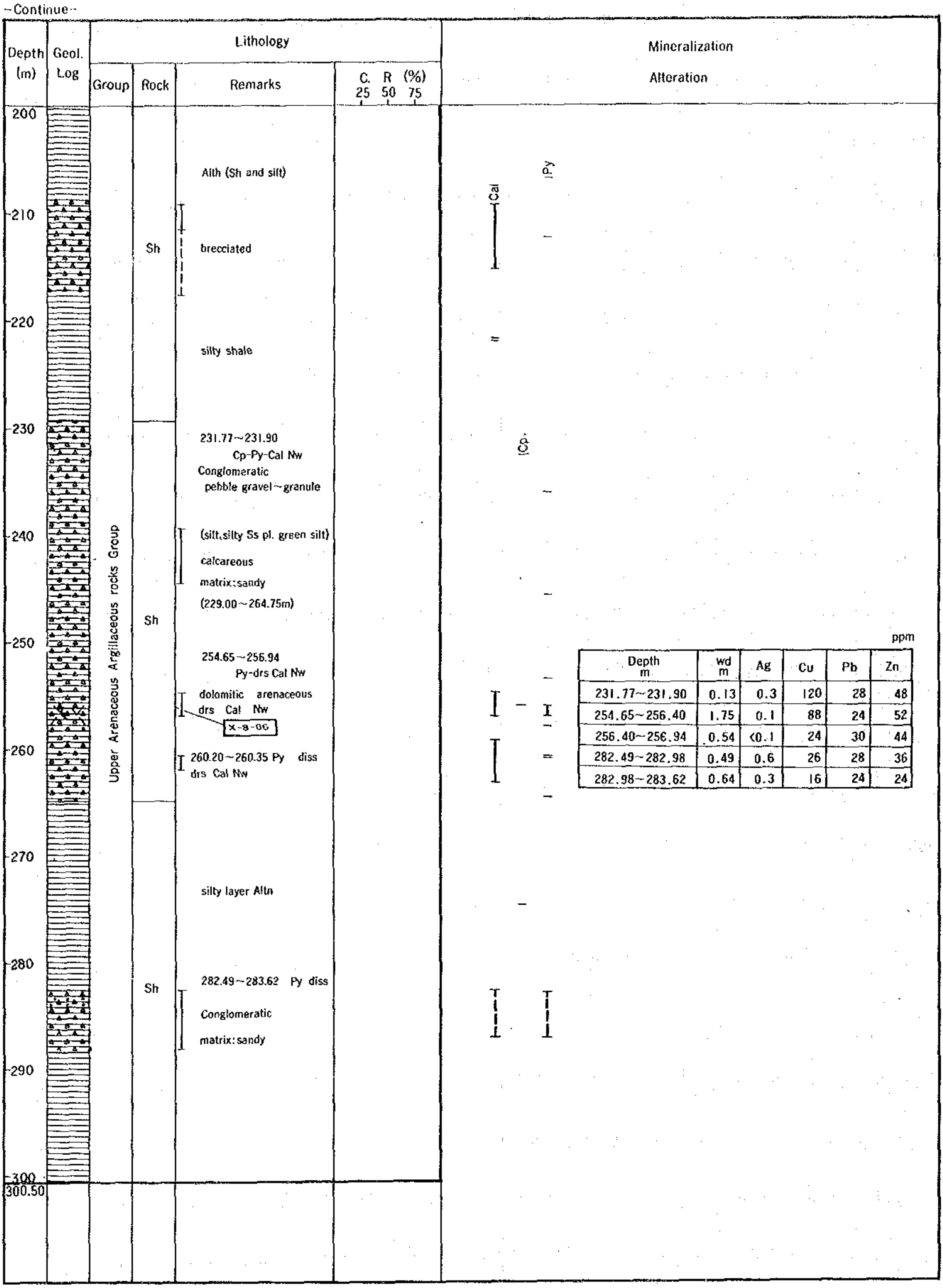


Alth (Sh and silt)

brecciated

silty shale

231.77~231.90
Cp-Py-Cal Nw
Conglomeratic
pebble gravel~granule

(silt,silty Ss pl. green silt)
calcareous
matrix:sandy
(229.00~264.75m)

254.65~256.94
Py-drs Cal Nw
dolomitic arenaceous
drs Cal Nw

260.20~260.35 Py diss
drs Cal Nw

silty layer Altn

282.49~283.62 Py diss
Conglomeratic
matrix:sandy

ppm

Depth m	wd m	Ag	Cu	Pb	Zn
231.77~231.90	0.13	0.3	120	28	48
254.65~256.40	1.75	0.1	88	24	52
256.40~256.94	0.54	<0.1	24	30	44
282.49~282.98	0.49	0.6	26	28	36
282.98~283.62	0.64	0.3	16	24	24

MJZ-8 (Ⅱ)

Drill Hole No.	MJZ-11	Inclination	−45°
Location	Sable Antelope	Bearing	20°
Elevation	Approx 1200m	Term	Sept. 21～29 '86
Depth	300.50m	Core Recovery	95.3%

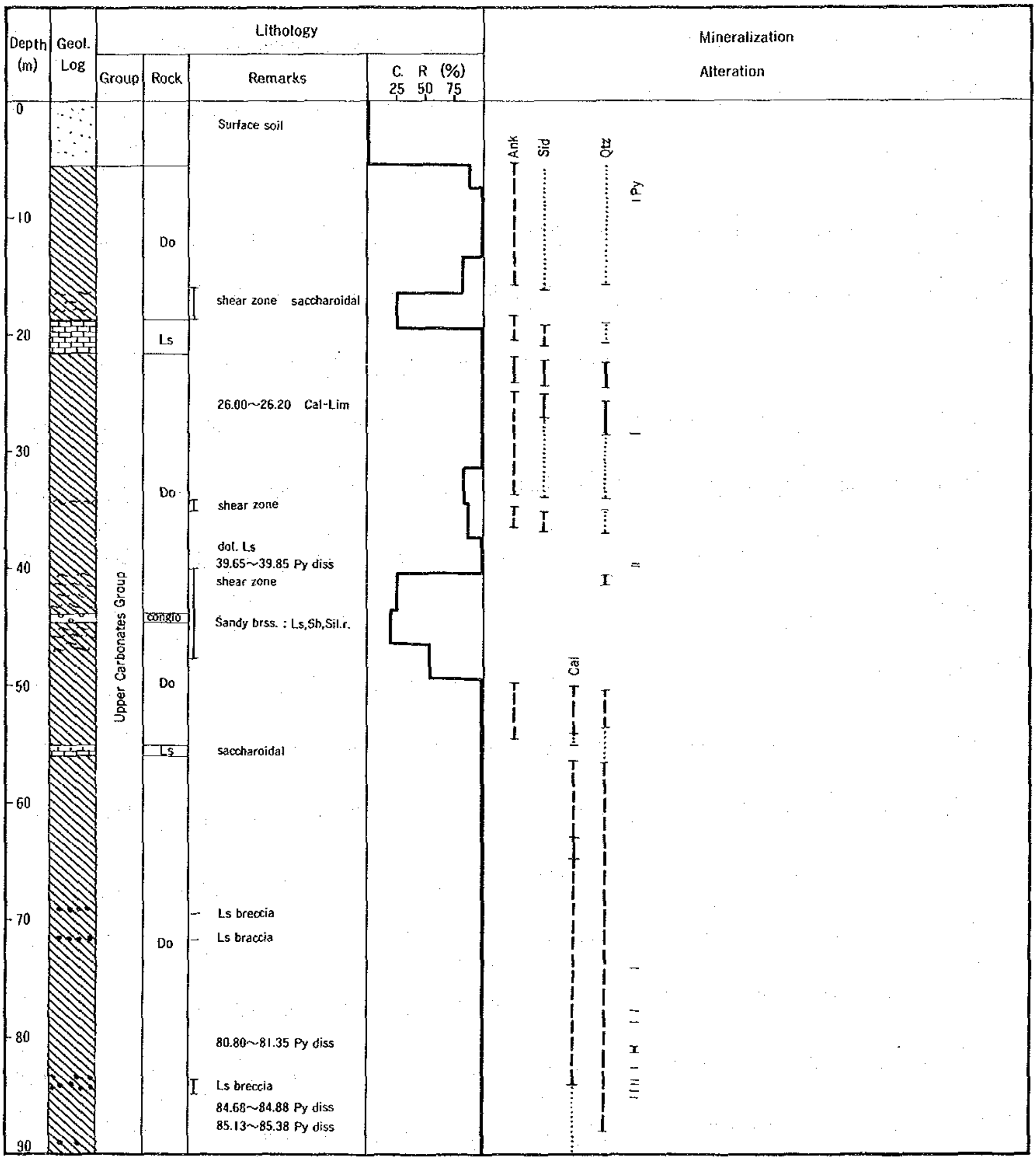
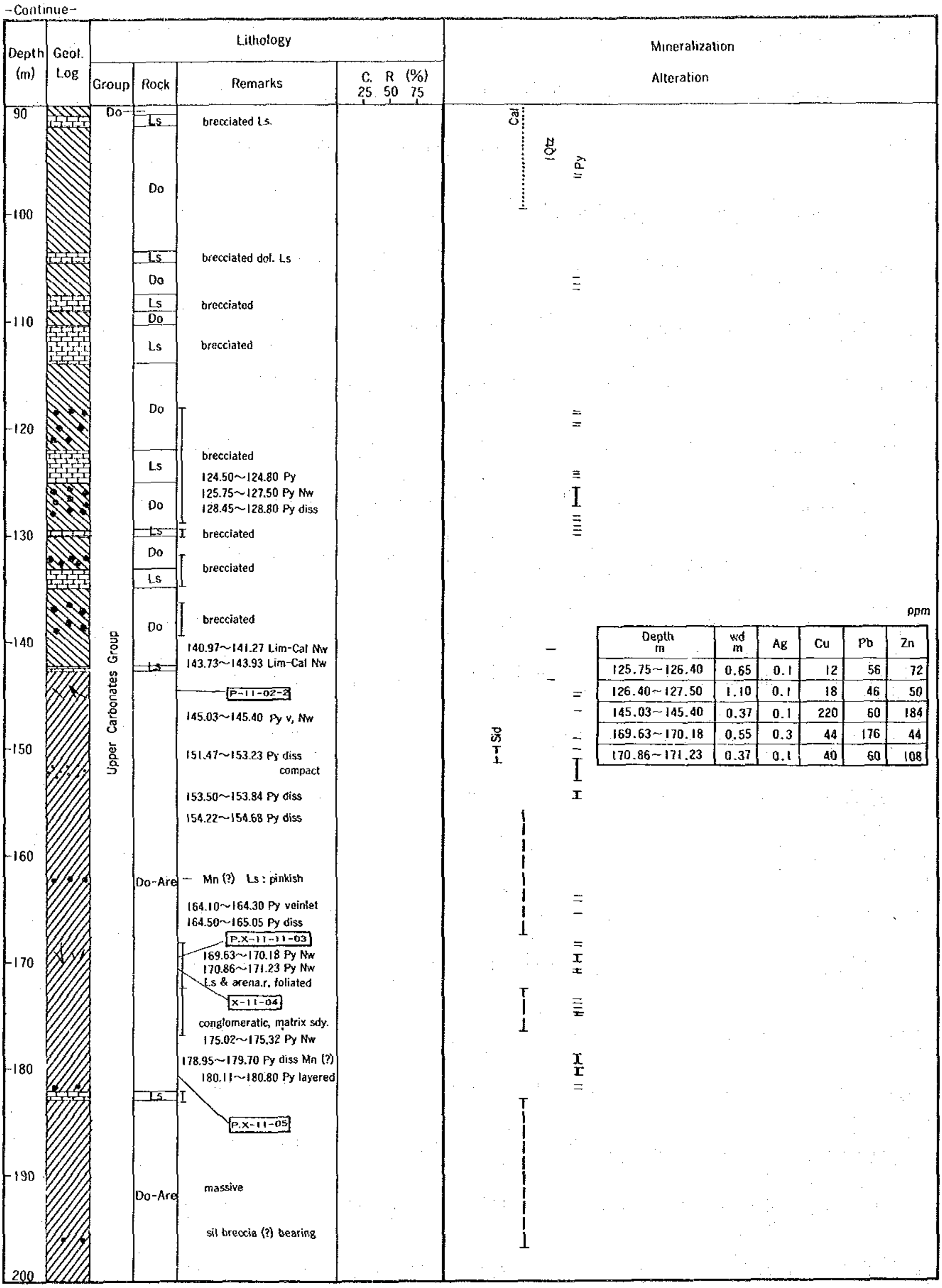


Fig. 24 Geological Log M J Z－11 (I)

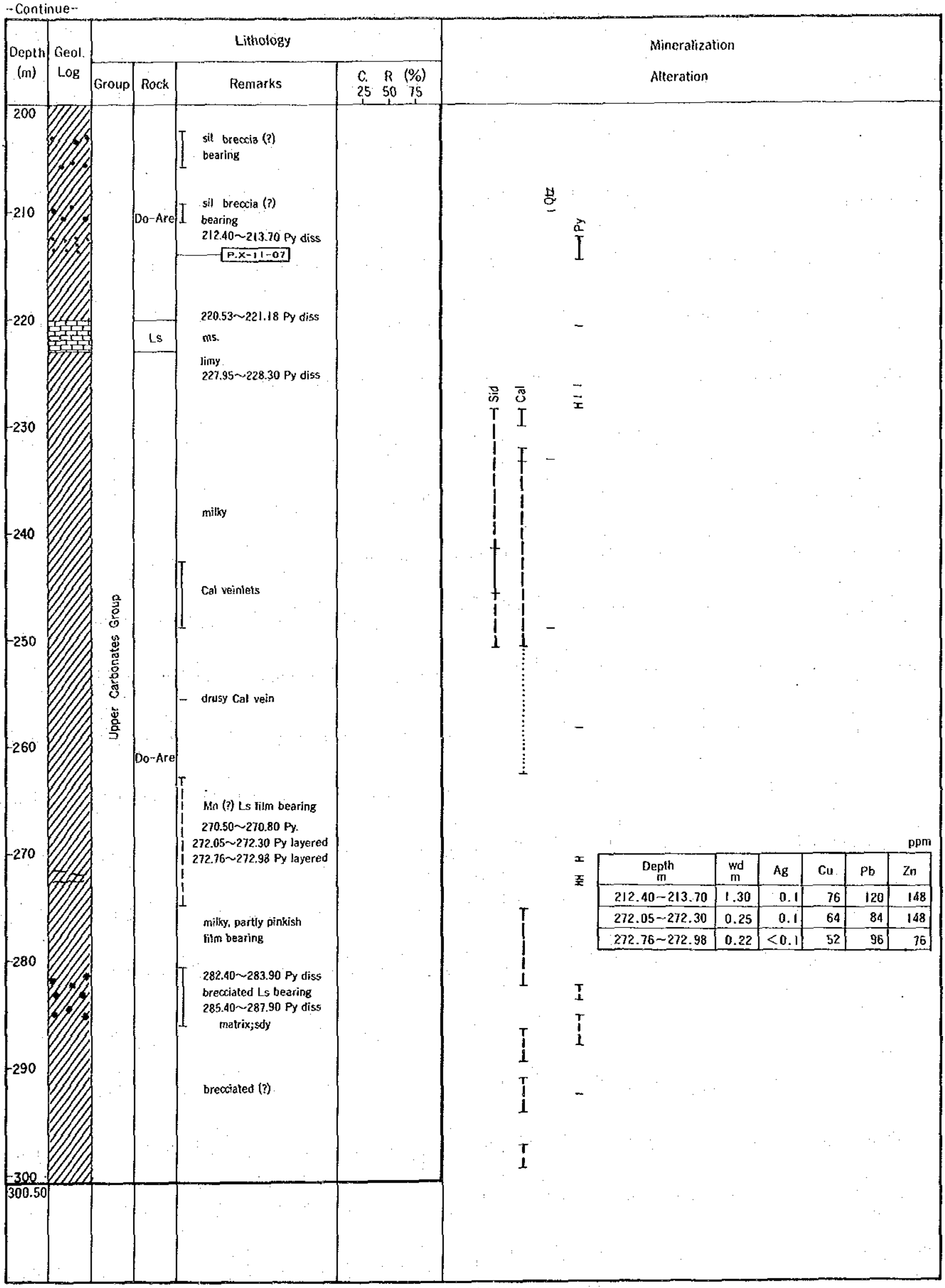
-Continue-



Depth m	wd m	Ag	Cu	Pb	Zn
125.75~126.40	0.65	0.1	12	56	72
126.40~127.50	1.10	0.1	18	46	50
145.03~145.40	0.37	0.1	220	60	184
169.63~170.18	0.55	0.3	44	176	44
170.86~171.23	0.37	0.1	40	60	108

M J Z－11 (Ⅱ)

-Continue-

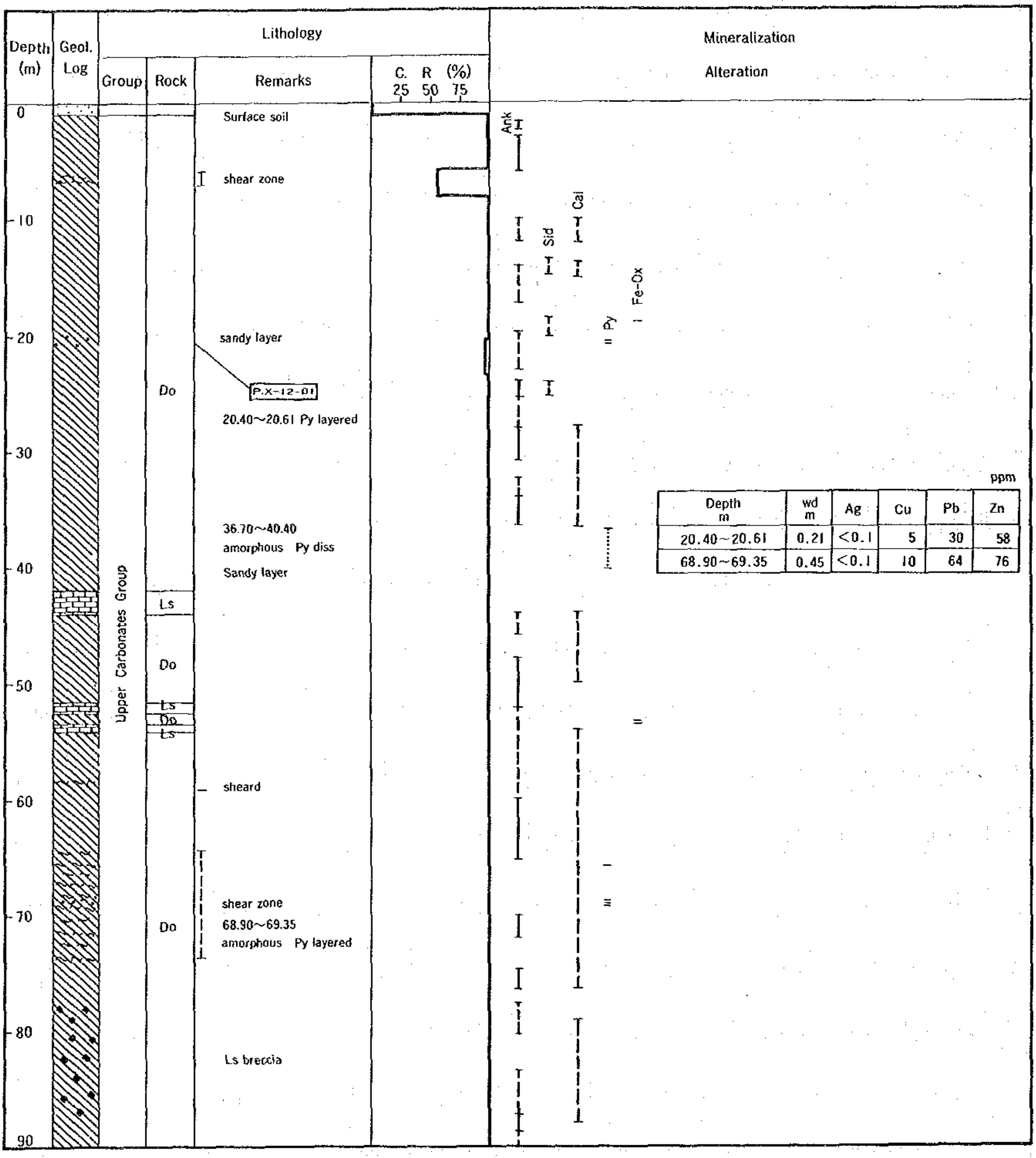


ppm

Depth m	wd m	Ag	Cu	Pb	Zn
212.40~213.70	1.30	0.1	76	120	148
272.05~272.30	0.25	0.1	64	84	148
272.76~272.98	0.22	<0.1	52	96	76

M J Z - 11 (Ⅲ)

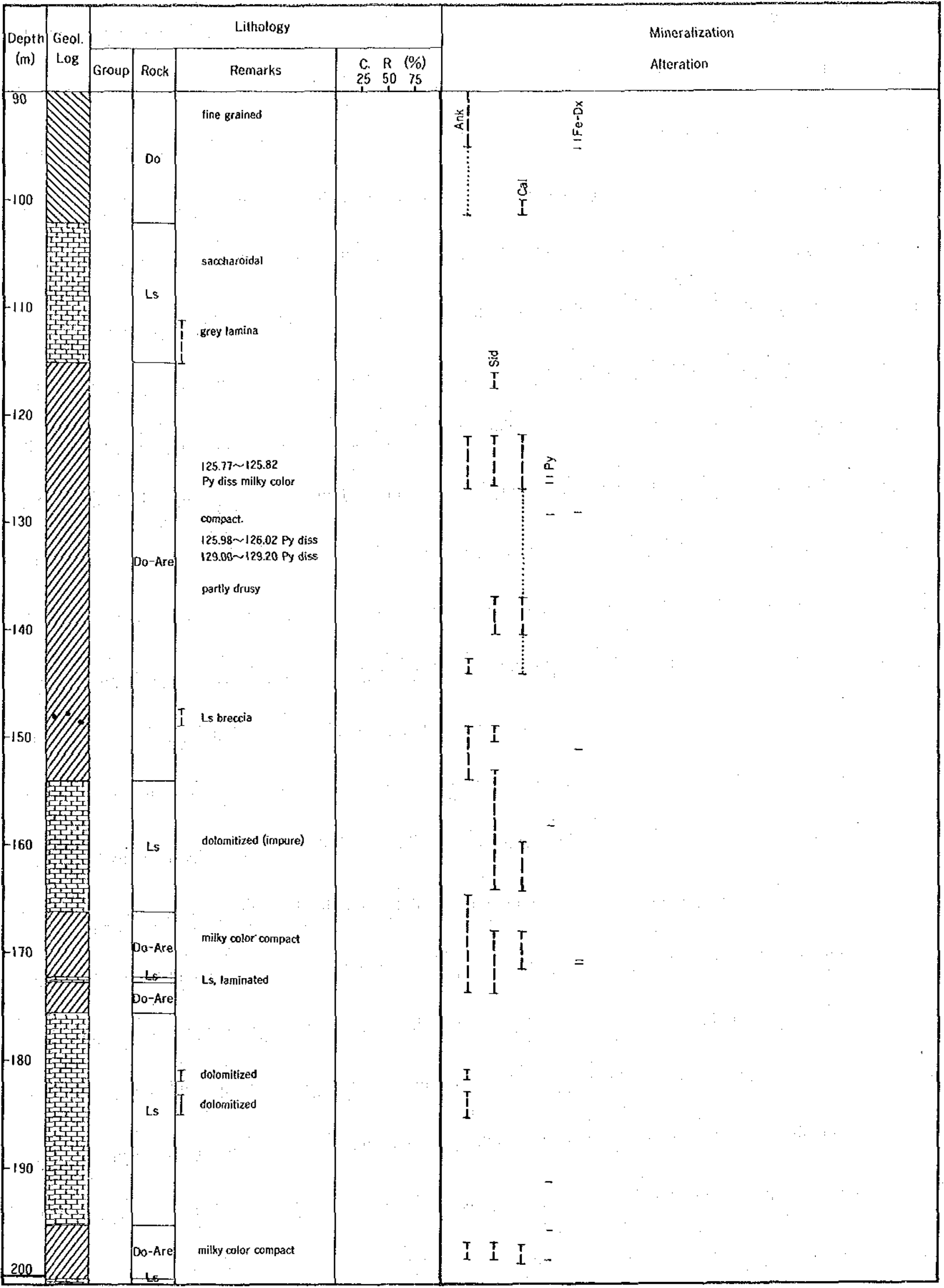
Drill Hole No.	MJZ-12	Inclination	90°
Location	Sable Antelope	Bearing	
Elevation	Approx 1200m	Term	Oct 4~9 '86
Depth	200.60 m	Core Recovery	99.4%



Depth m	wd m	Ag	Cu	Pb	Zn
20.40~20.61	0.21	<0.1	5	30	58
68.90~69.35	0.45	<0.1	10	64	76

Fig. 25 Geological Log MJZ-12(I)

-Continue-



M J Z − 12 (Ⅱ)

sandstone)

At depths of 46.23 - 46.41m (Cu 1220ppm), 47,29 - 47.66m (Cu 3600ppm), 48.00 - 48.41m, 49.62 - 52.05m, 53.45 - 58.50m, dolomite and calcite stockworks bearing mainly chalcopyrite. Tetrahedrite and rarely pyrites are found.

At a depth 127.82 - 137.55m, there is a strati-formed pyrites impregnation and calcite veinlets. It appears to be S 1 to 2%. At depths of 183.50 - 183.70m, 197.77 - 198.20m, and 251.05 - 256.96m, chalcopyrite partly associated with pyrite is recognized to disseminate in drusy calcite veinlets. At a depth of between 256.50 and 256.86m, Cu was 1900ppm and Zn was 940ppm.

At depths of 279.51 - 277.62m, 280.56 - 281.63m, and 292.20 - 292.49m (Cu 320ppm, Zn 700ppm, Pb 124ppm), there was a dissemination by chalcopyrite and pyrites.

Down to a depth of 30m, there are siderite veins and further down sideritic calcite veins or dolomitic calcite veins developing with the mineralization occur mainly in the arenaceous rock.

2-3-2 MJZ-8 Hole

Depth	0 - 2.70m	Laterite
"	2.70 - 122.00m	Mainly arenaceous rock (sandstone) with a number of layers of intercalated limestone
"	122.00 - 300.50m	Mainly black shale intercalating a thin layers of fine-grained arenaceous rock (sandstone) in the shallow part

At a depth of between 3.40 and 3.80m, azurite, malachite and siderite were observed indicating Cu 3.75%, Zn 112ppm and Pb 44ppm.

At a depth of between 3.80 and 14.20m, veins and veinlets of dolomitic calcite and siderite was found, slightly companied with chalcopyrite.

At a depth of between 104.80 - 109.55m, dolomite and calcite veinlets are developing, and they are disseminated slightly by mainly chalcopyrite. At a depth of between 107.00 and 107.10m, there is a massive sulphide ore composed of bornite and chalcopyrite shows latticed ex solution texture, as well as tennantite, digenite and pyrites indicating Cu 13.75%, Zn 4400ppm, Pb 44ppm and Ag 480g/t. There was Cu 950ppm at a depth of between 104.80 and 107.00m. Chalcopyrite bearing dolomite and calcite veinlets were also found at depths of between 126.25 and 127.45m, and between 142.10 and 142.65m.

At a depth of 185.00m and deeper, fine flake like laminated pyrites were often observed along the schistose black shale. At depths of between 231.77 and 231.90m, and between 254.65 and 264.75m, chalcopyrite bearing calcite veinlets were found, indicating a maximum of Cu 120ppm. At a depth of between 282.49 and 286.90m, siderite and calcite veinlets were observed.

2-3-3 MJZ-11 Hole

Depth	0 - 1.50m	Laterite

"	1.50 - 142.70m	Mainly medium-grained dolomite with intercalated thin layers of limestone and brecciated and sheared zones
"	142.70 - 300.50m	Mainly dolomitic arenaceous rock (fine-grained sandstone)

Powderly or laminated pyrites were observed mainly in the brecciated zones at depths of 124.50 - 128.80m, 140.97 - 145.40m, 151.47 - 153.84m, 164.10 - 180.80m, 212.40 - 213.70m, and 270.50 - 272.98m, and they are estimated to be 2 - 3% S.

(Cu 220ppm, Pb 60ppm and Zn 184ppm were observed at a depth of between 145.03 and 145.40m), and Cu 44ppm, Pb 176ppm and Zn 44ppm at a depth of between 169.63 and 170.18m.

In the shallow part, there was a tendency for ankerite (about 50m and shallower) and siderite (about 90m and shallower) to develop.

2-3-4 MJZ-12 Hole

Depth	0 - 1.00m	Laterite
"	1.00 - 102.05m	Mainly medium-to-fine-grained dolomite with intercalated arenaceous rock (sandstone), and limestone
"	102.05 - 200.60m	Partly-striped massive limestone and arenaceous rock (fine-grained sandstone)

Stratiformed pyrites are observed at depths of 36.70 - 40.40m, and 68.90 - 69.35m (Pb 64ppm, Zn 76ppm). Specularite veinlets are observed, apart from pyrite zone.

Ankerite is developing to a depth of 95m from the surface.

CHAPTER 2 KAMIYOBO AREA

1. Geophysical survey

1-1 Purpose and area of the survey

Two anomalous zones have been delineated in Kamiyobo area by geological survey and geochemical prospecting of Cu, Pb and Zn in the second year. The anomaly at the southwest was judged promising, being composed of many anomalies high in Cu, Pb and Zn values.

The SIP method was conducted in this year to delineate a depth and inclination of ore deposits which might be intersected by drilling.

Three lines M, N and O of one kilometre each were laid down to traverse an area of about 0.3 square kilometres as illustrated in Fig.26.

1-2 Survey and analysis

The geochemical anomaly being as a target of the SIP survey in this year is a highly anomalous zone in Cu, Pb and Zn extending more than one kilometre and its centre being more than the value of the mean plus a triple of standard deviation is of some 300m in length. No outcrop has been observed on the surface, but due to an existence of magnetite around the anomaly, it was assumed that an effect of weathering would be rather small and a primary sulphide deposit might occur.

1-2-1 Sections of PFE and AR (Fig. 27)

Anomalous zones of 3 to 4%PFE were broadly detected in central parts of lines M, N and O. These zones have similar contour patterns of PFE and depths of top are considered to be about 150m. The AR of the anomaly ranges from 300 to 500 ohm-m but the AR in the east of each line exceeds 1,000 ohm-m and it becomes less than 300 ohm-m in the west. The anomaly is located in a middle of these ends.

1-2-2 Plans of PFE and AR (Fig. 28)

The anomaly was located in the central part of each line with a N-S elongation. A zone of more than 4%PFE at N=3 roughly coincides with the centre of the geochemical anomaly.

The AR in the zone of PFE anomaly ranges from 300 to 500 ohm-m and becomes more than 1000 ohm-m in the east or less than 300 ohm-m in the west where no PFE anomaly has been detected, reflecting strongly a difference of geology.

1-2-3 Phase section (Figs. 29 to 31)

Anomalous zones of phase ranging from -20 to -30 mrad were delineated in each of lines on the area of 3 to 4% PFE. One the line M, areas of -20 mrad appear both in a field of phase decrease to the west of No.4 and in a field of phase increase at a change from 0.125 to 0.375 Hz. On the line O, an area of -20 mrad is situated in the field of phase decrease. From a reference to rock properties in the laboratory, anomalies in black shales on line M can be distinguished in a zone of pyrite dissemination and in a zone without mineralization. The anomaly of line O is deemed to indicate a zone of pyrite dissemination.

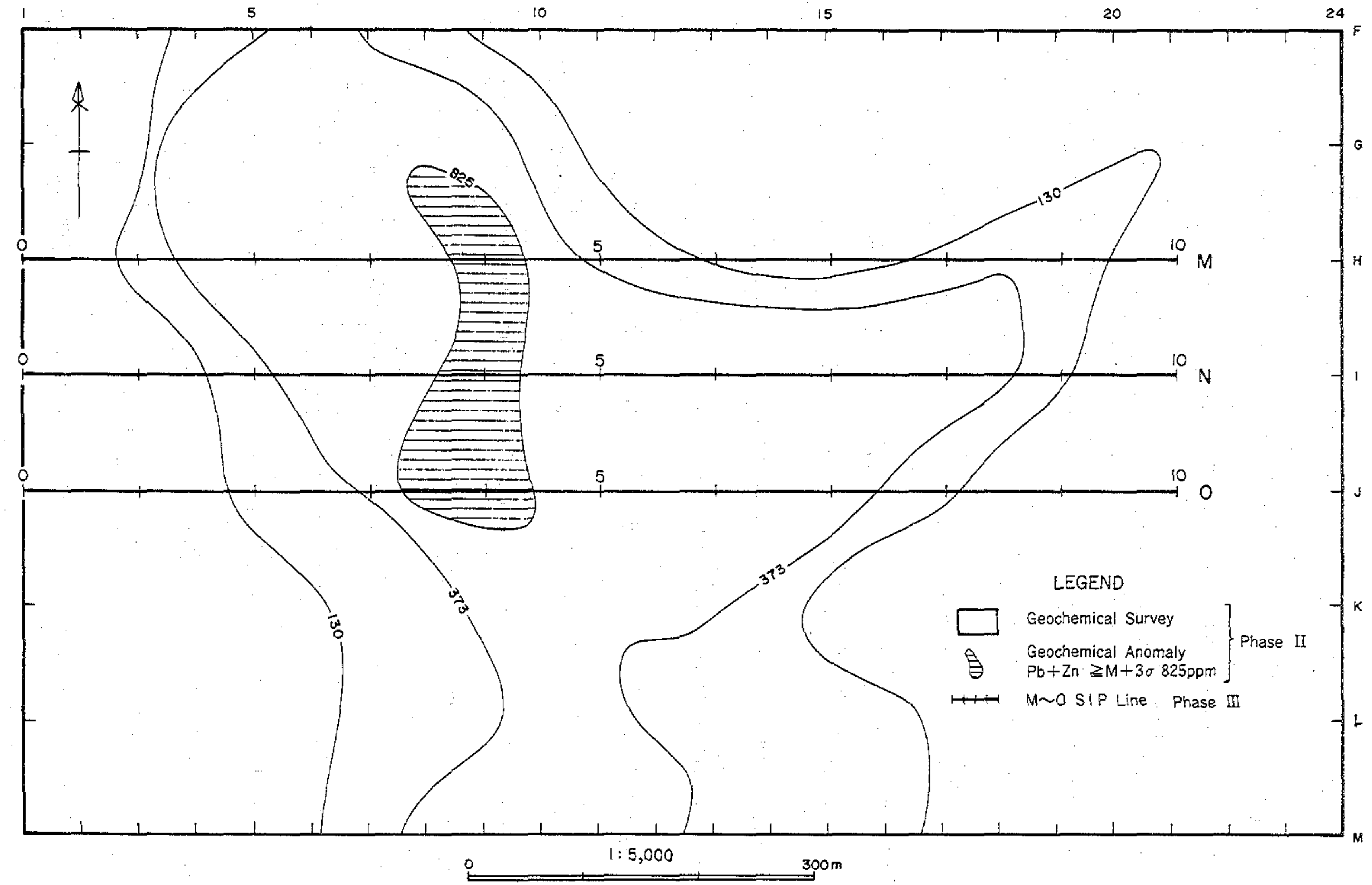


Fig. 26 Location Map of S I P Survey Line in Kamiyobo Area

1-2-4 Diagrams of various spectra (Figs. 32 to 34)

These diagrams of spectra give characteristics over the whole range of frequency from 0.125 to 88 Hz. Almost data show a tendency to increase phases in accordance with an increase of frequency in the field of high frequency. The phases in the field of low frequency are of great interest as pointed out in the previous section.

All magnitude spectra have a tendency to decrease in accordance with an increase of frequency without giving a specific useful information.

1-2-5 Decoupling (Figs. 29 to 35)

As indicated in the case of Sable Antelope, a part of information of IP response in the range of low frequency seems to have been lost after a correction of electromagnetic coupling in the range of high frequency.

The most useful information seems to be provided by raw data of phase spectra in the range of low frequency.

1-2-6 Simulation (Fig. 36)

Lines of M, N and O give similar patterns of PFE contours. The simulation was conducted on line O which showed the broadest anomaly. An existence of mineralized zone is expected in a central part of the line, dipping to the east.

2. Drilling Survey

2-1 Outline of the Drilling Survey

2-1-1 Location of the drill holes and the condition of drilling

The drilling of 2 holes in this area was conducted in the geochemical and geophysical anomaly zone of the southwestern area.

The locations and geological section of the drill holes are shown in Figs.37 & 38 and the condition of drilling in Table 10.

Table 10 The List of the Drillings (Kamiyobo Area)

Drill Hole No.	Depth (m)	Inclination	Bearing	Depth of Laterite (m)	Length of Core (m)	Core recovery (%)	Term		Exploration Target
							Starting	Completion	
JMZ-9	300.5	-45°	90°	6.0	285.2	96.8	23 Aug.	31 Aug.	IP anomaly zone and geochemical anomaly zone
MJZ-10	300.5	-45°	270°	19.0	269.8	95.8	4 Sep.	13 Sep.	Ditto

$$\text{Core Recovery} = \frac{\text{Length of Core}}{\text{Depth} - \text{Depth of Laterite}} \times 100$$

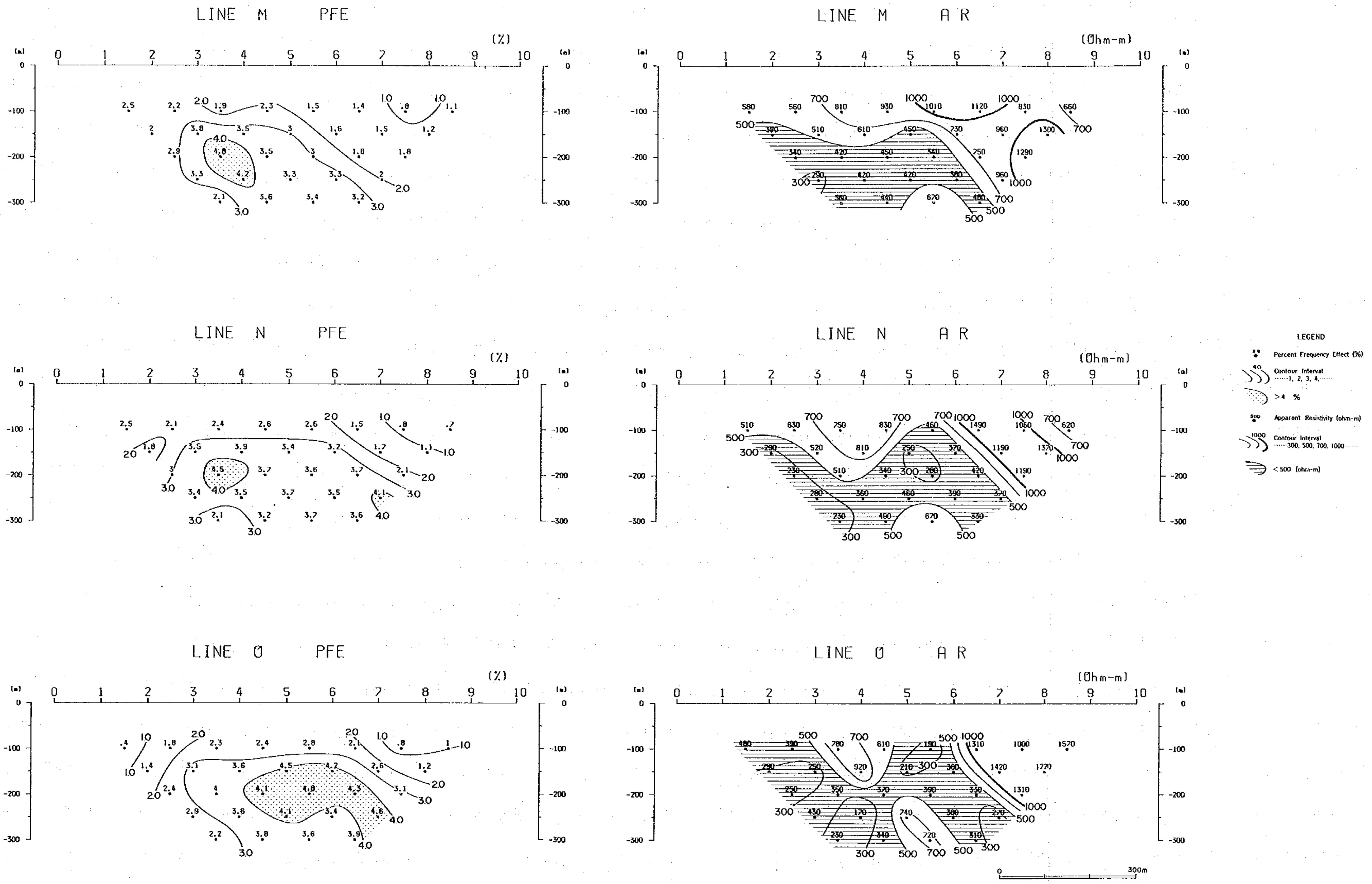


Fig. 27 Pseudo—Secition of PFE & AR (Line M, N, O)

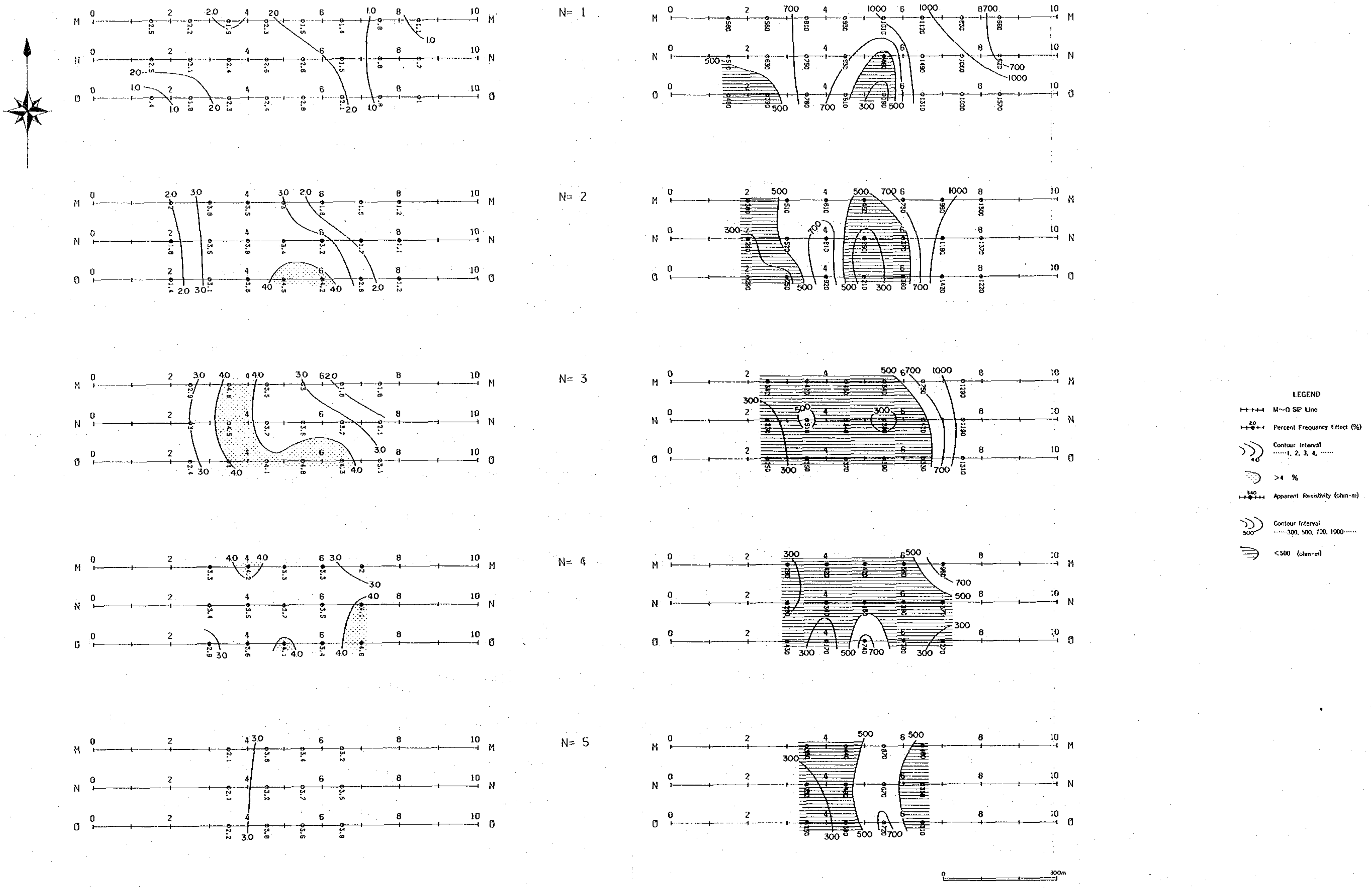


Fig. 28 Plan Map of PFE〔0.125-1.0Hz〕& AR〔0.125Hz〕(n=1~5)

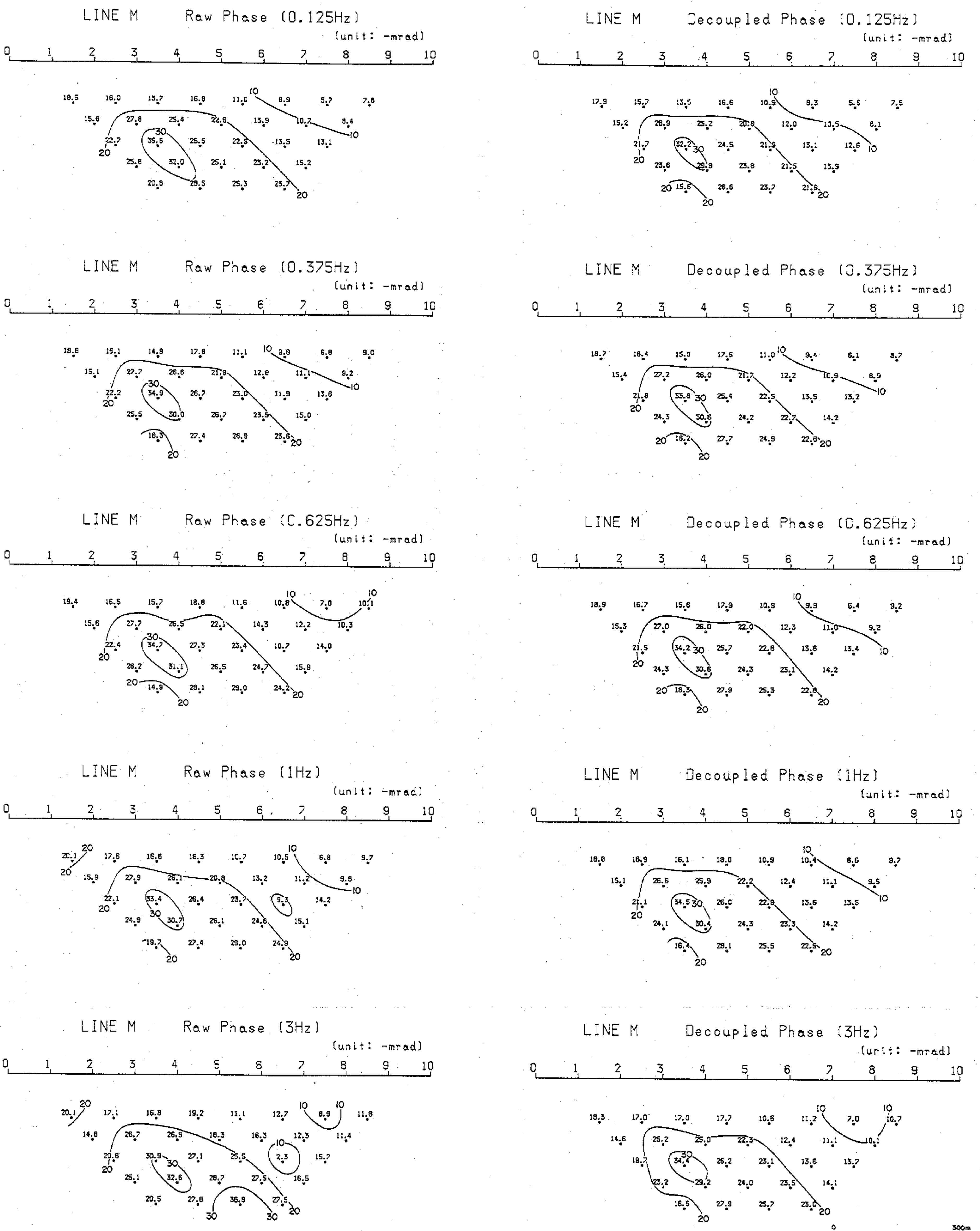


Fig. 29 Phase at Five Freguencnes Line M

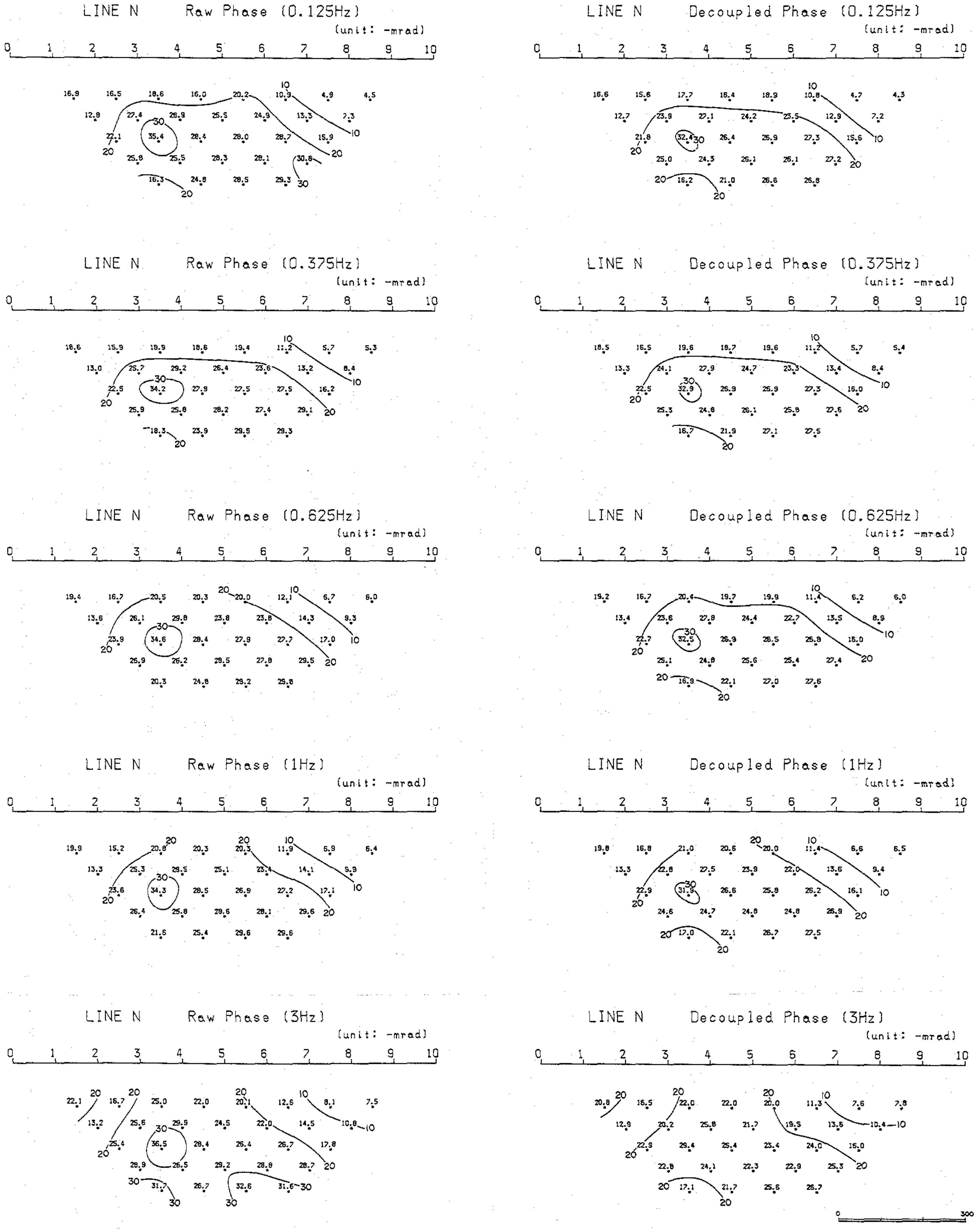


Fig. 30 Phase at Five Frequencies Line N

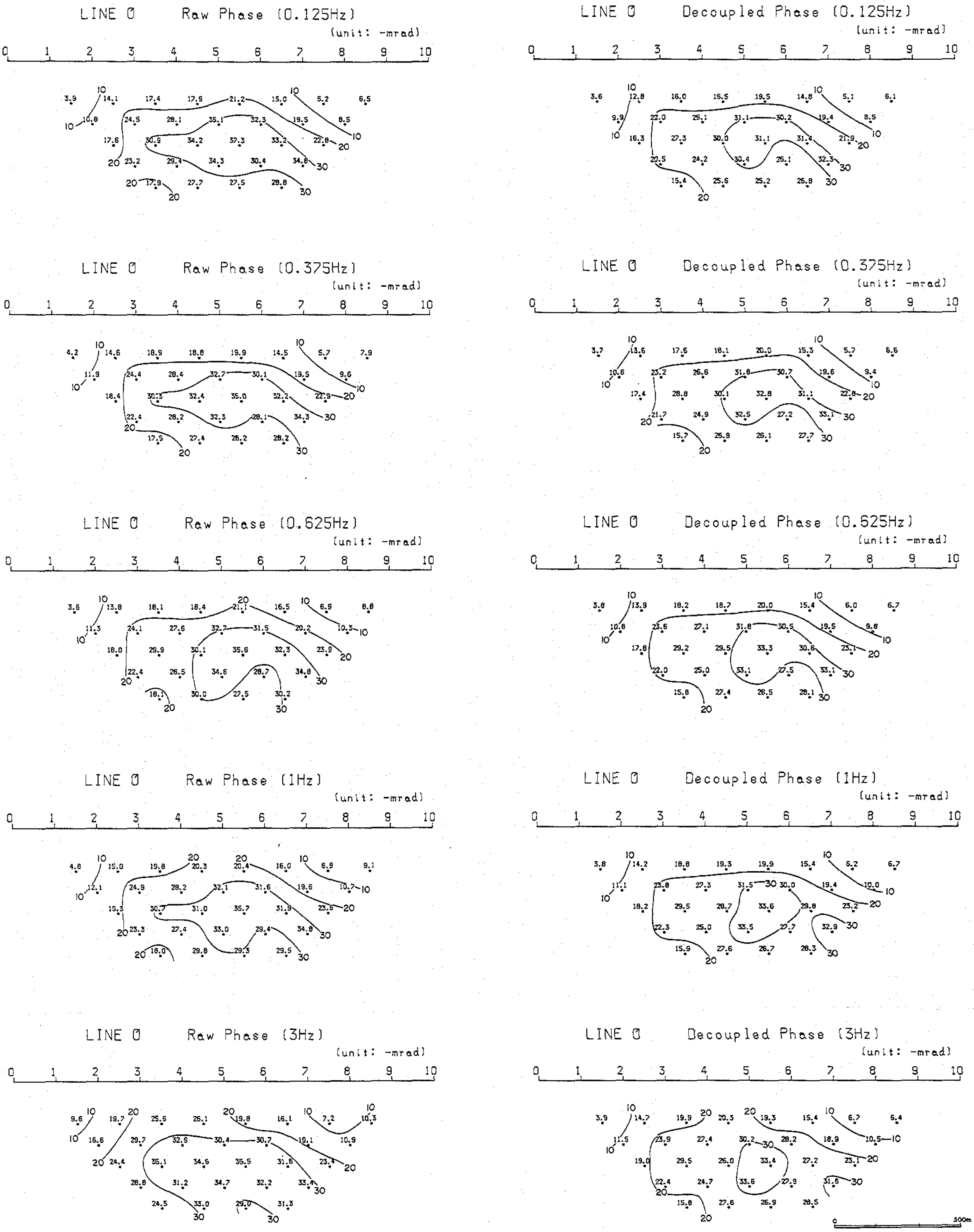


Fig. 31 Phase at Five Frequeucies Line O

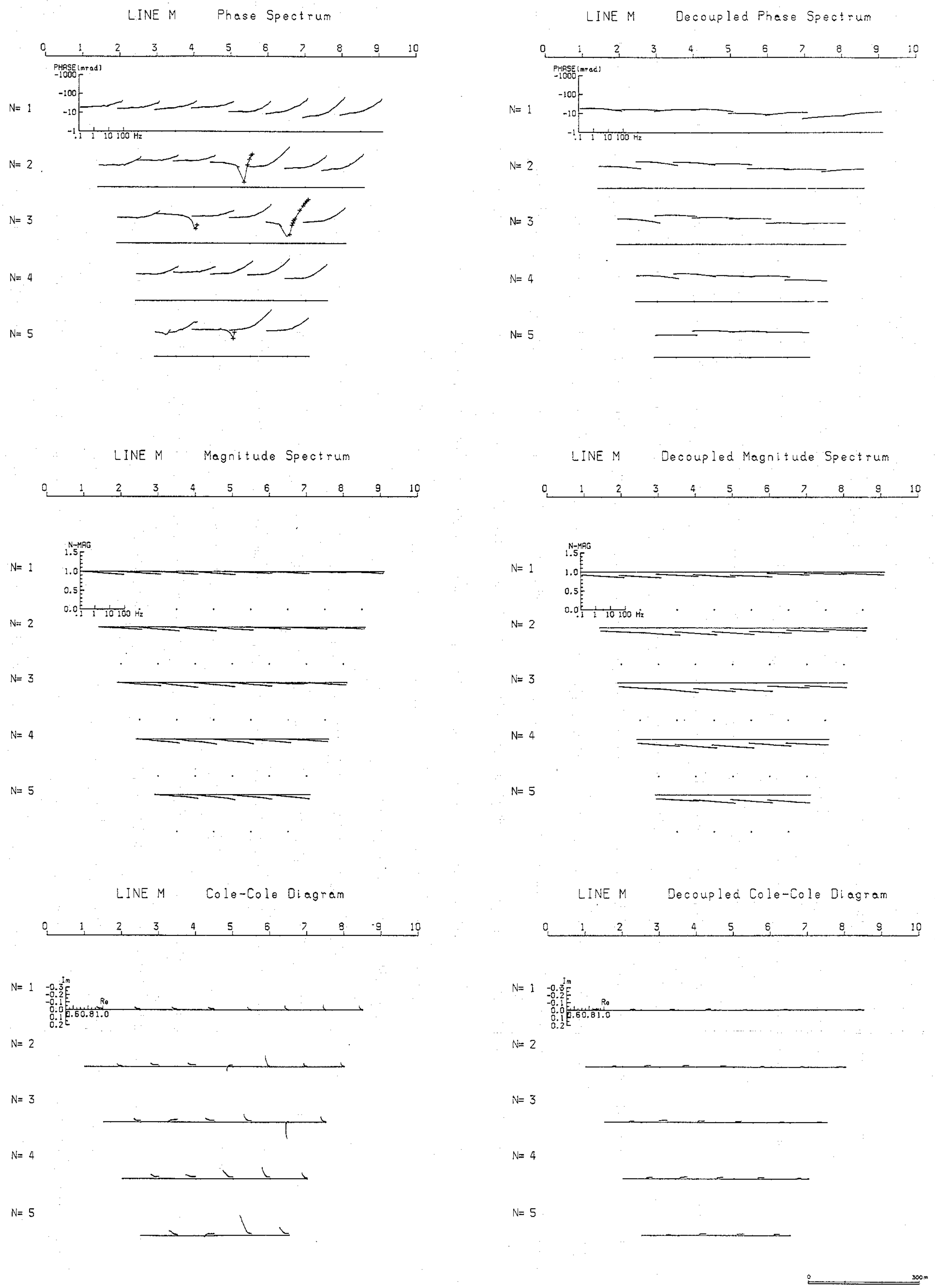


Fig. 32 Phase,Magnitude & Cole.Cole Spectrum Line M

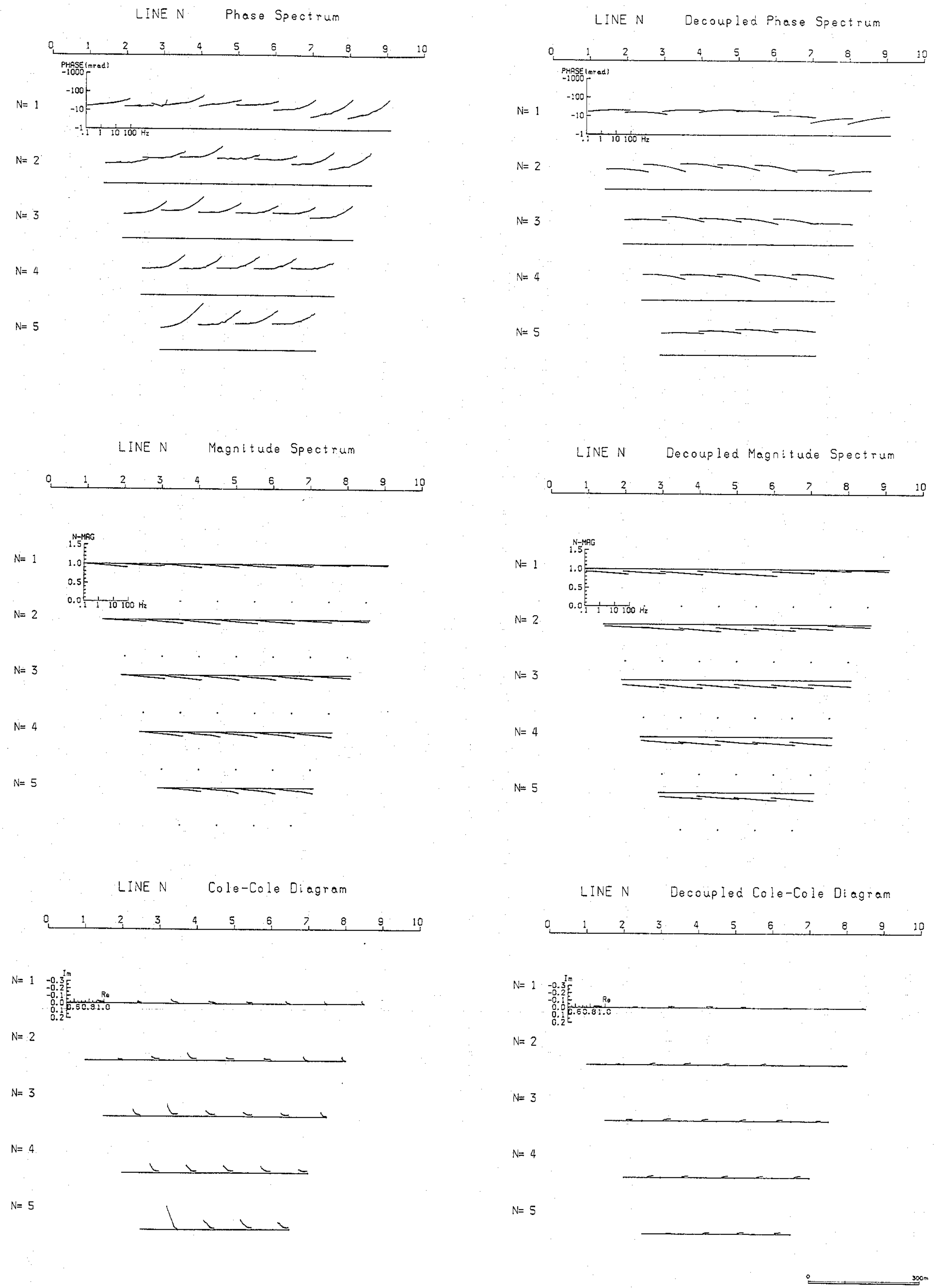


Fig. 33 Phase,Magnitude & Cole.Cole Spectrum Line N

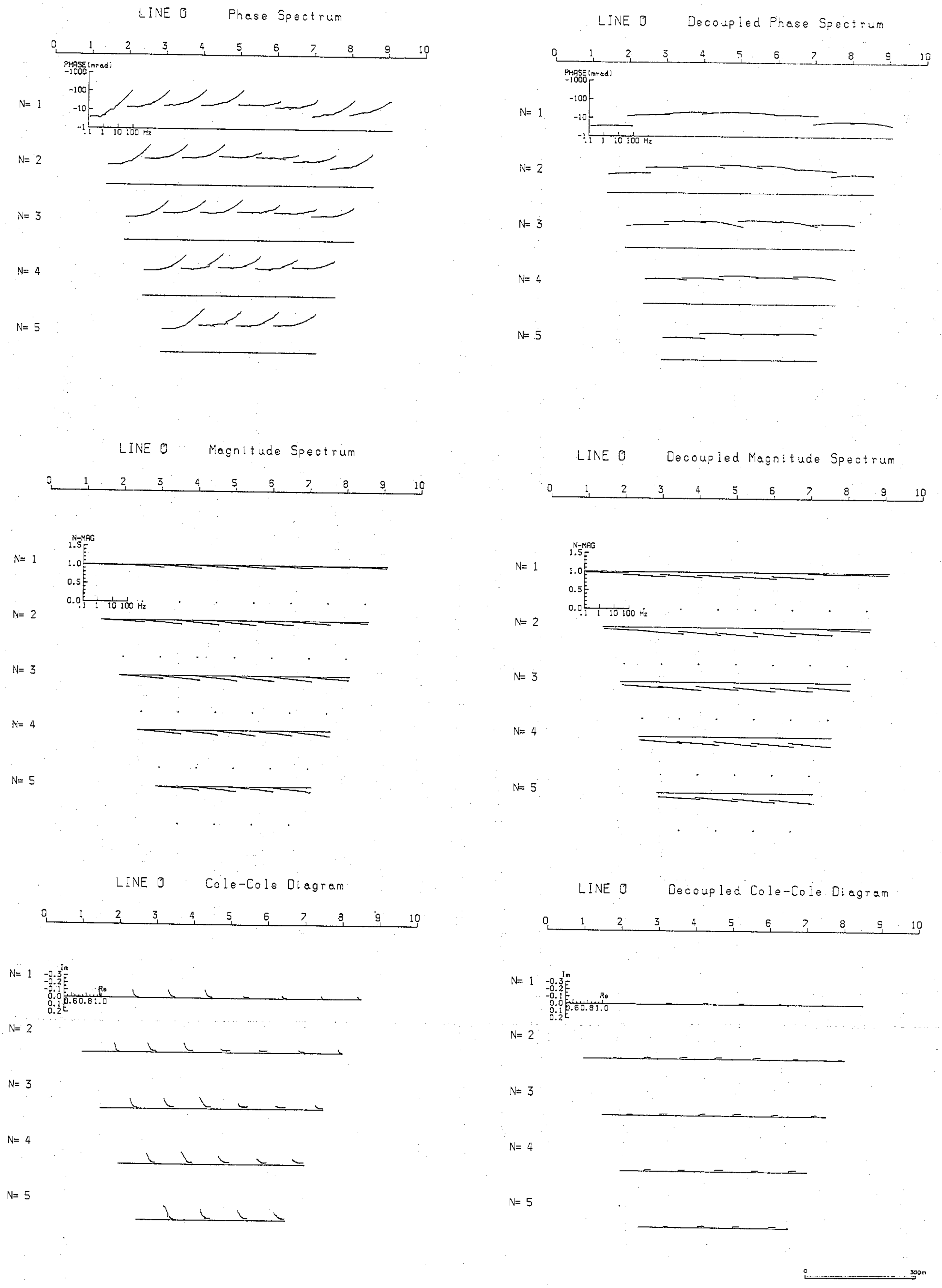


Fig. 34 Phase,Magnitude & Cole.Cole Spectrum Line O

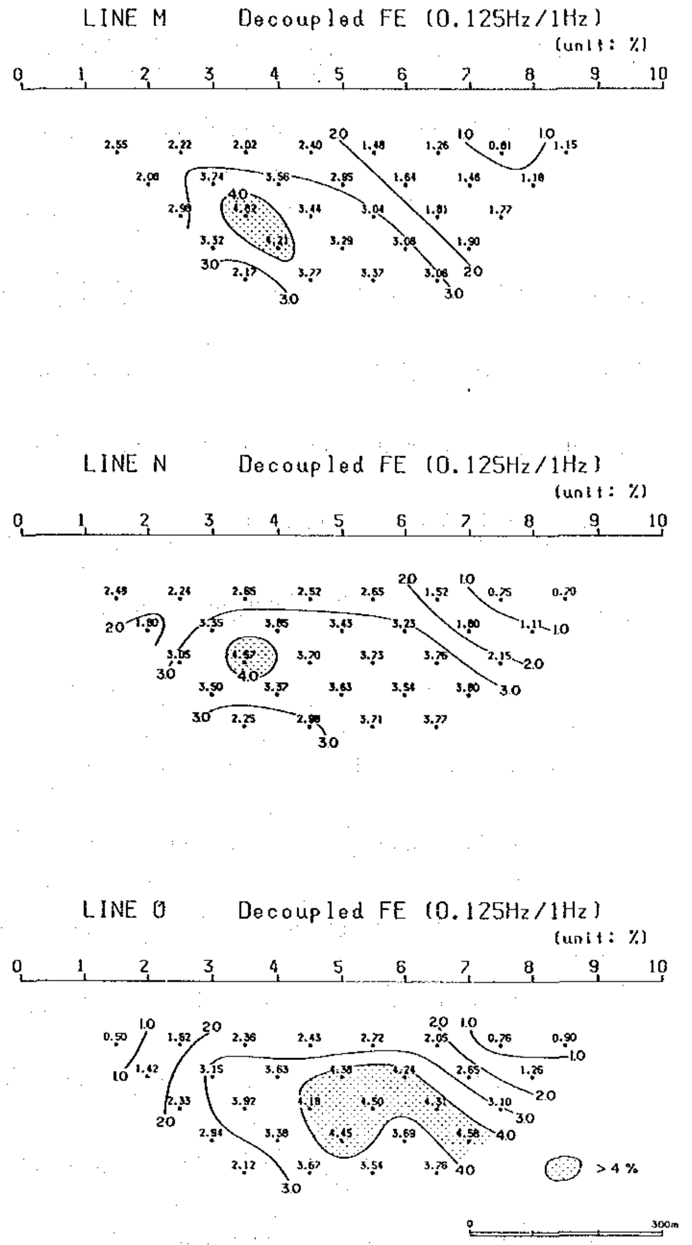
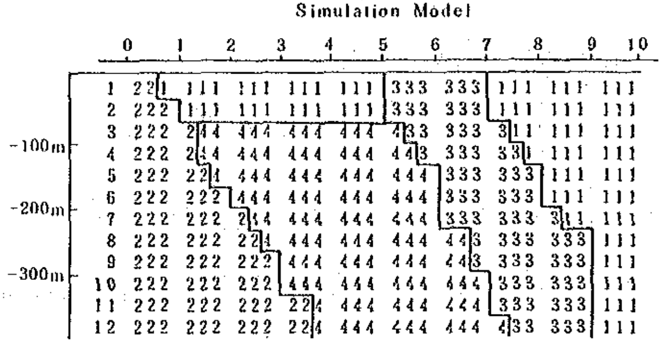


Fig. 35 Decoupled PFE Line M, N, O

MODEL NO. N-8

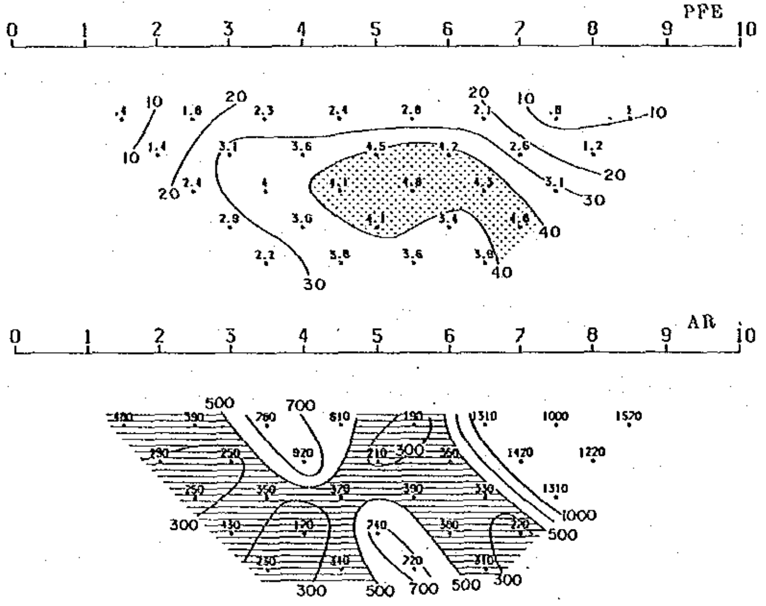
CODE	RESISTIVITY OHM M	F.E. %
1	1000.	1.2
2	200.	1.2
3	1500.	1.2
4	200.	5.0
5	0.	.0
6	0.	.0
7	0.	.0
8	0.	.0
9	0.	.0



Simulation Model

```
        0    1    2    3    4    5    6    7    8    9   10
 1  221  111  111  111  111  333  333  111  111  111
 2  222  111  111  111  111  333  333  111  111  111
 3  222  244  444  444  444  433  333  311  111  111
 4  222  244  444  444  444  443  333  331  111  111
 5  222  224  444  444  444  444  333  333  111  111
 6  222  222  444  444  444  444  333  333  111  111
 7  222  222  244  444  444  444  333  333  311  111
 8  222  222  224  444  444  444  443  333  333  111
 9  222  222  222  444  444  444  443  333  333  111
10  222  222  222  444  444  444  444  333  333  111
11  222  222  222  224  444  444  444  333  333  111
12  222  222  222  224  444  444  444  433  333  111
```

Pseudo-Section of Line O



Calculated Anomaly

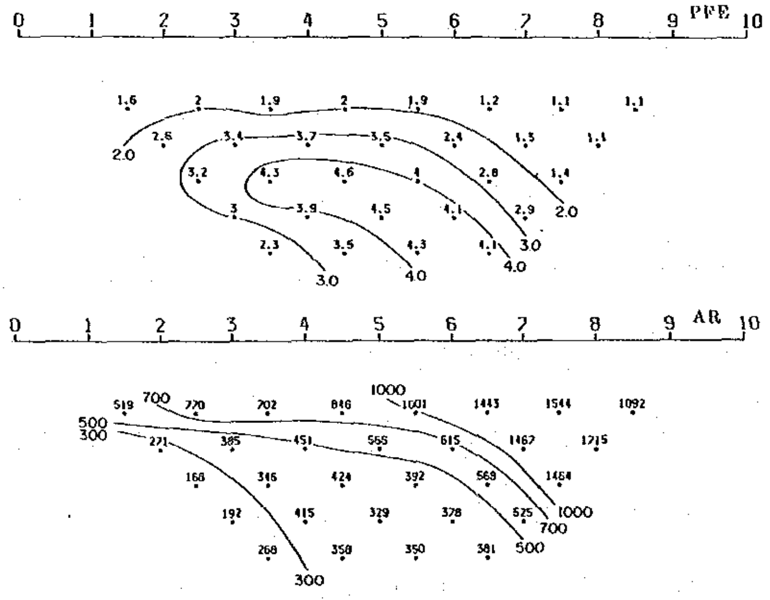


Fig. 36 Result of Model Simulation Line O

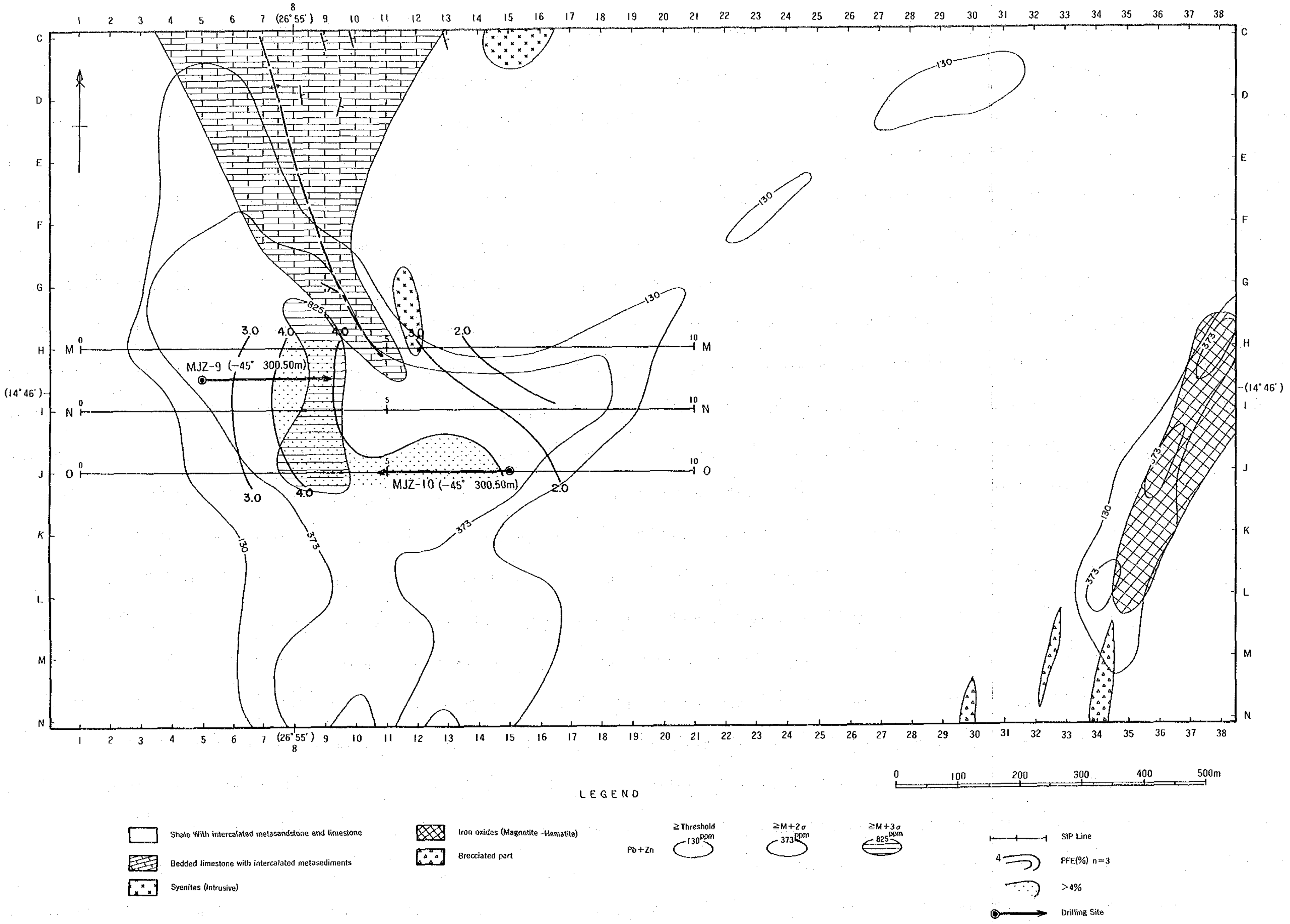


Fig. 37 Lacation Map of Drillings in Kamiyobo Area

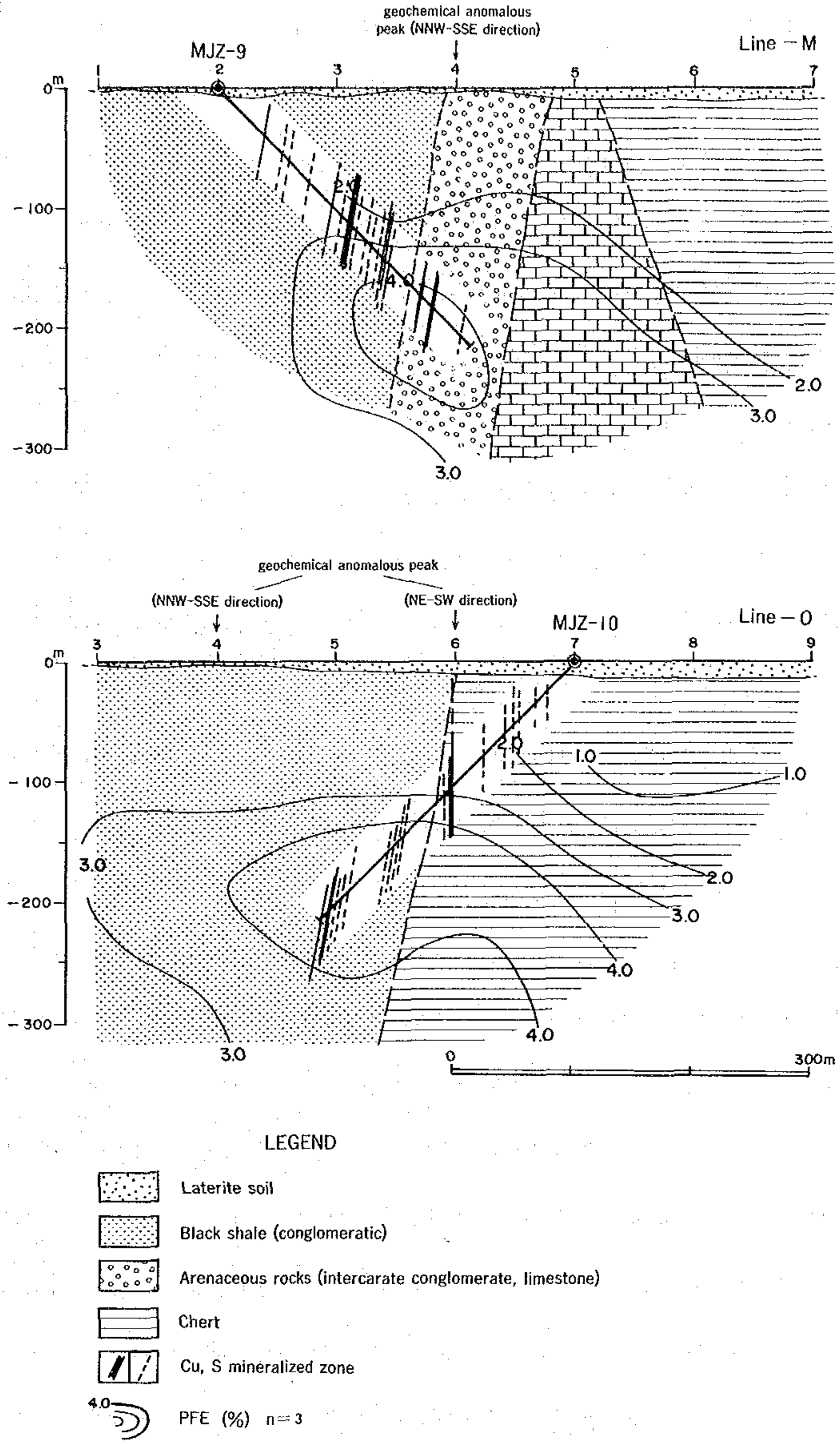


Fig. 38 Geological Section in Kamiyobo Area

2-1-2 Surface Geology

The geology of this area consists of bedded limestone of the upper carbonate rocks, shale of arenaceous, argillaceous rocks overlying the above carbonate rock, and syenite porphyry intruding these rocks locally in small scale (Fig.37).

In the vicinity of the drilling site exists the bedded limestone which, being a core at the top of an anticline, is distributed over a small area. These rocks are intercalated by a few millimeters thick of sandstone. These rocks alternate or interfinger with the fine-grained sandstone and chert. Shale which is exposed relatively well in the west is reddish-brown to yellowish brown in color. The rock contains medium to fine-grained sandstone and partly has a conglomeratic appearance, particularly near the bedded limestone.

The geological structure strikes N20°W dips 80°W in the west. The above-mentioned anticline is assumed to strike NNW-SSE and plunges SSE. The east is not known in detail.

In the vicinity of the drilling site, limonite and hematite veinlets are observed with a thickness of a few centimeters. In the east area, however, there are outcrops of hematite and magnetite, and in the north of this area the Kamiyobo mineralized zone, a predominant effect of copper mineralization is confirmed.

The geochemically anomalous zone extending for more than 1km in NNW-SSE (Fig.37) consists of anomalies of Cu, Pb and Zn elements. Pb+Zn geochemical anomalous zones are composed of two different elongation peaks: an elongation NNW-SSE in the west and a NE-SW in the east. The anomalous value of the former elongation is highest, and its total length of the central part ($M+3\sigma$) is approximately 300m.

2-2 Drilling operation

(1) Drilling Method

Same as described in Chapter 1, 2-2 (1)

(2) Rig and Materials

Same as described in Chapter 1, 2-2 (2)

(3) Operation

Same as described in Chapter 1, 2-2 (3)

(4) Results of drilling Progress

The results of the drilling progress classified by hole are shown in Tables 11 to 12, the overall results of the drilling operation in Tables 13 to 14, and the drilling work schedule in Figs. 39 to 40.

2-3 Geology and mineralization of the drill holes

The drilling logs for the MJZ-9 and MJZ-10 are shown in Fig.41 and Fig.42 and the results of a chemical analysis, a microscopic observation of polished section and X-ray diffractive analysis of the mineral are shown in Ap.Tables 9 to 11, respectively.

2-3-1 MJZ-9 Hole

Table 11 Record of the Drilling Operation on MJZ-9

	Drilling length			Total		Shift		Working man	
	Shift. 1	Shift. 2	Shift. 3	Drilling	Core length	Drilling	Total	Engineer	Worker
August	m	m	m	m	m	shift	shift	man	man
17	Pds.								
18	Transpor.								
19	Transpor.								
20	Transpor.								
21	Reassemb.								
22	Reassemb.								
23	12.00	13.20	6.30	31.50	19.60	3	9	28	119
24	4.70	12.40	12.30	29.40	27.20				
25	15.00	9.20	15.40	39.60	39.00				
26	18.00	15.00	10.40	43.40	42.80				
27	6.90	13.40	14.20	34.50	34.50				
28	12.00	12.00	15.00	39.00	39.00				
29	12.00	10.80	13.20	36.00	36.00				
30	12.00	12.00	6.00	30.00	30.00	21	21	28	103
31	9.00	8.10	Out-C.P	17.10	17.10				
September									
1	Dismant					2	4	7	27
Total	101.60	106.10	92.80	300.50	285.20	26	34	63	249

Table 12 Record of the Drilling Operation on MJZ-10

	Drilling length			Total		Shift		Working man	
	Shift. 1	Shift. 2	Shift. 3	Drilling	Core length	Drilling	Total	Engineer	Worker
September	m	m	m	m	m	shift	shift	man	man
2	Reassemb.								
3	Reassemb.								
4	19.50	12.00	10.50	42.00	18.60				
5	10.50	12.00	13.00	35.50	28.50				
6	8.00	12.00	9.00	29.00	28.70	9	11	20	79
7	12.00	12.00	10.50	34.50	34.50				
8	7.40	12.00	9.00	28.40	28.40				
9	9.00	12.00	10.50	31.50	31.50				
10	7.50	9.00	9.00	25.50	25.50				
11	9.00	8.00	7.00	24.00	24.00				
12	12.00	12.00	9.00	33.00	33.00				
13	9.00	8.10	Out-C.P.	17.10	17.10	20	21	28	109
14	Dismant.						1	3	15
Total	103.90	109.10	87.50	300.50	269.80	29	33	51	203

Abbreviation

Pds. : Preparation for drilling site

Transpor. : Transportation

Reassemb. : Reassemblage

Dismant. : Dismantlement

Table 13 Summary of the Drilling Operation on MJZ-9

		Survey Period				Total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	17.8.1986~22.8.1986	6	days 6	days 0	man 24	man 102
	Drilling	23.8.1986~31.8.1986	9	drilling 9	0	36	135
				recovering 0	0	0	0
	Removing	1.9.1986~1.9.1986	1	1	0	3	12
	Total	17.8.1986~1.9.1986	16	16	0	63	249

Drilling length	Length planned	300.00 m	Surface soil Overburden Quaternary	6.00 m
	Increase or Decrease in length	- m	Core length	285.20 m
	Length drilled	300.50 m	Core recovery	96.8 %

Core recovery of 100 m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	90.7	90.7
100 ~ 200	99.4	95.2
200 ~ 300.5	100	96.8

		h	%	%
Working hours	Drilling	143°10'	66.3	51.5
	Other working	70°30'	32.6	25.4
	Recovering	2°20'	1.1	0.8
	Total	216°00'	100	77.7
	Reassemblage	54°00'		19.4
	Dismantlement	8°00'		2.9
	Water transportation	(156°00')		
	Road construction and others			
	G. Total	278°00'		100

Efficiency of Drilling

Total m/work period(m/day)	300.50m/9 days (33.38m/day)
Total m/total shift(m/shift)	300.50m/26shifts (11.55m/shift)

Drilling length/bit (each sized bit)

Bit size	HX	NQ	BQ
Drilled length	5.00	138.90	156.60
Core length	-	128.60	156.60

Casing pipe inserted	Size	meterage (m)	$\frac{\text{meterage}}{\text{drilling length}} \times 100$ (%)	Recovery (%)
	HX	5.00	1.7	100
	NX	33.10	11.0	100
	BX	143.90	47.9	100

Table 14 Summary of the Drilling Operation on MJZ-10

		Survey Period				Total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	2.9.1986∿3.9.1986	2	days 2	days 0	man 8	man 34
	Drilling	4.9.1986∿13.9.1986	10	drilling 10	0	40	154
				recovering 0	0	0	0
	Removing	14.9.1986∿14.9.1986	1	1	0	3	15
	Total	2.9.1986∿14.9.1986	13	13	0	51	203

Drilling length	Length planned	300.00 m	Surface soil Overburden Quaternary	19.00 m
	Increase or Decrease in length	– m	Core length	269.80 m
	Length drilled	300.50 m	Core recovery	95.8 %

Core recovery of 100 m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ∿ 100	85.5	85.5
100 ∿ 200	100	93.5
200 ∿ 300.5	100	95.8

		h	%	%
Working hours	Drilling	164°00'	68.3	61.0
	Other working	76°00'	31.7	28.2
	Recovering			
	Total	240°00'	100	89.2
	Reassemblage	20°00'		7.4
	Dismantlement	9°00'		3.4
	Water transportation	(166°00')		
	Road construction and others			
	G. Total	269°00'		100

Efficiency of Drilling

Total m/work period(m/day)	300.50m/10days (30.05m/day)
Total m/total shift(m/shift)	300.50m/29shifts (10.36m/shift)

Drilling length/bit (each sized bit)

Bit size	HX	NQ	BQ
Drilled length	18.80	122.20	159.50
Core length	–	110.30	159.50

Casing pipe inserted	Size	meterage (m)	$\frac{\text{meterage}}{\text{drilling length}} \times 100$ (%)	Recovery (%)
	HX	9.50	3.2	100
	NX	27.00	9.0	100
	BX	141.00	46.9	100

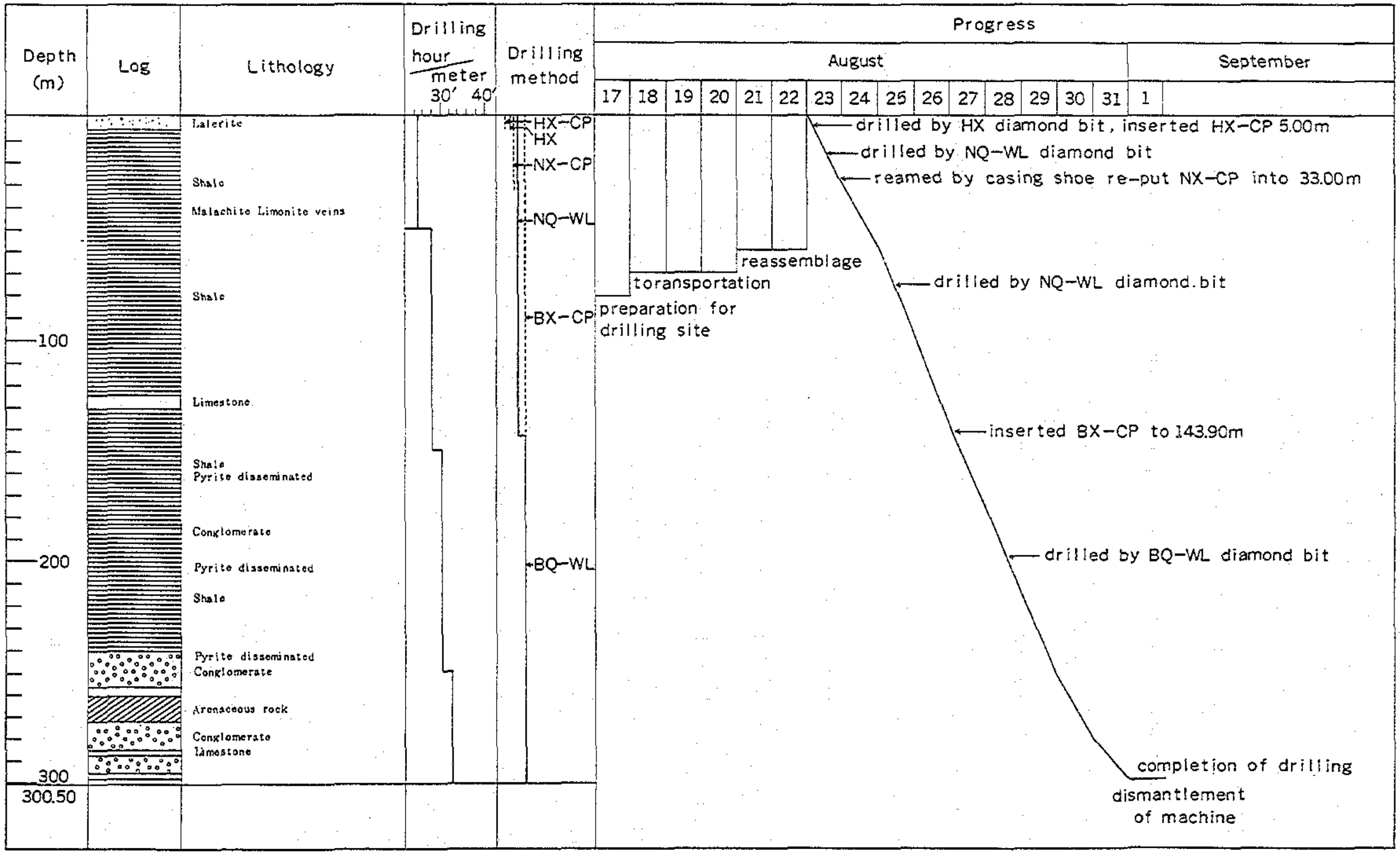


Fig. 39 Drilling Progress on MJZ-9

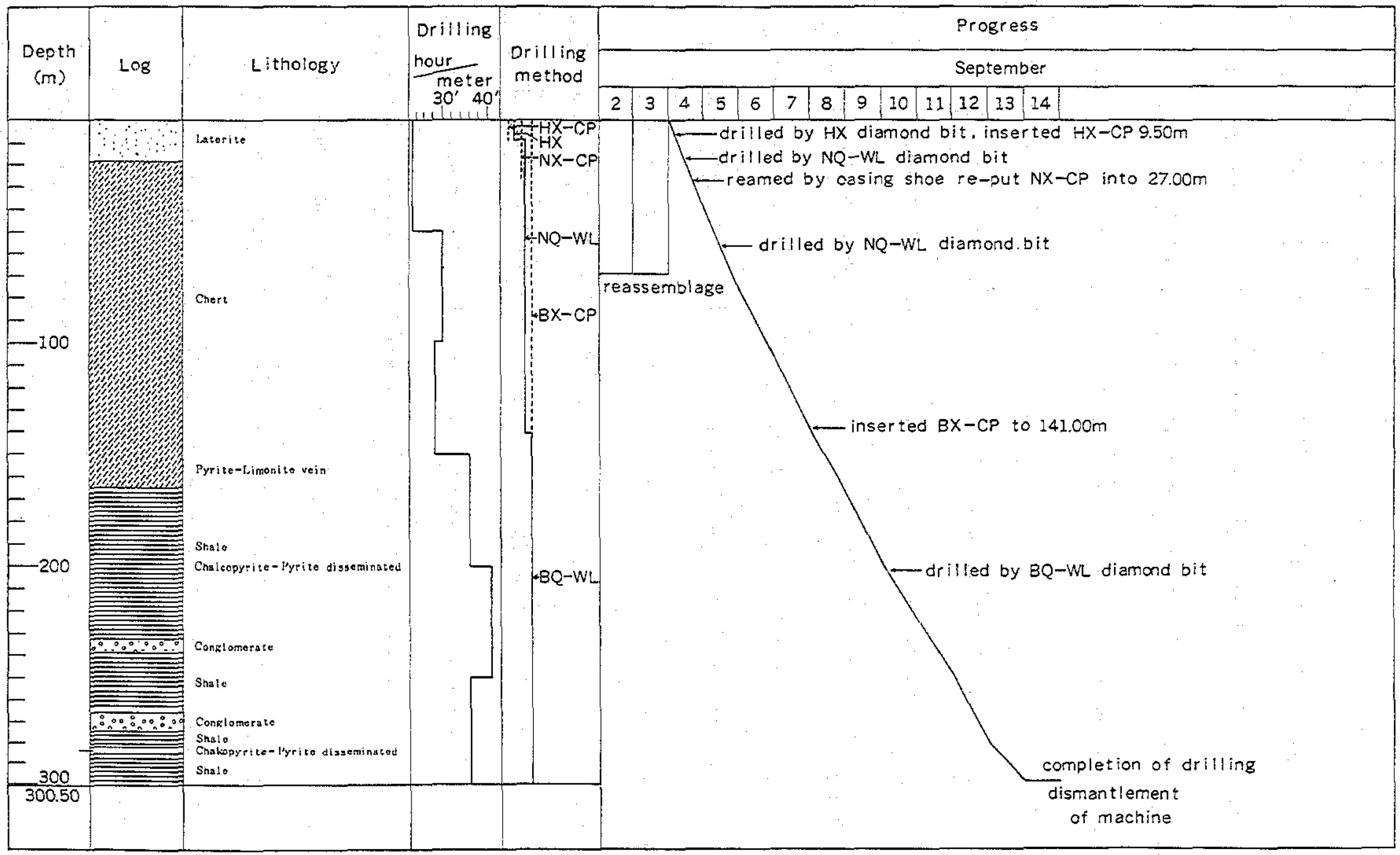
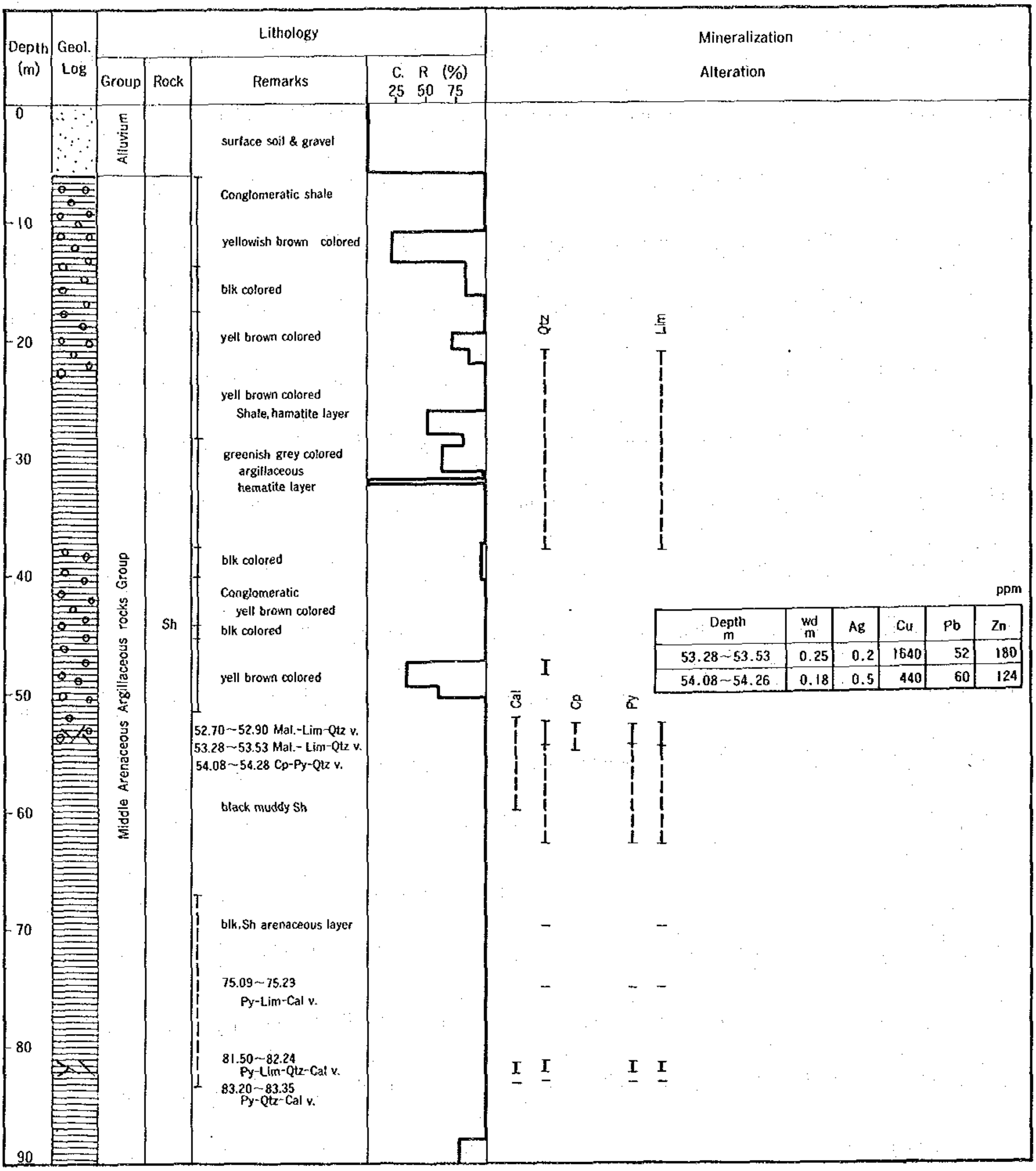


Fig. 40 Drilling Progress on MJZ-10

Drill Hole No.	MJZ-9	Inclination	−45°
Location	KAMIYOBO	Bearing	90°
Elevation	Approx 1200m	Term	Aug. 23∼Aug 31 '86
Depth	300.50m	Core Recovery	96.8%

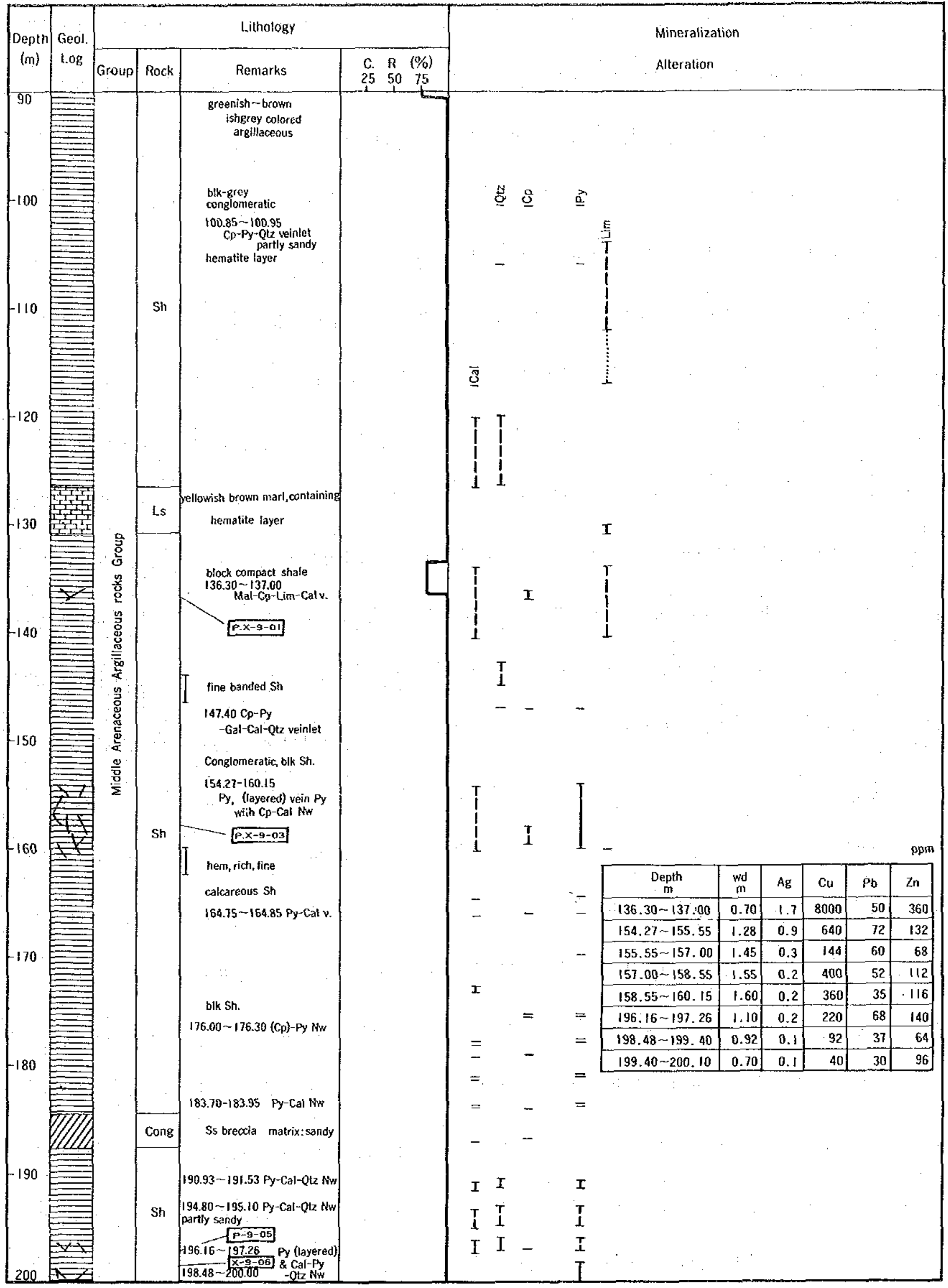


ppm

Depth m	wd m	Ag	Cu	Pb	Zn
53.28∼53.53	0.25	0.2	1640	52	180
54.08∼54.26	0.18	0.5	440	60	124

Fig. 41 Geological Log MJZ−9 (I)

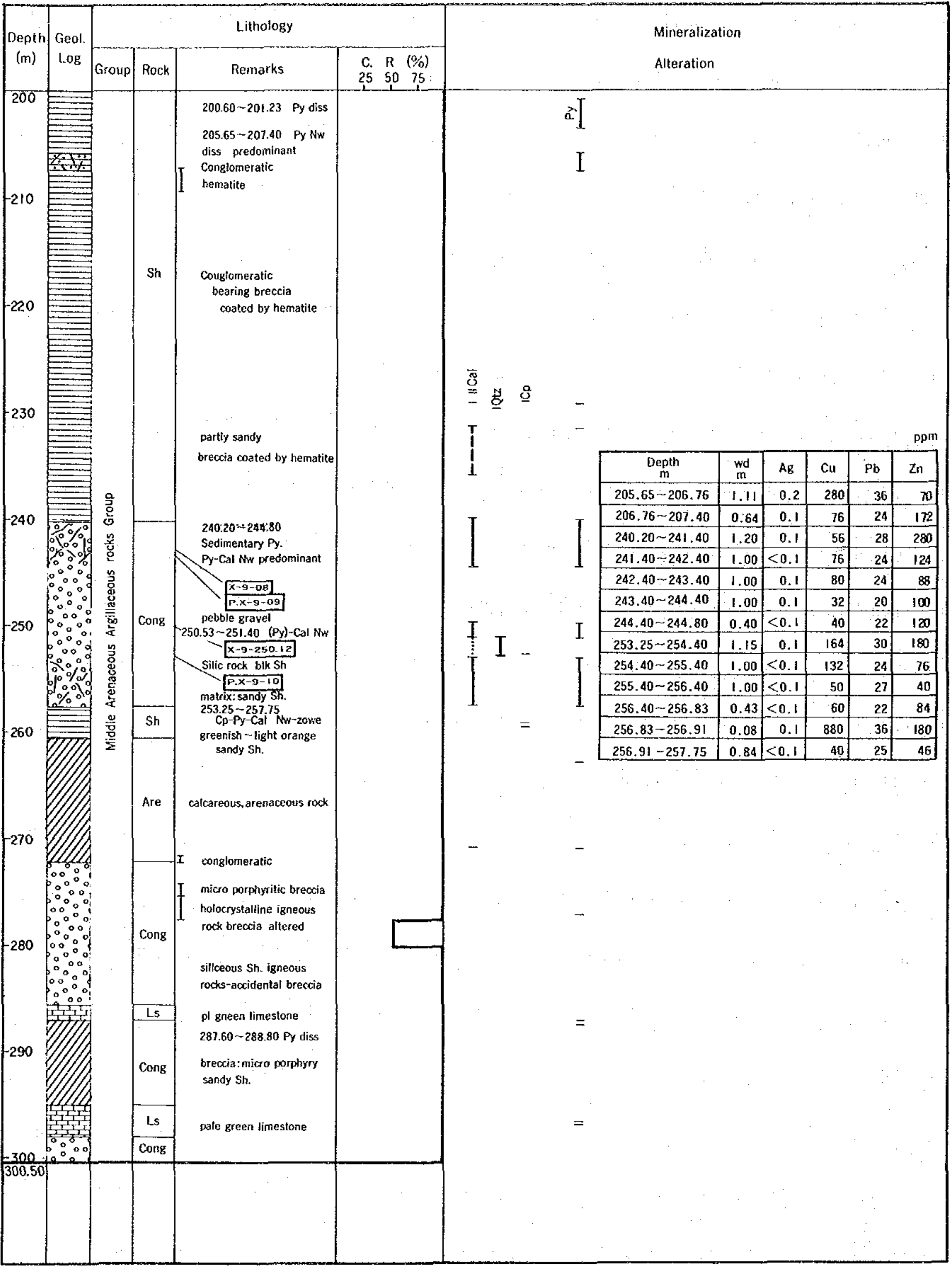
-Continue-



Depth m	wd m	Ag	Cu	Pb	Zn
136.30～137.00	0.70	1.7	8000	50	360
154.27～155.55	1.28	0.9	640	72	132
155.55～157.00	1.45	0.3	144	60	68
157.00～158.55	1.55	0.2	400	52	112
158.55～160.15	1.60	0.2	360	35	116
196.16～197.26	1.10	0.2	220	68	140
198.48～199.40	0.92	0.1	92	37	64
199.40～200.10	0.70	0.1	40	30	96

M J Z－9 (Ⅱ)

-Continue-



ppm

Depth m	wd m	Ag	Cu	Pb	Zn
205.65~206.76	1.11	0.2	280	36	70
206.76~207.40	0.64	0.1	76	24	172
240.20~241.40	1.20	0.1	56	28	280
241.40~242.40	1.00	<0.1	76	24	124
242.40~243.40	1.00	0.1	80	24	88
243.40~244.40	1.00	0.1	32	20	100
244.40~244.80	0.40	<0.1	40	22	120
253.25~254.40	1.15	0.1	164	30	180
254.40~255.40	1.00	<0.1	132	24	76
255.40~256.40	1.00	<0.1	50	27	40
256.40~256.83	0.43	<0.1	60	22	84
256.83~256.91	0.08	0.1	880	36	180
256.91 ~257.75	0.84	<0.1	40	25	46

M J Z − 9 (Ⅲ)

Drill Hole No.	MJZ-10	Inclination	−45°
Location	KAMIYOBO	Bearing	270°
Elevation	Approx 1200m	Term	Sept. 4～Sept. 13 '86
Depth	300.50m	Core Recovery	95.8%

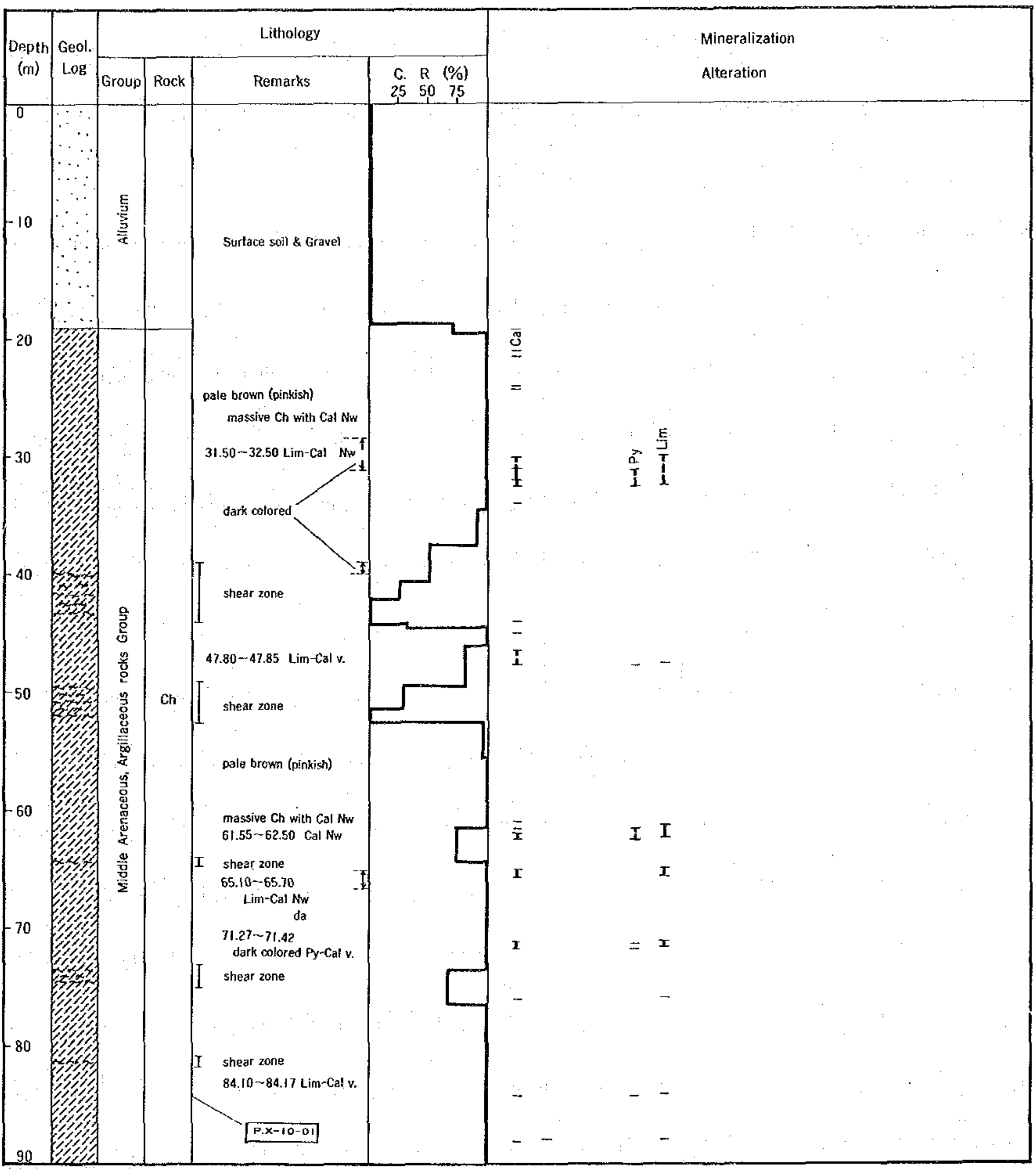
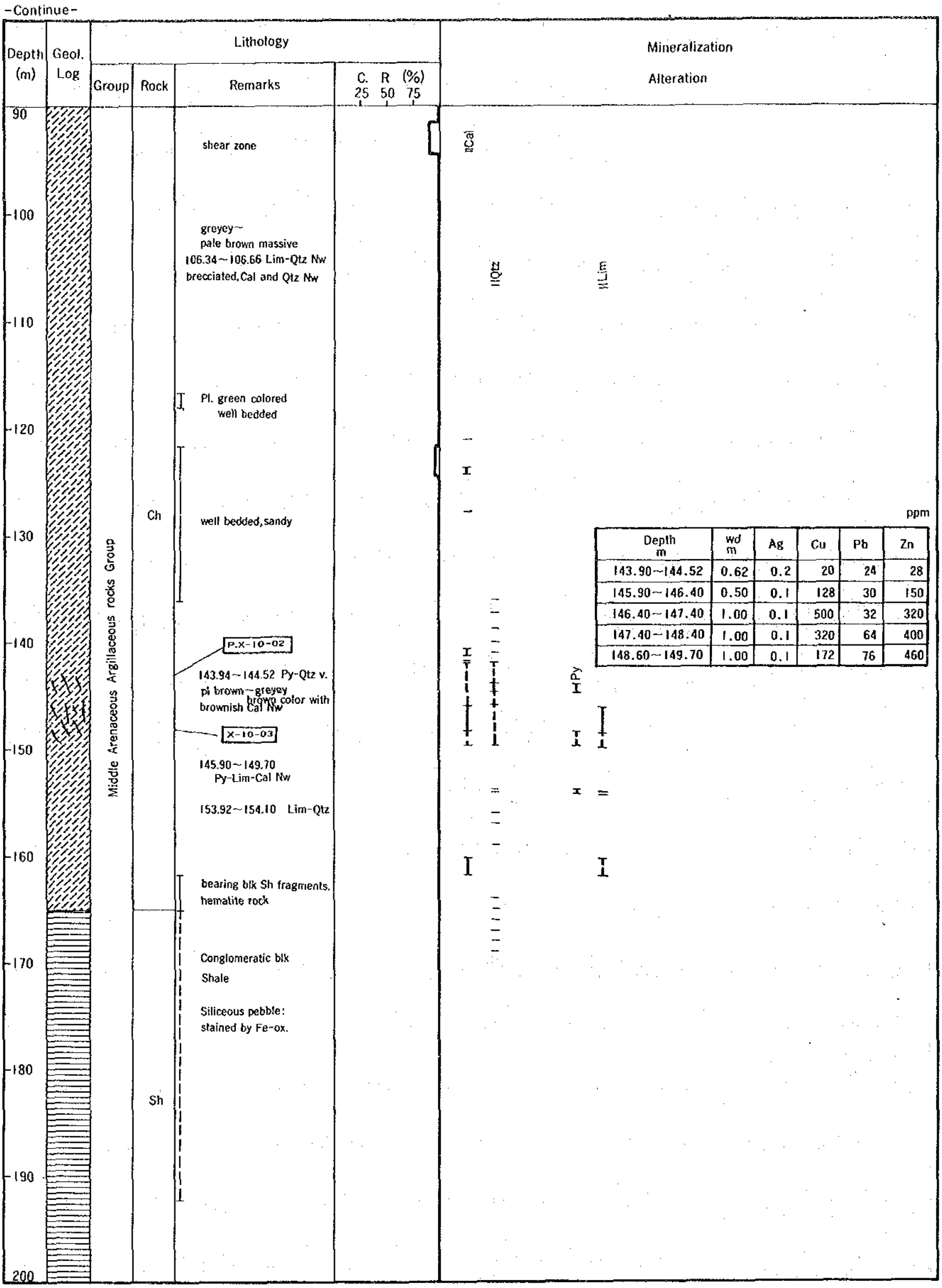


Fig. 42 Geological Log M J Z − 10 (I)

-Continue-

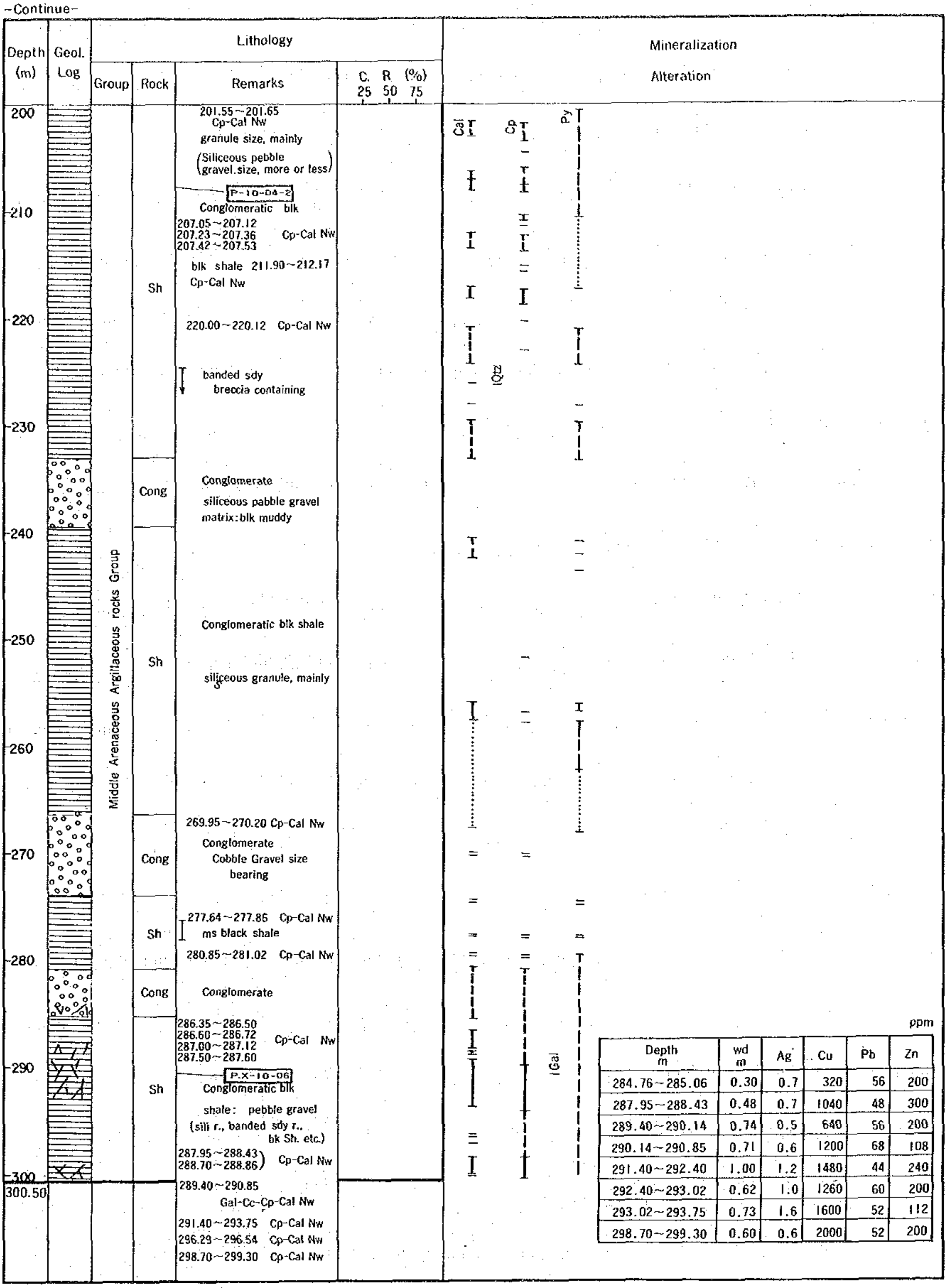


ppm

Depth m	wd m	Ag	Cu	Pb	Zn
143.90~144.52	0.62	0.2	20	24	28
145.90~146.40	0.50	0.1	128	30	150
146.40~147.40	1.00	0.1	500	32	320
147.40~148.40	1.00	0.1	320	64	400
148.60~149.70	1.00	0.1	172	76	460

MJZ－10 (Ⅱ)

-Continue-



201.55~201.65
Cp-Cal Nw
granule size, mainly
(Siliceous pebble
gravel.size, more or less)

P-10-04-2
Conglomeratic blk

207.05~207.12
207.23~207.36 Cp-Cal Nw
207.42~207.53

blk shale 211.90~212.17
Cp-Cal Nw

220.00~220.12 Cp-Cal Nw

banded sdy
breccia containing

Conglomerate
siliceous pabble gravel
matrix:blk muddy

Conglomeratic blk shale

siliceous granule, mainly

269.95~270.20 Cp-Cal Nw
Conglomerate
Cobble Gravel size
bearing

277.64~277.86 Cp-Cal Nw
ms black shale
280.85~281.02 Cp-Cal Nw

Conglomerate

286.35~286.50
286.60~286.72
287.00~287.12 Cp-Cal Nw
287.50~287.60

P.X-10-06
Conglomeratic blk
shale: pebble gravel
(sili r., banded sdy r.,
bk Sh. etc.)
287.95~288.43
288.70~288.86) Cp-Cal Nw
289.40~290.85
Gal-Cc-Cp-Cal Nw
291.40~293.75 Cp-Cal Nw
296.29~296.54 Cp-Cal Nw
298.70~299.30 Cp-Cal Nw

ppm

Depth m	wd m	Ag	Cu	Pb	Zn
284.76~285.06	0.30	0.7	320	56	200
287.95~288.43	0.48	0.7	1040	48	300
289.40~290.14	0.74	0.5	640	56	200
290.14~290.85	0.71	0.6	1200	68	108
291.40~292.40	1.00	1.2	1480	44	240
292.40~293.02	0.62	1.0	1260	60	200
293.02~293.75	0.73	1.6	1600	52	112
298.70~299.30	0.60	0.6	2000	52	200

MJZ－10 (Ⅲ)

Depth	0 - 6.00m	Laterite
"	6.00 - 130.70m	Mainly conglomeratic black shale with intercalated thin layer of hematite and dark-green to yellowish brown shale
"	130.70 - 257.75m	Mainly conglomeratic black shale, containing pebbles covered with hematite are seen remarkably at a depth of 207.40m and deeper.
"	257.75 - 300.50m	Mainly sandstone and conglomerate containing at a depth greater than 272.50m a conglomerate composed of igneous rocks and thin layers of pale green limestone are intercalated.

At a depth of between 51.70 and 62.90m are observed calcite and quartz veins bearing mainly pyrite and limonite and partly malachite (depth 53.28 to 53.53m; Cu 1640ppm, Zn 180ppm).

Cu 8000ppm and Zn 360ppm were indicated at a depth of between 136.30 and 137.00m.

At depths of 154.27 - 160.15m, 240.20 - 244.80m, and 253.25 - 257.75m, a considerably high concentrated zones of stratiformed pyrite, associated with calcite - dolomite veinlets partly bearing chalcopyrite and pyrite are distinguished (including S 5 - 10%).

Cu 640ppm, Pb 72ppm and Zn 132ppm were detected almost at a depth of 155m, Zn 280ppm, Zn 280ppm almost at 241m and Cu 880ppm and Zn 180ppm almost at 256.85m

At a depth of 147.42m, fine-grained galena was observed together with chalcopyrite and pyrite in calcite - quartz-veinlet.

Moreover, at a depth of 275 to 285m, an extrusion of clay took place during the drilling work, by which a fractured fault zone was confirmed.

2-3-2 MJZ-10 Hole

Depth	0 - 19.00m	Laterite
"	19.00 - 165.00m	Massive, partly brecciated chert. Bedded chert at 116.50 to 136.00m is intercalated.
"	165.00 - 300.50m	Mainly conglomeratic black shale containing a thin layer of conglomerate composed of sandstone and black shale.

Chalcopyrite-quartz veins and iron oxide-calcite veins are recognized well at a depth of 141.90 - 149.70m, and pyrite-calcite veinlets are recognized at depths of 201.55 - 212.17m, and 277.64 - 300.50m.

Zn 400ppm and Pb 60ppm were detected at a depth of almost 148m and Cu 1,200 to 2,000ppm, Zn 100 to 200ppm and Pb 40 to 60ppm at a depth of 290m and deeper. Although pyrite, which was observed as a veinlet stratiformed pyrite is frequently recognized to occur along the bedding of the black shale sulphur concentrations of these pyrite zones sporadically are assumed S 1 - 2%. It should also be noted that galena, too, was observed to be associated with chalcopyrite and pyrite at a depth of 290.55m.

PART Ⅲ

SYNTHETIC INTERPRETATION AND DISCUSSION

PART III SYNTHETIC INTERPRETATIN AND DISCUSSION

1. Sable Antelope area

1-1 Geophysical Anomalies and Mineralized Zones (Figs. 43 to 45)

The result of SIP is to be interpreted by AR, PFE and phase in the range of low frequency. Due to smallness of anomalies on lines J, K and L in this year being at less than 2%PFE, two drill holes were sunk on the anomalies of Nos.1 and 2 (MJZ-11 and MJZ-12) on line C, on which the IP survey was carried out in the second year.

The AR in these anomalies ranges from 9,000 to 10,000 ohm-m with 2 to 3%PFE. Being inferred from the result on adjacent line J, the phase of the anomalous zones is less than -20 mrad and decreases in accordance with a change of frequency from 0.125 to 0.375 Hz (Fig. 5). After drilling, dissemination of pyrite in siliceous rocks became apparent, indicating to be an origin of geophysical anomalies.

Two holes (MJZ-7 and MJZ-8) were put down on geophysical anomalies on Blue Jacket. The AR of the anomalous zone ranges from 300 to 800 ohm-m with 4 to 6%PFE. According to the result on line I which is one of SIP lines in the second year laid down between line A and line B, the phase in the anomalous zone stands at -30 to -40 mrad and decreases with a change of frequency from 0.125 to 0.375 Hz (Fig. 26).

Drilling revealed an existence of black shale associated with chalcopyrite and pyrite dissemination and this probably accounts for an origin of geophysical anomaly.

In the anomalous zone on line G, which is a SIP line in the second year between line B and line C, there appeared a zone of phase increase at the southwest of No.15 and a zone of phase decrease in the northeast of No.15 when the frequency increased from 0.125 to 0.375 Hz. A part of the zone of phase increase became a part of the zone of phase decrease when the frequency was changed from 1 to 3 Hz. According to rock properties of samples, this phase characteristic is similar to that of ores in the second year from Sable Antelope and is of great interest.

1-2 Correlation of Drilling Survey Result

Blue Jacket mineralized area in the southwestern part of the Area consists of argillaceous-arenaceous metasediments, while Sable Antelope deposit area in the central to northeastern part of the Area consists of carbonate rocks, as shown respectively in the results of MJZ-7 and MJZ-8, MJZ-11 and MJZ-12. The formations strike WNW-ESE , steeply dipping south in a monoclinic structure. Intraformational foldings and breccia-fractured zones occur extensively in the argillaceous-arenaceous metasediments, on the other hand breccia-fractured zone are common in carbonate rocks.

Mineralizations are observed in these tectonic zones in both areas, but there are respective characteristics in mineralization type in each area, namely network type veins are common in Blue Jacket, whereas mineralizations are embedded in fractured zone in Sable Antelope. The copper ores are mostly emplaced in the argillaceous-arenaceous rocks, and pyrites occur as marginal facies of the copper mineralization. According to results of chemical analysis of drill cores, zinc-lead mineralization

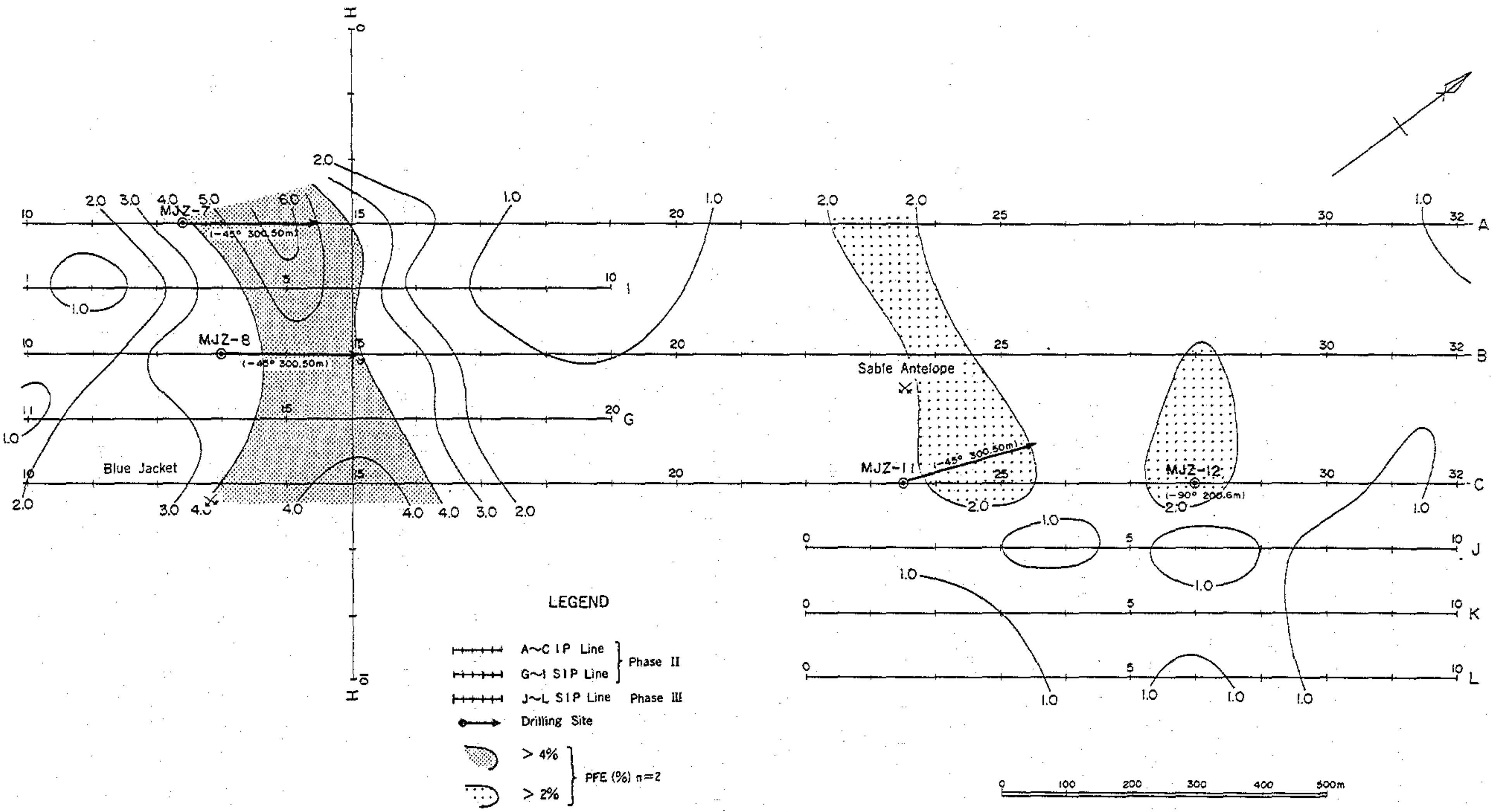


Fig. 43 Geophysical Anomaly & Drilling Sable Antelope Area

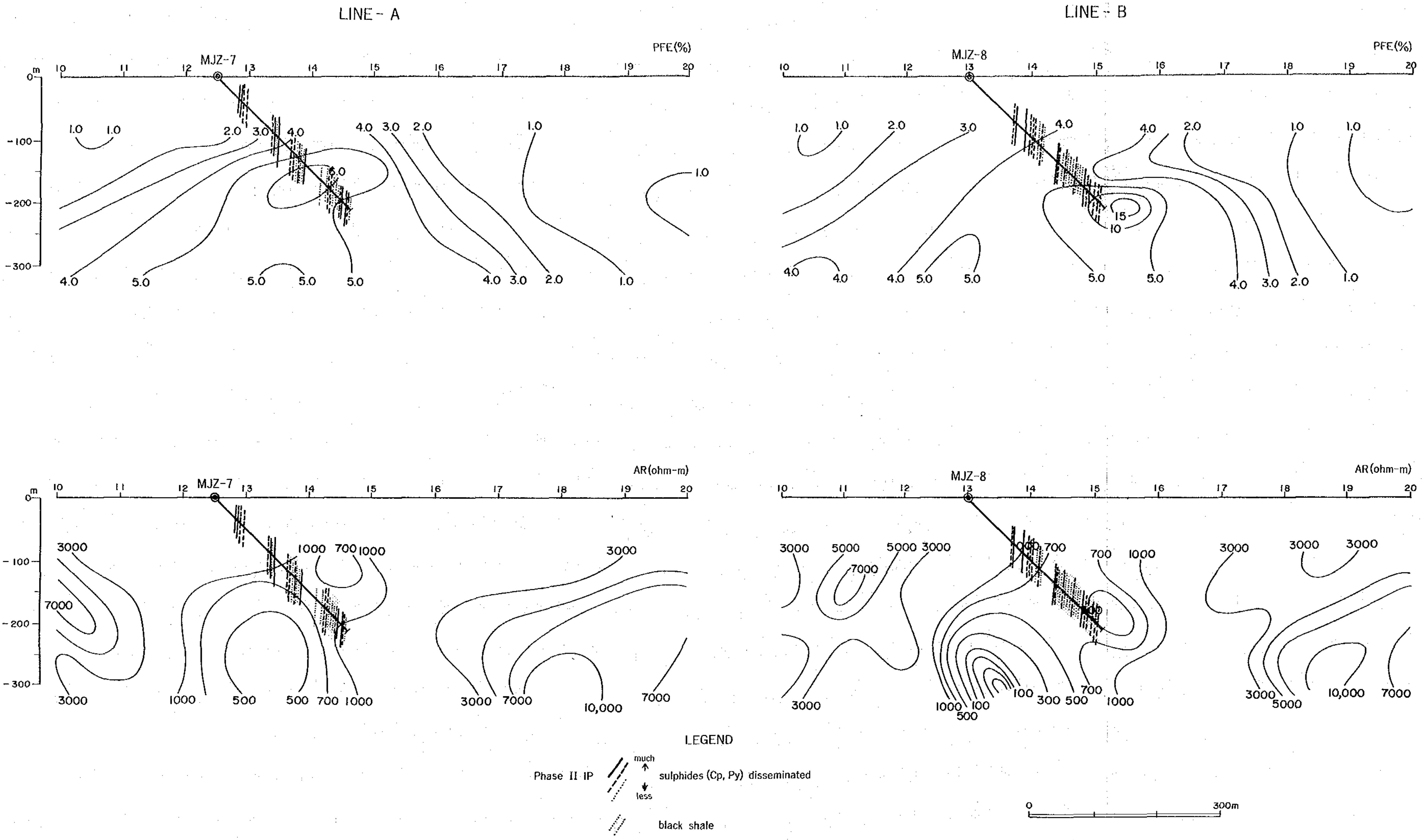


Fig. 44 Geophysical Anomaly & Drilling Result in Sable Antelope Area (I)

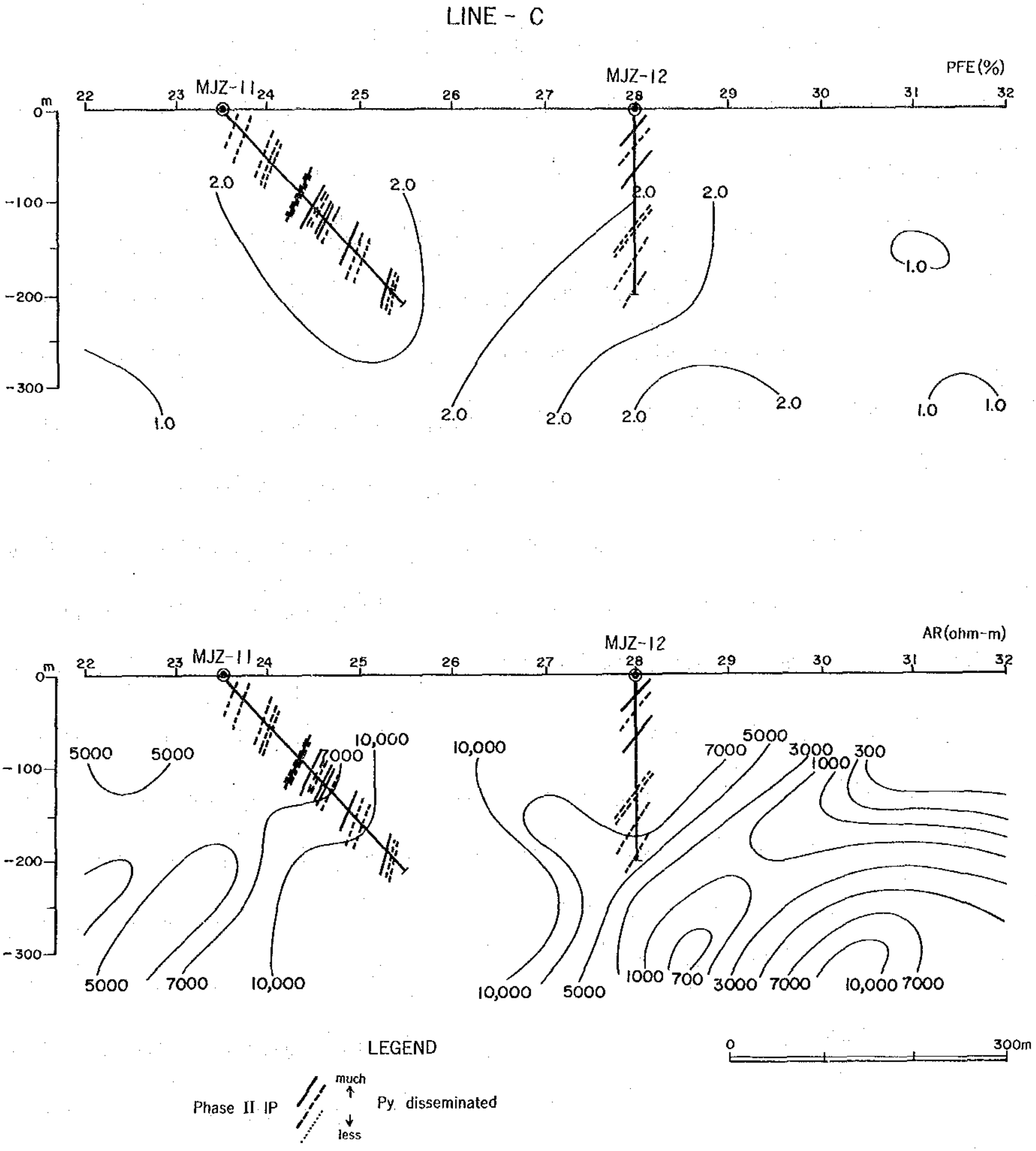
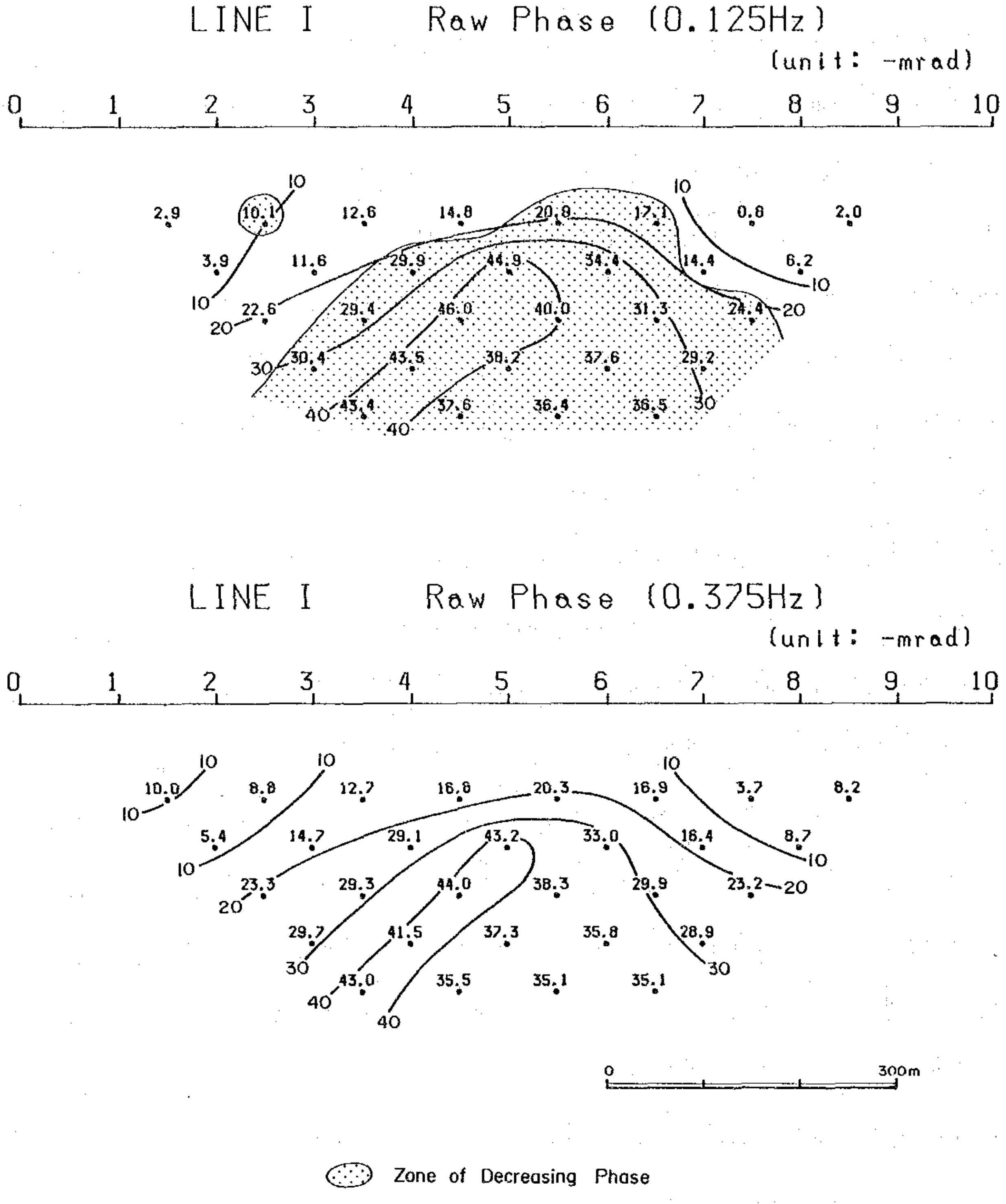


Fig. 45 Geophysical Anomaly & Drilling Result in Sable Antelop Area (II)



LINE I Raw Phase (0.125Hz)

(unit: -mrad)

LINE I Raw Phase (0.375Hz)

(unit: -mrad)

Zone of Decreasing Phase

Fig. 46 Phase Characteristics in the Low Frepuency Range (Line I) tends to be present in the carbonate rocks at deeper part from 280m of MJZ-7, and also in MJZ-11 and MJZ-12.

Blue Jacket mineralized zone and Sable Antelope Deposit are respectively embedded in various formation, and the former occurs coming off and on in lens shape in the arenaceous rock formation, and the latter is partly accompanied by massive sulphide ore bodies. It may be inferred that the copper, zinc and lead were mostly re-moved from some source to network crack zone and fractured zone formed along the strata owing to tectonic movement, and concentrated there as present type of mineralization. This mineralization type consists presumably of a concentration part of copper, zinc and lead, and a sulphide zone occuring at marginal of the concentration part. It is supposed in fact that MJZ-7 penetrated at north west marginal part of Blue Jacket, and MJZ-11 at east marginal part of Sable Antelope Deposit. A ore in MJZ-8 is of high temperature facies, because of existence of exsolution texture of chalcopyrite and bornite, while ores of MJZ-7 belong to low temperature side owing to low ratio of Cu/Pb and Zn/Pb. Mineralization of MJZ-11 is also regarded as marginal facies of Sable Antelope Deposit, considering resemblance to mineralization of MJZ-7.

2 Kamiyobo Area

2-1 Geophysical Anomalies and Mineralized Zones (Fig. 47 and Fig. 48)

Two holes (MJZ-9 and MJZ-10) were drilled in this area on geophysical anomalies.

In the anomaly zone on line M, the AR ranges from 300 to 500 ohm-m, with 3 to 4%PFE and -20 to -30 mrad in phase. With a change of frequency from 0.125 to 0.375 Hz, a field of phase increase in the east of No.4 and a field of decrease in the west of No.4 appeared (Fig. 29). The drill hole passed the proximity of boundary between these fields.

The anomalous zone on line O is larger than those of lines M and N. The AR in the zone ranges from 200 to 500 ohm-m with 3 to 4%PFE and a phase of -20 to -30 mrad. The most of phases in the anomalous zone decrease with a change of frequency from 0.125 to 0.375 Hz (Fig. 31). Black shales and pebble-bearing shales with chalcopyrite and pyrite disseminations were penetrated as an origin of geophysical anomalies.

2-2 Correlation of Drilling Survey Result

The area consists mainly of argellaceous-arenaceous rocks. Sandstone and chert and distributed from the northeast part to the east part of the Area including drilling sites, while conglomeratic black shale in the west part. In the central part placed between these, limestone exists with wedge in shape from the northern side.

An anticline runs presumably with a NNW-SSE axial direction in the central part of the limestone area, and in the drilling site area the strata dips 80° WSW in a isoclinal folding.

Mineralization is mainly of a stratabound deposit type, which (dolomitic) calcite network veinlets (several mm in each thickness) associated with dissemination of chalcopyrite and pyrite are embedded along bedding planes in the central part, although a calcite-quartz bearing vein type, disseminated pyrite and chalcopyrite with 1 - 2 cm, at time 10 cm, in width, occurs in the east and west part including drilling sites.

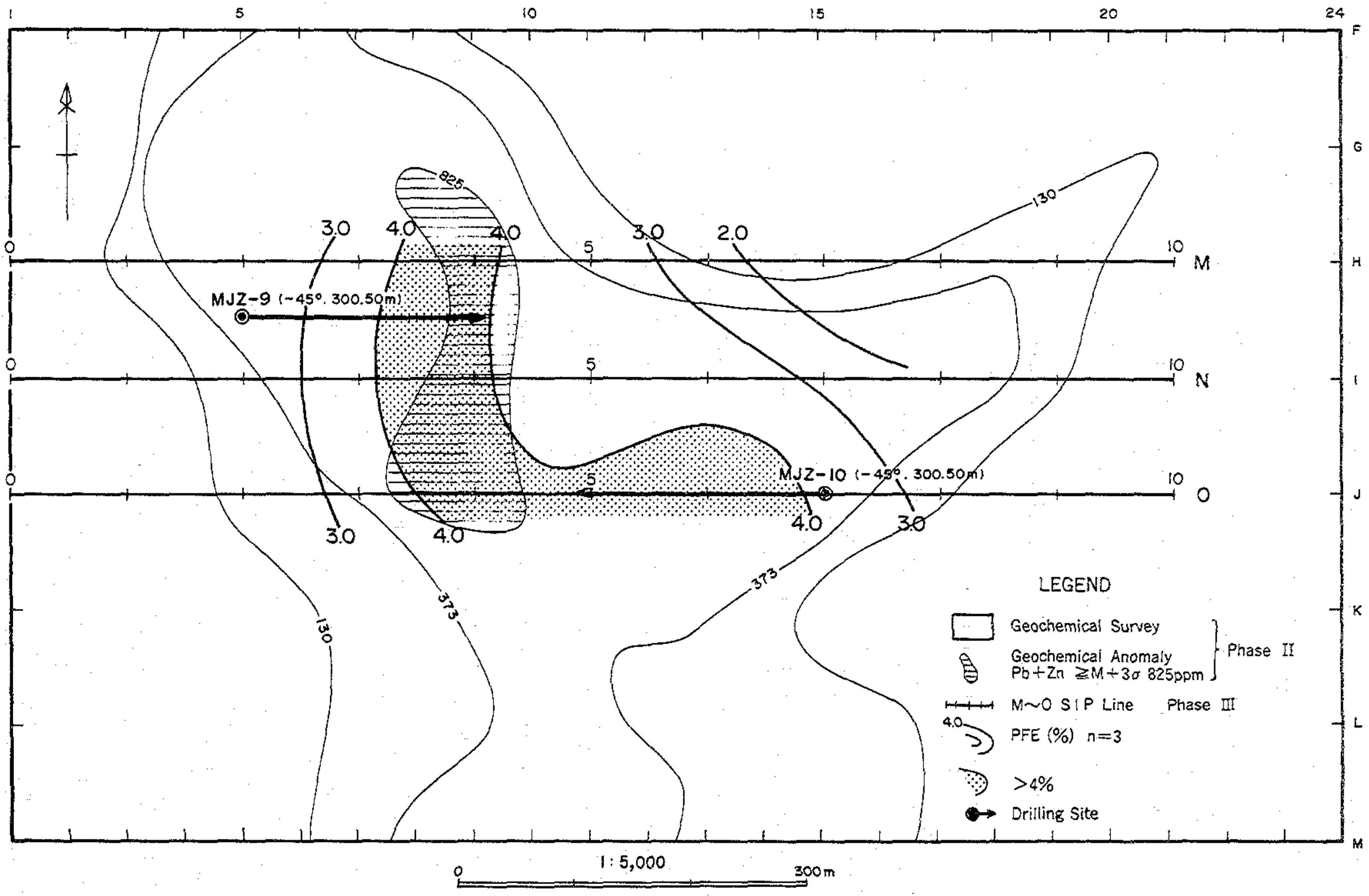


Fig. 47 Geophysical Anomaly & Drilling Site in Kamiyobo Area

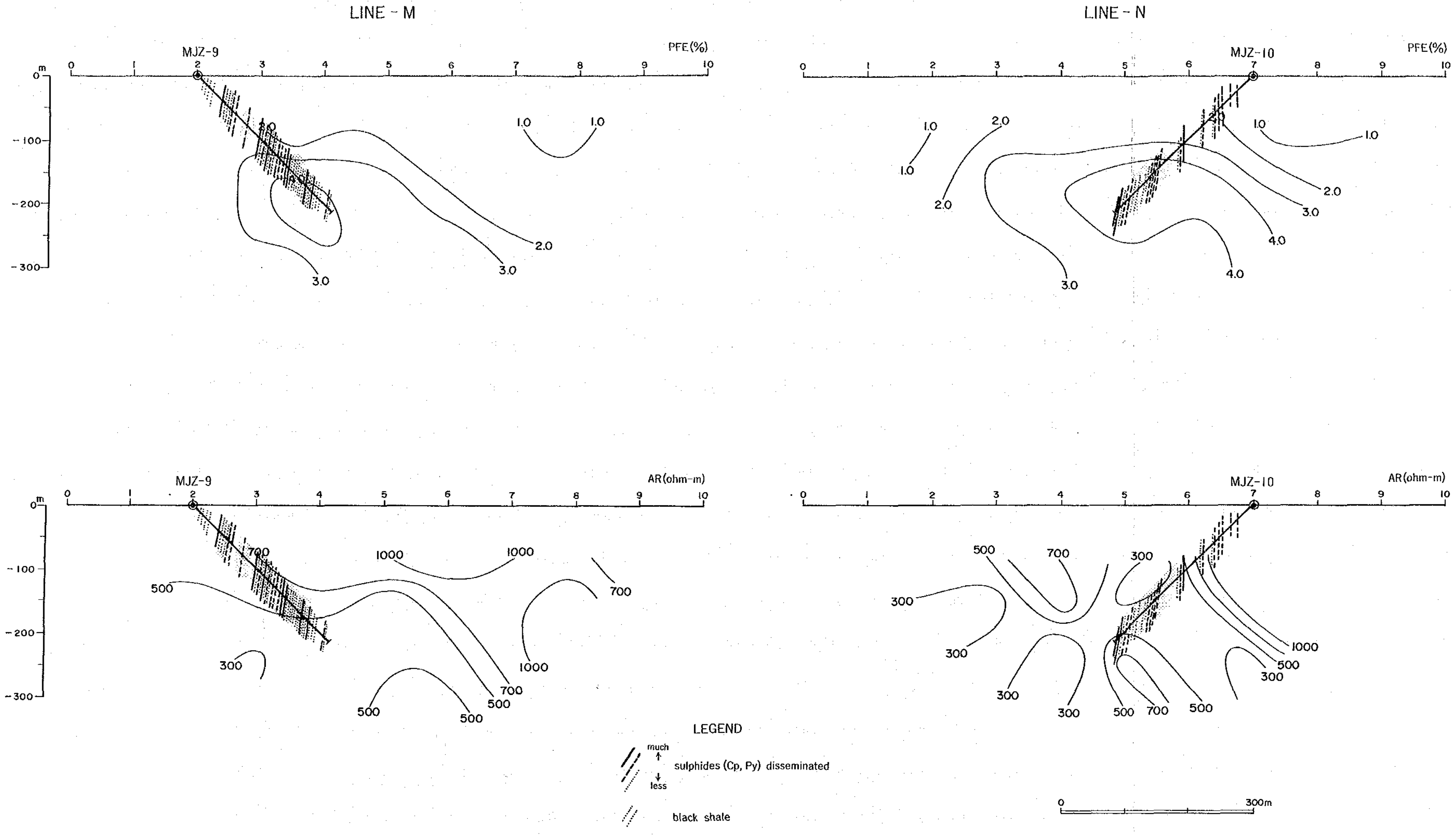


Fig. 48 Geophysical Anomaly & Drilling Result in Kamiyobo Area

The mineralization of chalcopyrite and pyrite is predominantly emplaced in conglomeratic black shale of conglomerate composed of pebbles of sandstone and shale, and also accompanies sedimentary-origined nodular pyrite or lamina pyrite. The dissemination of galena is rarely observable with naked eye. Copper concentration in the mineralization of the Area is lower than that in Sable Antelope Area. On the other hand, ratio of Zn/Pb is smaller, and contents of Pb and Zn are slightly richer than that of the Sable Antelope Area.

In the correlation between geochemical anomalous values and analytical values of ores from drilling cores, the latter contains larger value of copper and smaller values of lead and zinc (particularly smaller value of lead) than that of the former, while ratio of Cu/Zn of the latter is larger, Zn/Pb of the latter is slightly larger than that of the former. It is unclear how copper, lead and zinc behave under dissolution and dispersion near the ground surface. However from the above-mentioned fact it may be inferred that copper-riched mineralization was emplaced in deep place, on the contrary lead-zinc-riched mineralization in shallow part, and the geochemical anomaly reflects the residual part of the mineralization on the ground surface.

The result of the MJZ-10 indicates that east side peak in the geochemical anomalous zone is caused by vein type mineralization occuring along fractures.

PART Ⅳ

SYNTHESIS AND CONCLUSION

PART IV SYNTHESIS AND CONCLUSION

1. Synthesis

1-1 Geophysical Anomalies and Mineralized Zones

The drilling survey conducted in the geophysical anomaly reveals relationship between the anomaly and mineralization as follows;

In the Blue Jacket anomaly zone, the anomalies are attributed to the pyrite-disseminated black shale. The apparent resistivity (AR) ranging from 300 ohm-m to 800 ohm-m, and frequency effect (PEF) from 4% to 6% were detected in the anomalous zone. The difference in phase decreases from 0.125Hz to 0.375Hz.

In the Kamiyobo anomaly zone, the anomalies is attributed to pyrite-disseminated black shale. AR of 200 - 500 ohm-m and PEF of 3 - 4% were detected in this anomalous zone. The difference in phase increases or decreases depending on the points along the survey line M, and almost always shows decreases from 0.125 to 0.375Hz along the survey line O.

In the Sable Antelope anomaly zone, the anomalies is attributed to pyrite-dissemination in the siliceous rocks. AR of 5,000 - 10,000 ohm-m and PEF of 2 - 3% were detected in this anomalous zone. The difference in phase, as inferred from the results, of the survey along the line J shows decreases from 0.125 to 0.375Hz.

The anomalies in the Blue Jacket anomaly zone and the Kamiyobo anomaly zone are attributed exclusively to the pyrite-disseminated black shale. According to the difference in phase of the samples, the rocks are characterised by that keeping constant, although it decreases in the low phase domain (from 0.125Hz to 0.375Hz). On the other hand, ores of the Sable Antelope increase difference in phase, in many case, in low frequency domain (from).125Hz to 0.375Hz), while keeping constant difference in phase in another phase from 1Hz to 3Hz. Consequently, the difference in phase in a low-frequency domain is important as a means to distinguish the types of ores in this area. It can be assumed that a large difference in phases, an increase of the difference in phase in the low frequency domain from 0.125Hz to 0.375Hz, and increase of the difference in phase from 1 to 3Hz are useful for detecting the presence of ores.

1-2 Characteristics of Mineralized Zone

A large number of mineralized zones contain copper, zinc and lead, though minor extent, in the Sable Antelope and the Kamiyobo Areas. These mineralized zones form locally a stockwork type mineralized zone with relatively high concentration of copper. Although there are differences in feature between individual mineralized zones, they are generally characterized by stratabound deposit type suggesting sedimentary origin.

1-2-1 Structure of the mineralized zones

In the vicinity of the Sable Antelope deposit, pyrite dissemination or stockwork mineralized zones are mainly emplaced in fine-grained compact dolomitic sandstone.

In the Blue Jacket mineralized area, dolomitic stockwork mineralized zone is disseminated by copper sulfide ores, and pyrite disseminated zone forms network veinlets, beds and fine lamina. The former occurs in fine-grained dolomite sandstone, and the latter in shistosed black shale, partly in breccia-fractured zone or silicified rock. Minor lead and zinc mineralization are observed in the carbonate rock zone.

In the Kamiyobo area, there are several types of mineralization, namely stratiformed mineralized zone consisting of chalcopyrite and pyrite bearing network veinlets, alternated mineralized zone of fine pyrite and black shale, and pyrite-disseminated zone with pyrite nodules and fragments of siliceous rocks crusted by aggregated pyrite.

Pyrite dissemination occurs partly in a thin layer of limestone intercalated in the black shale. In addition, vein type mineralization such as a calcite vein and quartz vein each with a few cm in width occur in the black shale and the chert.

1-2-2 Distribution of copper, zinc and lead in the mineralized zone

Mineral assemblage and country rock of the ores are as follows;

(mineral assemblage *)	(country rock)
Chalcopyrite-bornite-tetrahedrite	arenaceous rocks, carbonates
chalcopyrite	argillaceous, arenaceous rocks
chalcopyrite-pyrite	argillaceous rocks (particularly predominant)
chalcopyrite-pyrite-galena	argillaceous rocks

* Dolomite, calcite, and quartz accompany as gangue minerals in all the above assemblage.

The descending order of these mineral assemblages corresponds with the distance from the center of the mineralized zone to the periphery. A lattice-patterned exsolution texture is distinctly observed in the assemblage of chalcopyrite-bornite. A chalcopyrite often forms idiomorphic crystal. Pyrites in dolomite, calcite and quartz is also of idiomorphic crystal. A pyrite of the layer intercalated in the black shale are generally granular in shape, and retaines original texture of sedimentation. A part of the pyrite has undergone recrystalization. Lead and zinc ores are rarely recognized with necked eye.

Copper, zinc and lead, in connection with the mineral assemblage shows a some tendency in their distribution, namely copper generally is high contents in the arenaceous rocks in which large ratio of Cu/Pb and Zn/Pb are detected. On the other hand, in carbonate rocks is lowest ratio of Cu/Pb owing to scarce content of copper, and contents relatively high zinc and lead with small ratio of Zn/Pb. Pyrite generally occurs often in high concentration in the argillaceous metasediments, whereas contents of the lead and zinc are not high.

Argillaceous metasediments contain generally a low copper, and show low ratios of Cu/Zn and Zn/Pb.

As can be seen from foregoing, a high concentration of copper is observed in the arenaceous rocks, while high concentrations of lead and zinc are in the carbonate rocks. It is assumed that in the mechanism contributing toward such high concentrations of minerals, an important role is played by particular temperature conditions brought by the intrusive rocks which simultaneously have intruded into the area near the mineralized zone with the formation of the cracks along the breccia-fractured zone formed later or weak line.

2 Conclusion

The geophysical and the drilling surveys were conducted in the Sable Antelope and Kamiyobo Areas in the third phase. The results of the surveys unravel relationship between geophysical anomaly and mineralized zone, and characteristics of the mineralization, as follows;

1) Sable Antelope Area

Drilling reveals that No.3 IP anomaly results mainly from pyrite-disseminated black shale, while No.1 and No.2 IP anomalies from pyrite disseminations in sandstone.

Of the mineralization obtained by drilling, there are two types mineralizations, namely one is mainly of copper in sandstone, another concentrates comparatively zinc and lead in dolomite or sandstone. However both are weak mineralization. Pyrites are also disseminated in above mentioned rocks, but some pyrites are sedimentary-origined, and are embedded frequently in black shale.

2) Kamiyobo Area

The IP anomaly zone found by geophysical survey in the geochemical anomaly area, also results from pyrite-disseminated black shale.

The thin pyrite layers, which is infered to be sedimentary origin, alternate in the black shale, and network veins and veins having dissemination of chalcopyrite, pyrite are also emplaced in black shale. These mineralizations are widely distributed, but most are weak copper-zinc-lead in content.

3 Recommendation for the future

On the basis of characteristic of the mineralization unravelled through this phase surveys, it is recommendable to prospect along mineralized horizone, and survey on the geological structure. It is desirable to apply the knowledge obtained through this survey to prospecting works in the other area.

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