PART II
DETAILED DISCUSSIONS

PART II DETAILED DISCUSSIONS

Chapter 1 MJZC - 9

1-1 Progress of Drilling

The location and the collar elevation of MJZC-9 are appended.

Summary of the drilling, record of the drilling operation and the drilling progress are shown in Tables 2-1-1 and 2-1-2, and Figure 2-1-1, respectively.

For the near surface zone to 40.00m, non-core drilling was made by 254mm percussion bit, and 219mm casing pipes were inserted to 40.00m. At 40.00 to 72.00m, non-core drilling was made by 203mm percussion bit, and 177mm casing pipes were inserted to 62.00m. Percussion drilling was continued by 165mm bit to 97m where percussion was given up due to the increase of water flow out from 62m depth,changed to skid-mounted WL, and 114mm casing pipes were inserted to 97m. Cuttings were collected at 1 m intervals during non-core drilling.

WL Coring was done by HQ bit to 201m, and NW casing pipes were inserted to 201m, drilled further to 1,144.76m by NQ bit and CHD rods. Rod grease, cutting oil and Drillprops were used in order to prevent vibration during operation.

Waters were supplied after pumping up from a water borehole drilled in the site.

Soft sheared zones were encountered at 405.8-420.2m. At the zone, the wall was cemented in order to prevent collapse.

Borehole deviation was measured at 60m intervals. Measurement showed northeastward deviation (Appendices).

1-2 Geology and Mineralization

The geologic log is appended. The geology of this borehole compared to that of the survey area described in 3-2 of PART I,

Table 2-1-1 Summary of the Drilling Operation on MJZC-9

Operation	Survey Period: Period	Day	Work Day		Off Day	Total Man Day: Engineer	Worker
Preparation	06.07.1995~10.07.1995 15.07.1995	6		5	1	15	48
Drilling	11.07.1995~13.07.1995 17.07.1995~21.09.1995	71	Drilling	53	9	224	430
			Recovering	6	3	29	54
Dismantling	14.07.1995 22.09.1995~26.09.1995	6		5	1	18	39
Total		83		69	14	286	571

Drilling Length	m		m
Length Planed	1100.00	Overburden	60.00
Increase/Decrease in Length	44.76	Core Length	1031.27
Length Drilled	1144.76	Core Recovery	98.43
(N/C Drilling)	97.00		
(Core Drilling)	1047.76		

Working Hours	h	%	%
Drilling	625.00	45.69	35.96
Other Working	550.00	40.20	31.65
Recovering	193.00	14.11	11.10
Subtotal	1368.00	100.00	78.71
Reassemblage	32.00		1.84
Dismantlement	18.00		1.04
Water Supply	270.00		15.54
Road Construction	8.00		0.46
Transportation	42.00		2.42
Grand Total	1738.00		100.00

Core Recovery of 100m Hole: Depth of Hole (m)	Core Recovery (%)	Core Recovery Cumulated (%)
0.00- 100.00	98.20	98.20
100.00- 200.00	94.16	94.28
200.00- 300.00	95.31	94.79
300.00- 400.00	97.99	95.85
400.00- 500.00	97.34	96.22
500.00- 600.00	100.00	96.97
600.00- 700.00	100.00	97.47
700.00- 800.00	99.16	97.71
800.00- 900.00	100.00	98.00
900.00-1000.00	100.00	98.22
1000.00-1100.00	99.60	98.36

Efficiency of Drilling			
	m	day	m/day
Total Length / Drilling Period	1144.76	71	16.12
	m	shift	m/shift
Total Length / Total Drilling Shifts	1144.76	100	11.45

Casing Pipe Inserted: Size	Meterage (m)	Meterage / Drilling Length ×100 (%)	Recovery (%)
219mm	40.00	3.49	0.0
177mm	62.00	5.42	0.0
114mm	97.00	8.47	0.0
NW	201.00	17.56	100.0
BX	0.00	0.00	

Drilling Length / Each Bit (m): Bit Size	Drilled Length	Core Length
254mm	40.00	N/C
203mm	22.00	N/C
165mm	35.00	N/C
HQ	104.00	98.10
NQ	943.76	933.17
BQ	0.00	0.00

Table 2-1-2 Record of the Drilling Operation on MJZC-9

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	shift 1	shift 2	Total Cumulated	Drilling Length	Core Length	Drilling	Total	Engineer	Worker
Jul 6	Rd-con	-	0.00	0.00	0.00	0.00	1.00	1.00	4.00
7	Pds	-	0.00	0.00	0.00	0.00	1.00	3.00	10.00
8	Tra	-	0.00	0.00	0.00	0.00	1.00	3.00	10.00
9	Day off	Day off	0.00	0.00	0.00	0.00	0.00	2.00	2.00
10	Tra	-	0.00	0.00	0.00	0.00	1.00	3.00	11.00
11	30.00	20.00	50.00	50.00	0.00	2.00	2.00	4.00	10.00
12	20.00	17.00	87.00	37.00	0.00	2.00	2.00	4.00	10.00
13	10.00	Drl-w/h	97.00	10.00	0.00	1.00	2.00	4.00	10.00
14	Drl-w/h	-	97.00	0.00	0.00	0.00	1.00	3.00	6.00
15	Tra	-	97.00	0.00	0.00	0.00	1.00	3.00	11.00
16	Day off	Day off	97.00	0.00	0.00	0.00	0.00	2.00	2.00
17	9.25	18.60	124.85	27.85	27.35	2.00	2.00	4.00	8.00
18	9.71	Maint	134.56	9.71	8.40	2.00	2.00	3.00	8.00
19	5.42	11.77	151.75	17.19	14.73	2.00	2.00	4.00	8.00
20	14.08	13.72	179.55	27.80	26.37	2.00	2.00	4.00	8.00
21	10.50	10.95	201.00	21.45	21.25	2.00	2.00	4.00	8.00
22	In-cp	In-cp	201.00	0.00	0.00	2.00	2.00	4.00	8.00
23	Day off	Day off	201.00	0.00	0.00	0.00	0.00	2.00	2.00
24	1.16	3.70	205.85	4.86	4.80	2.00	2.00	4.00	8.00
25	8.00	15.38	229.24	23.38	21.28	2.00	2.00	4.00	8.00
26	14.92	9.93	254.09	24.85	24.47	2.00	2.00	4.00	8.00
27	5.07	7.65	266.81	12.72	12.69	2.00	2.00	4.00	8.00
28	Day off	Day off	266.81	0.00	0.00	0.00	0.00	2.00	2.00
29	Day off	Day off	265.81	0.00	0.00	0.00	0.00	2.00	2.00
30	Day off	Day off	266.81	0.00	0.00	0.00	0.00	2.00	2.00
31	11.10	17.85	295.76	28.95	27.05	2.00	2.00	4.00	8.00
Aug 1	17.37	18.63	331.76	36.00	34.23	2.00	2.00	4.00	8.00
2	17.00	8.00	356.76	25.00	24.80	2.00	2.00	4.00	8.00
3	5.00	24.00	385.75	29.00	29.00	2.00	2.00	4.00	8.00
4	23.12	4.88	413.76	28.00	27.51	2.00	2.00	4.00	8.00
5	5.40	2.60	421.76	8.00	7.70	2.00	2.00	4.00	8.00
6	Day off	Day off	421.76	0.00	0.00	0.00	0.00	2.00	2.00
7	5.81	Cem	427.57	5.81	5.42	1.00	1.00	3.00	5.00
8	Dr-cem	7.59	435.16	7.59	7.29	2.00	2.00	4.00	8.00
9	16.60	18.00	469.75	34.60	34.31	2.00	2.00	4.00	8.00
10	18.00	7.86	495.62	25.86	25.28	2.00	2.00	4.00	8.00
11	0.43	Recov-bt	496.05	0.43	0.43	2.00	2.00	4.00	8.00
12	Recov-bt	Recov-bt	496.05	0.00	0.00	0.00	2.00	4.00	8.00
13	Day off	Day off	496.05	0.00	0.00	0.00	0.00	2.00	2.00
14	Wash	Cem	498.05	0.00	0.00	0.00	2.00	4.00	8.00
15	Day-off	Day-off	496.05	0.00	0.00	0.00	0.00	2.00	2.00
16	Day off	Day off	496.05	0.00	0.00	0.00	0.00	2.00	2.00
17	Day off	Day off	495.05	0.00	0.00	0.00	0.00	2.00	2.00
18	Day off	Dr-cem	436.05	0.00	0.00	0.00	1.00	3.00	5.00
19	Dra-cem	Dr-cem	495.05	0.00	0.00	0.00	2.00	4.00	8.00
20	Dr-cem	Day off	496.05	0.00	0.00	1.00	1.00	3.00	5.00
21	Dr-cem	3.76	499.81	3.76	3.20	2.00	2.00	4.00	8.00
22	23.95	21.22	544.98	45.17	45.17	2.00	2.00	4.00	8.00
23	20.78	6.00	571.76	26.78	25.78	2.00	2.00	4.00	8.00
24	6.00	24.00	601.76	30.00	30.00	2.00	2.00	4.00	8.00
25	24.00	18.00	643.76	42.00	42.00	2.00	2.00	4.00	8.00
26	12.00	12.00	667.76	24.00	24.00	2.00	2.00	4.00	8.00
27	18.00	24.00	709.76	42.00	42.00	2.00	2.00	4.00	8.00
28	24.00	24.00	757.76	48.00	49.00	2.00	2.00	4.00	8.00
29	11.80	6.20	775.76	18.00	17.18	2.00	2.00	4.00	8.00
30	12.00	6.00	793.76	18.00	18.00	2.00	2.00	4.00	8.00
31	6.00	Day off	799.76	6.00	6.00	1.00	1.00	3.00	5.00
Sep 1	Day off	Day off	799.76	0.00	0.00	0.00	0.00	2.00	2.00
2	Day off	Day off	857.86	0.00	0.00	0.00	0.00	2.00	2.00
3	Day off	Day off	799.76	0.00	0.00	0.00	0.00	2.00	2.00
4	Out-In-rd	12.00	811.76	12.00	12.00	2.00	2.00	4.00	8.00
5	21.40	20.60	853.76	42.00	42.00	2.00	2.00	4.00	8.00
6	16.31	12.48	882.55	28.79	28.79	2.00	2.00	4.00	8.00
7	19.21	18.00	919.76	37.21	37.21	2.00	2.00	4.00	8.00
8	Out-In-rd	Wash	919.76	0.00	0.00	2.00	2.00	4.00	8.00
9	12.00	9.00	940.76	21.00	21.00	2.00	2.00	4.00	8.00
10	18.00	12.00	970.76	30.00	30.00	2.00	2.00	4.00	8.00
11	24.00	18.00	1012.76	42.00	42.00	2.00	2.00	4.00	8.00
12	12.00	3.80	1028.56	15.80	15.80	2.00	2.00	4.00	8.00
13	2.20	4.30	1035.06	6.50	6.40	2.00	2.00	4.00	8.00
14	Out-In-rd	Wash	1035.06	0.00	0.00	0.00	2.00	4.00	8.00
15	Wash	4.70	1039.76	4.70	4.70	1.00	2.00	4.00	8.00
16	Maint	10.77	1050.53	10.77	10.77	1.00	2.00	4.00	8.00
17	11.81	6.92	1069.26	18.73	18.43	2.00	2.00	4.00	8.00
18	6.34	9.84	1085.44	16.18	15.18	2.00	2.00	4.00	8.00
19	14.32	12.00	1111.76	26.32	26.32	2.00	2.00	4.00	8.00
20	12.47	14.53	1138.75	27.00	27.00	2.00	2.00	4.00	8.00
21	4.70	1.30	1144.76	6.00	6.00	2.00	2.00	4.00	8.00
22	Surv	Out-cp	1144.76	0.00	0.00	0.00	2.00	4.00	8.00
23	Dis	Day off	1144.76	0.00	0.00	0.00	1.00	4.00	11.00
24	Day off	Day off	1144.76	0.00	0.00	0.00	0.00	2.00	2.00
25	Tra	Day off	1144.76	0.00	0.00	0.00	1.00	3.00	8.00
26	Dis	-	1144.76	0.00	0.00	0.00	1.00	2.00	4.00
Total	591.23	553.53	1144.76	1144.76	1031.27	100.00	123.00	285.00	571.00

Abbreviation
Band
:Banding
Cem
:Cementing
cp
:casing pipe
Dism
:Dismantlema
Dra-cem
:Dredging cem
Drl-w/h
:drilling wa
Exc
:Exchange
Ins
:Inserting
mac
:machine
Main
:Maintenace
Out
:Taking out
Pds
:Preparation
rd
:rod
Rd-con
:Road constr
Ream
:Reaming
Reass
:Reassembling
Recov-bt
:Recovering I
Surv
: Surveying
Tra
:Transportat
Wash
:Washing
Wedge
:Wedging
Wt-hd
:Waiting for

lacks the "Footwall Conglomerate" immediately below the "Ore Shale Horizon", but otherwise it agrees well. Geological description of the borehole is as follows.

Lower Roan Group

"Footwall Quartzite": 1,112.20 to 1,144.76m. It mainly consists of quartzite and sandstone with intercalation of biotite-anhydrite rock and thin conglomerate. the upper pebbly quartzite and coarse quartzite partly contain pelitic parts. Anhydrite, biotite and dolomite occur in the lower quartzite. The conglomerates are composed of quartz, altered granite and biotite schist pebbles and biotite matrix. Dissemination of minute chalcopyrite is observed at 1,112.20-1,121.40m.

"Ore Shale Horizon": 1,079.50 to 1,112.20m. It mainly consists of dolomitic argillites with grey thinly laminated layers. The basal part of this formation is made up of schistose argillite. The interval of 1,080.20 to 1112.20m is the sulfide mineralized zone composed of chalcopyrite and pyrite, partly rich in chalcopyrite. The sulfides occur as dissemination in the bedding planes and dissemination in silica concretion or dolomite veinlet. Results of ore assay are shown in Table 2-6-3. The cobalt mineral of this borehole was identified to be Cattierite and carrollite (Table 2-5-2).

"Hangingwall Quartzite and Argillite": 1,069.60 to 1079.50m. It mainly consists of grey quartzites. In the upper part, pelitic bands are intercalated. The lowest part is composed of thin alternation of pelitic beds and sandy beds.

"Interbedded Argillite and Quartzite": 1,038.80 to 1,069.60m. It is mainly composed of dark grey pelitic to dolomitic sandstone with intercalation of thin argillite, dolomite and quartzite. The lower part is composed of quartzitic sandstone. Lenses of anhydrites are observed frequently.

"Upper Quartzite": 1,028.00 to 1,038.80m. It is composed of grayish white coarse quartzite with minor amounts of pelitic bands and thin dolomitic sandstone beds.

Upper Roan Group

"Interbedded Argillite, Dolomite and Quartzite": 989.20 to 1,028.00m. The upper part consists mainly of pelitic sandstone with intercalation of thin argillite and dolomite beds. The

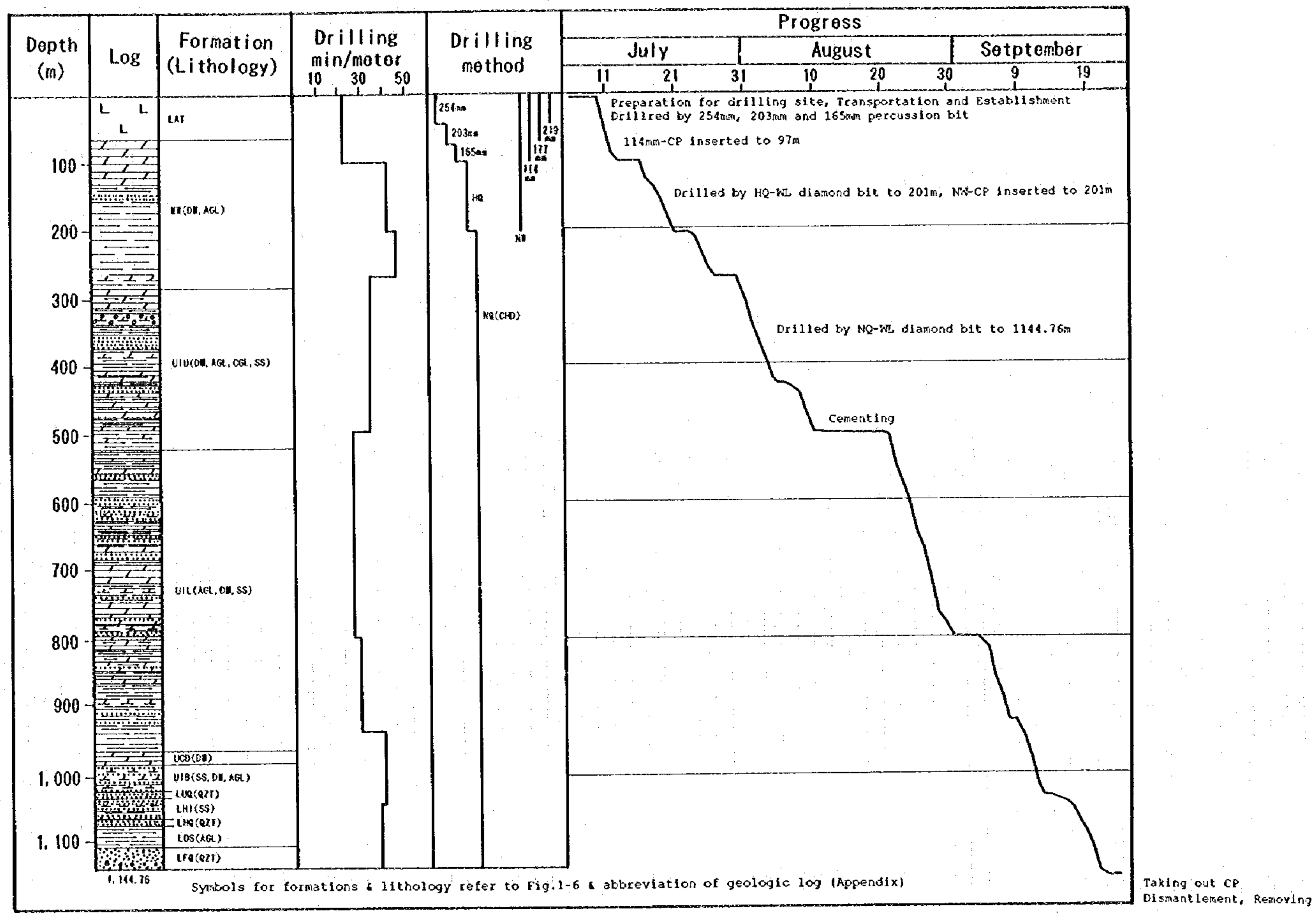


Fig. 2-1-1 Drilling Progress of MJZC-9

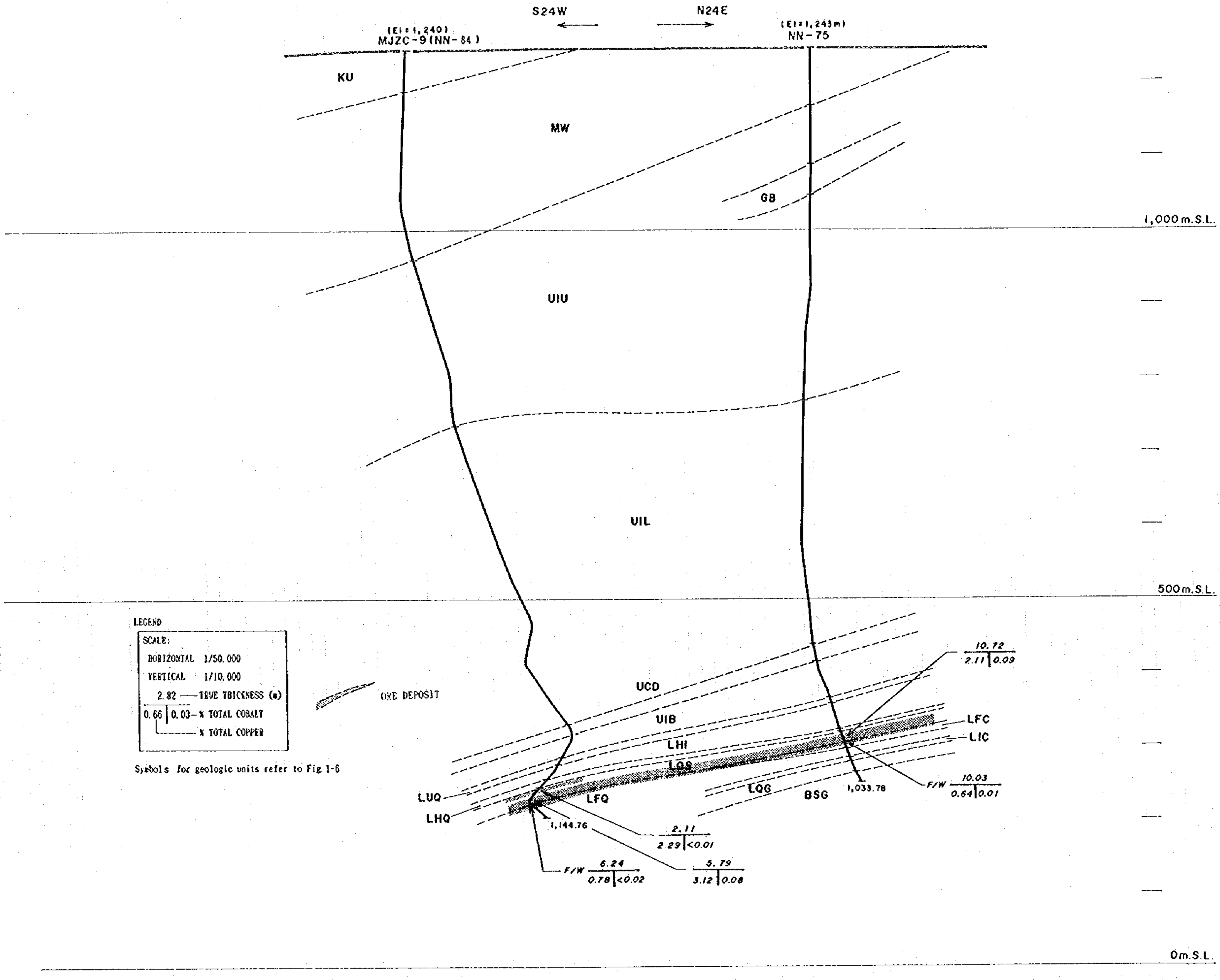


Fig. 2-1-2 Geological Profile of Drill Hole (MJZC-9)

lower part consists of thin-bedded alternation of dolomite, argillite and sandstone with quartzite lenses.

"Cherty Dolomite": 969.20 to 989.20m. It mainly consists of massive white dolomite with silica lenses. In the upper part, grey argillite (Marker Shale) is intercalated. Very fine-grained chalcopyrite and pyrite are disseminated between 984.60 and 987.70m.

"Arenite, Argillite and Dolomite with Anhydrite": 520.70 to 969.20m. It mainly consists of sandy argillite, dolomite and pelitic sandstone. The upper part, the middle part and the lower part are rich in pelitic sandstone, dolomite and sandy argillite, respectively. There are many lenses or patches or veinlets of anhydrite in this formation.

"Interbedded Argillite and Dolomite with Tectono-Breccias": 283.30 to 520.70m. The upper part consists of an alternation of dolomite, argillite and conglomerate, the middle part of alternation of sandy rock, dolomite and argillite, the lower part of alternation of dolomite and argillite. The conglomerate is composed of dolomite pebbles of irregular shape, and is argillized. Contemporaneous brecciations are developed in the argillite and sandstone, and many fractures are filled with dolomite or quartz. Minor amounts of gypsum bands and patches of anhydrite or disseminations of pyrite are partly observed in the upper part and the middle to lower part, respectively.

"Mwashia Group": 60.00 to 283.30m. The upper part is composed of pelitic dolomite. The lower part is composed mainly of argillite. The argillite is rich in shaly part with sandy or dolomitic intercalation.

1-3 Discussions

NN-75 is located to the north of the present site in question. This NN-75 confirmed the occurrence of a high-grade copper deposit. The mineralization encountered in both holes is developed from the "Ore Shale" to the footwall and belongs to the chalcopyrite zone. The geology of MJZC-9 is shown in the cross section (Figs. 1-7, 2-1-2). The "Ore Shale" is thicker in this borehole than in NN-75. In NN-75, the ore shoot occurs as one unit in "Ore Shale", whereas in this hole, the shoot is separated into two within the "Ore Shale" and the lower one continues into the footwall quartzite. The highest grade of copper and cobalt in both holes occurs in the lower part of the shoot, and it is possible that they are continuous.

Basement depth contour of the area was prepared from three holes (MJZC-6, 7, 10) drilled in the vicinity. And it is inferred that both holes are located over a basement depression which extend in the NE-SW direction. MJZC-6, 7, 10 are located on or near palaeo-basement highs at the time of ore deposition (2-3, 2nd year report).

From the similarity of mineralization encountered at this hole and NN-75 and the geologic structure of the area, the ore shoot confirmed by the two boreholes is concluded to be a continuous ore deposit emplaced over a basement depression which extend in approximately NE-SW . And this depression was formed on a limb of the palaeo-basement high at the time of ore deposition.

Chapter 2 MJZC -10

2-1 Progress of Drilling

The location and the collar elevation of MJZC-10 are appended.

Summary of the drilling, record of the drilling operation and the drilling progress are shown in Tables 2-1-1 and 2-1-2, and Figure 2-1-1, respectively.

For the near surface zone to 24.00m, non-core drilling was made by 254mm percussion bit, and 219mm casing pipes were inserted to 24.00m. At 24.00 to 32.00m, non-core drilling was made by 203mm percussion bit, and 177mm casing pipes were inserted to 32.00m. Percussion drilling was continued by 139mm bit to 60m where percussion was given up due to the increase of water flow out from around 32m depth. Then the method was changed to truck-mounted WL, and 114mm casing pipes were inserted to 60m. Cuttings were collected at 1 m intervals during non-core drilling.

WL Coring was done by HQ bit to 173.90m, and NW casing pipes were inserted to 173.90m, drilled further to 663.90m by NQ bit and CHD rods. Rods were broken at 520.35m depth, became impossible to drill further, the hole was wedged (1.5°) at 454.92m and drilling continued.

Soft sheared zones were encountered at 490-512m and 598-608m. At the zone, the wall was cemented in order to prevent collapse, and bentonite was used to drill further. At 958.40m depth drilled, rods breakage, hole bending and guide rod breakage in casing pipes happened at above sheared zone, and the drilling below 501m became impossible. These accidents seemed to be caused by the collapse. Consequently the hole was again wedged (1.5°) at 448.13m and drilling continued to 628.76m by NQ bit and BW casing pipes were inserted. Then core drilling was done by BQ bit to 1,009.86m.

Rod grease, cutting oil and Drillprops were used in order to prevent vibration during operation.

Waters were pumped up into a tanker from a water borehole

Table 2-2-1 Summary of the Drilling Operation on MJZC-10

Operation	Survey Period: Period	Day	Work Day		Off Day	Total Man Day: Engineer	Worker
Preparation	04.07.1995~07.07.1995 10.07.1995 06.10.1995~07.10.1995	6.00		5.00	1.00	21.00	62.00
Drilling	08.07.1995~09.07.1995 11.07.1995~04.10.1995 07.10.1995~27.11.1995	139.50	Drilling Recovering	84.00 44.50	5.00 6.00	370.00 190.00	821.00 398.00
Dismantling	10.07.1995 05.10.1995 28.11.1995~01.12.1995	5.50		5.50	0.00	21.00	49.00
Total		151.00		139.00	12.00	602.00	1330.00

Drilling Length	m		m
Length Planed	1100.00	Overburden	7.00
Increase/Decrease in Length	-90.14	Core Length	924.68
Length Drilled	1009.86	Core Recovery	97.35
(N/C Drilling)	60.00		
(Core Drilling)	949.86		

Working Hours	h	%	%
Drilling	634.00	21.30	17.16
Other Working	588.50	19.77	15.93
Recovering	1753.50	58.92	47.47
Subtotal	2976.00	100.00	80.56
Reassemblage	40.00		1.08
Dismantlement	28.00		0.76
Water Supply	612.00		16.57
Road Construction	8.00		0.22
Transportation	30.00		0.81
Grand Total	3694.00		100.00

Core Recovery of 100m Hole

Depth of Hole (m)	Core Recovery (%)	Core Recovery Cumulated (%)
0.00- 100.00	96.45	96.45
100.00- 200.00	95.46	95.74
200.00- 300.00	97.87	96.63
300.00- 400.00	90.27	94.76
400.00- 500.00	99.77	95.90
500.00- 600.00	98.15	96.31
600.00- 700.00	99.80	96.86
700.00- 800.00	99.25	97.18
800.00- 900.00	99.21	97.42
900.00-1000.00	96.76	97.35
1000.00-1100.00	96.94	97.35

Efficiency of Drilling

Total Length / Drilling Period	m 1009.86	day 151.00	m/day 6.69
Total Length / Total Drilling Shifts	m 1009.86	shift 167.00	m/shift 6.05

Casing Pipe Inserted

Size	Meterage (m)	Meterage / Drilling Length ×100 (%)	Recovery (%)
219mm	24.00	2.38	0.00
177mm	32.00	3.17	0.00
114mm	117.00	11.59	0.00
NW	173.90	17.22	100.00
BW	628.76	62.26	60.00

Drilling Length / Each Bit (m)

Bit Size	Drilled Length	Core Length
254mm	24.00	N/C
203mm	8.00	N/C
139mm	28.00	N/C
HQ	113.90	110.03
NQ	784.50	763.70
BQ	51.46	50.95

Table 2-2-2 Record of the Drilling Operation on MJZC-10 (1)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	shift 1	shift 2	Total Cumulated	Drilling Length	Core Length	Drilling	Total	Engineer	Worker
Jul 4	Rd-con	-	0.00	0.00	0.00	0.00	1.00	1.00	4.00
5	Pds	-	0.00	0.00	0.00	0.00	1.00	3.00	10.00
6	Tra	-	0.00	0.00	0.00	0.00	1.00	3.00	10.00
7	Ream	-	0.00	0.00	0.00	0.00	1.00	3.00	10.00
8	24.00	36.00	60.00	60.00	0.00	2.00	2.00	4.00	9.00
9	Day off	Day off	60.00	0.00	0.00	0.00	0.00	2.00	2.00
10	Ream	Day off	60.00	0.00	0.00	0.00	1.00	4.00	11.00
11	2.16	1.19	63.34	3.34	2.37	2.00	2.00	4.00	8.00
12	Main	6.10	69.44	6.10	6.10	2.00	2.00	4.00	8.00
13	15.30	3.10	87.84	18.40	18.40	2.00	2.00	4.00	8.00
14	5.30	1.04	94.18	6.34	5.97	2.00	2.00	4.00	6.00
15	Exc-bt	Day off	94.18	0.00	0.00	1.00	1.00	3.00	5.00
16	Day off	Day off	94.18	0.00	0.00	0.00	0.00	2.00	2.00
17	2.57	Recov	96.75	2.57	2.57	1.00	2.00	4.00	8.00
18	Recov	Recov	96.75	0.00	0.00	0.00	2.00	4.00	8.00
19	Recov	Recov	96.75	0.00	0.00	0.00	2.00	4.00	8.00
20	4.48	8.32	109.55	12.80	12.49	2.00	2.00	4.00	8.00
21	7.45	Ream	117.00	7.45	7.23	1.00	2.00	4.00	8.00
22	Ream	Ream	117.00	0.00	0.00	0.00	2.00	4.00	8.00
23	In-cp	In-cp	117.00	0.00	0.00	2.00	2.00	4.00	8.00
24	1.35	5.48	123.83	6.83	6.06	2.00	2.00	4.00	8.00
25	5.27	4.86	133.96	10.13	9.66	2.00	2.00	4.00	8.00
26	4.68	5.64	144.28	10.32	10.12	2.00	2.00	4.00	8.00
27	5.11	5.52	154.91	10.63	10.60	2.00	2.00	4.00	8.00
28	Day off	Day off	154.91	0.00	0.00	0.00	0.00	2.00	2.00
29	Day off	Day off	154.91	0.00	0.00	0.00	0.00	2.00	2.00
30	Day off	Day off	154.91	0.00	0.00	0.00	0.00	2.00	2.00
31	7.86	5.82	168.59	13.68	13.58	2.00	2.00	4.00	8.00
Aug 1	5.31	Recov	173.90	5.31	4.88	1.00	1.00	4.00	8.00
2	Recov	Recov	173.90	0.00	0.00	0.00	0.00	4.00	8.00
3	Recov	Recov	173.90	0.00	0.00	0.00	0.00	4.00	8.00
4	In-cp	Rd-ex	173.90	0.00	0.00	1.00	2.00	4.00	8.00
5	Main	Day off	173.90	0.00	0.00	0.00	1.00	3.00	5.00
6	Day off	Day off	173.90	0.00	0.00	0.00	0.00	2.00	2.00
7	10.04	10.71	194.65	20.75	18.66	2.00	2.00	4.00	10.00
8	17.35	17.50	229.50	34.85	34.85	2.00	2.00	4.00	10.00
9	10.80	14.10	254.40	24.90	23.56	2.00	2.00	4.00	10.00
10	14.50	7.50	276.40	22.00	21.59	2.00	2.00	4.00	10.00
11	12.80	14.00	303.20	26.80	26.37	2.00	2.00	4.00	10.00
12	3.00	Out-rd	306.20	3.00	2.84	1.00	1.00	4.00	10.00
13	Day off	Day off	306.20	0.00	0.00	0.00	0.00	2.00	2.00
14	In-rd	9.70	315.90	9.70	5.90	2.00	2.00	4.00	10.00
15	2.15	Recov	318.05	2.15	0.94	2.00	2.00	4.00	10.00
16	2.70	3.65	324.40	6.35	3.23	2.00	2.00	4.00	10.00
17	10.50	17.00	351.90	27.50	26.65	2.00	2.00	4.00	10.00
18	13.16	1.34	366.40	14.50	14.30	2.00	2.00	4.00	10.00
19	6.42	2.88	375.70	9.30	8.96	2.00	2.00	4.00	10.00
20	7.30	Day off	383.00	7.30	7.30	1.00	1.00	3.00	6.00
21	16.90	20.05	419.95	36.95	36.95	2.00	2.00	4.00	10.00
22	23.55	14.06	457.56	37.61	37.61	2.00	2.00	4.00	10.00
23	13.04	9.57	480.17	22.61	22.61	2.00	2.00	4.00	10.00
24	8.73	9.50	499.40	18.23	18.00	2.00	2.00	4.00	10.00
25	8.00	14.34	521.74	22.34	22.29	2.00	2.00	4.00	10.00
26	12.76	15.43	549.93	28.19	26.58	2.00	2.00	4.00	10.00
27	17.93	14.14	582.00	32.07	31.88	2.00	2.00	4.00	10.00
28	15.90	4.71	602.61	20.61	20.61	2.00	2.00	4.00	10.00
29	Band	Recov	602.61	0.00	0.00	2.00	2.00	4.00	10.00
30	In-rd	4.92	607.53	4.92	4.74	1.00	2.00	4.00	10.00
31	20.97	12.00	639.90	32.97	32.37	2.00	2.00	4.00	10.00
Sep 1	12.43	11.60	663.90	24.00	24.00	2.00	2.00	4.00	10.00
2	Recov	Recov	663.90	0.00	0.00	0.00	2.00	4.00	10.00
3	Recov	Recov	663.90	0.00	0.00	0.00	2.00	4.00	10.00
4	Recov	Recov	663.90	0.00	0.00	0.00	2.00	4.00	10.00
5	Recov	Recov	663.90	0.00	0.00	0.00	2.00	4.00	10.00
6	Recov	Recov	663.90	0.00	0.00	0.00	2.00	4.00	10.00
7	Recov	Recov	663.90	0.00	0.00	0.00	2.00	4.00	10.00
8	Recov	Wedge	663.90	0.00	0.00	0.00	2.00	4.00	10.00
9	Cem	Day off	663.90	0.00	0.00	0.00	1.00	3.00	6.00
10	Day off	Day off	663.90	0.00	0.00	0.00	0.00	2.00	2.00
11	Day off	Day off	663.90	0.00	0.00	0.00	0.00	2.00	2.00
12	In-rd	R-D(9.99)	663.90	0.00	0.00	1.00	2.00	4.00	10.00
13	R-D(2.44)	R-D(9.32)	663.90	0.00	0.00	2.00	2.00	4.00	10.00
14	R-D(9.45)	R-D(7.34)	663.90	0.00	0.00	2.00	2.00	4.00	10.00
15	R-D(12.04)	Day off	663.90	0.00	0.00	1.00	1.00	3.00	6.00
16	R-D(11.01)	R-D(9.39)	663.90	0.00	0.00	2.00	2.00	4.00	10.00
17	R-D(8.23)	R-D(9.77)	663.90	0.00	0.00	2.00	2.00	4.00	10.00
18	R-D(12.50)	R-D(5.50)	663.90	0.00	0.00	2.00	2.00	4.00	10.00
19	Cem	Day off	663.90	0.00	0.00	0.00	1.00	3.00	6.00
20	In-rd	Day off	663.90	0.00	0.00	0.00	0.00	3.00	6.00
21	Dre-cem	Dre-cem	663.90	0.00	0.00	0.00	0.00	4.00	10.00
22	R-D(12.40)	R-D(14.40)	663.90	0.00	0.00	2.00	2.00	4.00	10.00
23	R-D(18.18)	R-D(9.10)	663.90	0.00	0.00	2.00	2.00	4.00	10.00
24	R-D(24.00)	Out-In-rd	663.90	0.00	0.00	2.00	2.00	4.00	10.00
25	Cem	Day off	663.90	0.00	0.00	1.00	1.00	3.00	6.00
26	Day off	Day off	663.90	0.00	0.00	0.00	0.00	2.00	2.00
27	Dre-cem	Dre-cem	663.90	0.00	0.00	2.00	2.00	4.00	10.00
28	R-D(30.00)	14.65	678.56	14.66	14.66	2.00	2.00	4.00	10.00
29	6.14	In-rd	684.70	6.14	6.14	2.00	2.00	4.00	10.00
30	4.63	8.21	697.54	12.84	12.84	2.00	2.00	4.00	10.00
Oct 1	12.76	13.60	723.90	26.36	26.11	2.00	2.00	4.00	10.00
2	18.00	12.00	753.90	30.00	29.56	2.00	2.00	4.00	10.00

Table 2-2-2 Record of the Drilling Operation on MJZC-10 (2)

3	21.80	20.00	795.70	41.80	41.72	2.00	2.00	4.00	10.00
4	18.20	Day off	813.90	18.20	18.20	1.00	1.00	3.00	8.00
5	Day off	Day off	813.90	0.00	0.00	0.00	1.00	3.00	0.00
6	Day off	Day off	813.90	0.00	0.00	0.00	0.00	2.00	2.00
7	Reas	7.14	821.04	7.14	6.60	1.00	2.00	5.00	15.00
8	12.00	18.00	851.04	30.00	29.90	2.00	2.00	4.00	10.00
9	7.66	Recov	858.70	7.66	7.51	1.00	2.00	4.00	10.00
10	Recov	Recov	858.70	0.00	0.00	0.00	2.00	4.00	10.00
11	In-Out-rd	Exc-rd	858.70	0.00	0.00	0.00	2.00	4.00	10.00
12	Wash	Wash	858.70	0.00	0.00	0.00	2.00	4.00	10.00
13	Wash	13.41	872.11	13.41	13.41	1.00	2.00	4.00	10.00
14	20.93	12.00	905.04	32.93	32.93	2.00	2.00	4.00	10.00
15	14.06	9.55	928.65	23.61	23.41	2.00	2.00	4.00	10.00
16	Recov	In-rd	928.65	0.00	0.00	0.00	2.00	4.00	10.00
17	6.39	12.00	947.04	18.39	16.24	2.00	2.00	4.00	10.00
18	11.36	Recov	958.40	11.36	10.68	1.00	2.00	4.00	10.00
19	Recov	Recov	958.40	0.00	0.00	0.00	2.00	4.00	10.00
20	Recov	Recov	958.40	0.00	0.00	0.00	2.00	4.00	10.00
21	Recov	Recov	958.40	0.00	0.00	0.00	2.00	4.00	10.00
22	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
23	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
24	Day off	Day off	958.40	0.00	0.00	0.00	0.00	2.00	2.00
25	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
26	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
27	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
28	Recov	Day off	958.40	0.00	0.00	0.00	1.00	4.00	6.00
29	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
30	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
31	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
Nov 1	Wedge	In-rd	958.40	0.00	0.00	1.00	2.00	5.00	10.00
2	R-D(8.79)	R-D(9.70)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
3	R-D(9.61)	R-D(8.00)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
4	R-D(9.00)	R-D(9.00)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
5	R-D(5.26)	R-D(8.59)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
6	R-D(4.15)	R-D(10.21)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
7	R-D(15.01)	R-D(13.05)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
8	R-D(13.91)	R-D(11.31)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
9	R-D(14.34)	R-D(8.98)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
10	R-D(8.72)	R-D(13.56)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
11	R-D(4.92)	In-cp	958.40	0.00	0.00	1.00	2.00	5.00	10.00
12	In-cp	Surv	958.40	0.00	0.00	0.00	2.00	5.00	10.00
13	In-rd	Wash	958.40	0.00	0.00	0.00	2.00	5.00	10.00
14	R-D(21.95)	R-D(6.87)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
15	R-D(31.32)	R-D(24.99)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
16	R-D(24.60)	R-D(3.50)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
17	R-D(21.24)	R-D(27.00)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
18	R-D(27.00)	R-D(17.06)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
19	R-D(22.07)	R-D(14.27)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
20	R-D(19.19)	R-D(16.70)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
21	R-D(7.97)	R-D(4.40)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
22	Recov	Recov	958.40	0.00	0.00	0.00	2.00	5.00	10.00
23	R-D(1.94)	R-D(10.05)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
24	R-D(9.88)	R-D(14.17)	958.40	0.00	0.00	2.00	2.00	5.00	10.00
25	13.30	18.00	989.70	31.30	31.30	2.00	2.00	5.00	10.00
26	Out-In-rd	3.50	993.20	3.50	3.50	1.00	2.00	5.00	10.00
27	8.70	6.96	1009.86	16.66	16.15	2.00	2.00	5.00	10.00
28	Surv	Out-cp	1009.86	0.00	0.00	0.00	2.00	5.00	10.00
29	Dism	Day off	1009.86	0.00	0.00	0.00	1.00	5.00	11.00
30	Tra	Day off	1009.86	0.00	0.00	0.00	1.00	5.00	11.00
Dec 1	Dism	-	1009.86	0.00	0.00	0.00	1.00	3.00	8.00
	528.07	480.79		1009.86	924.68	187.00	250.00	602.00	1330.00

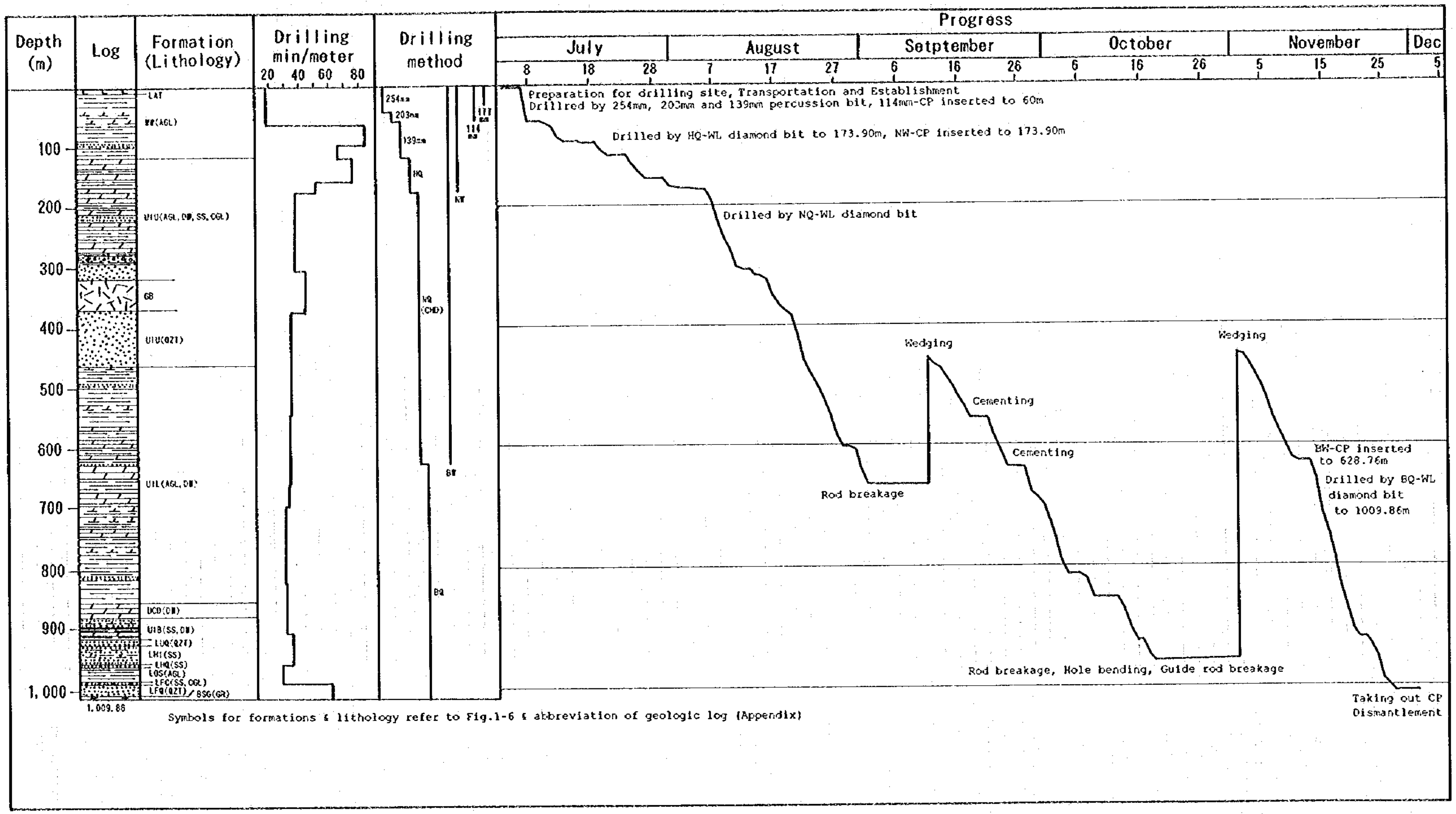


Fig. 2-2-1 Drilling Progress of MJZC-10

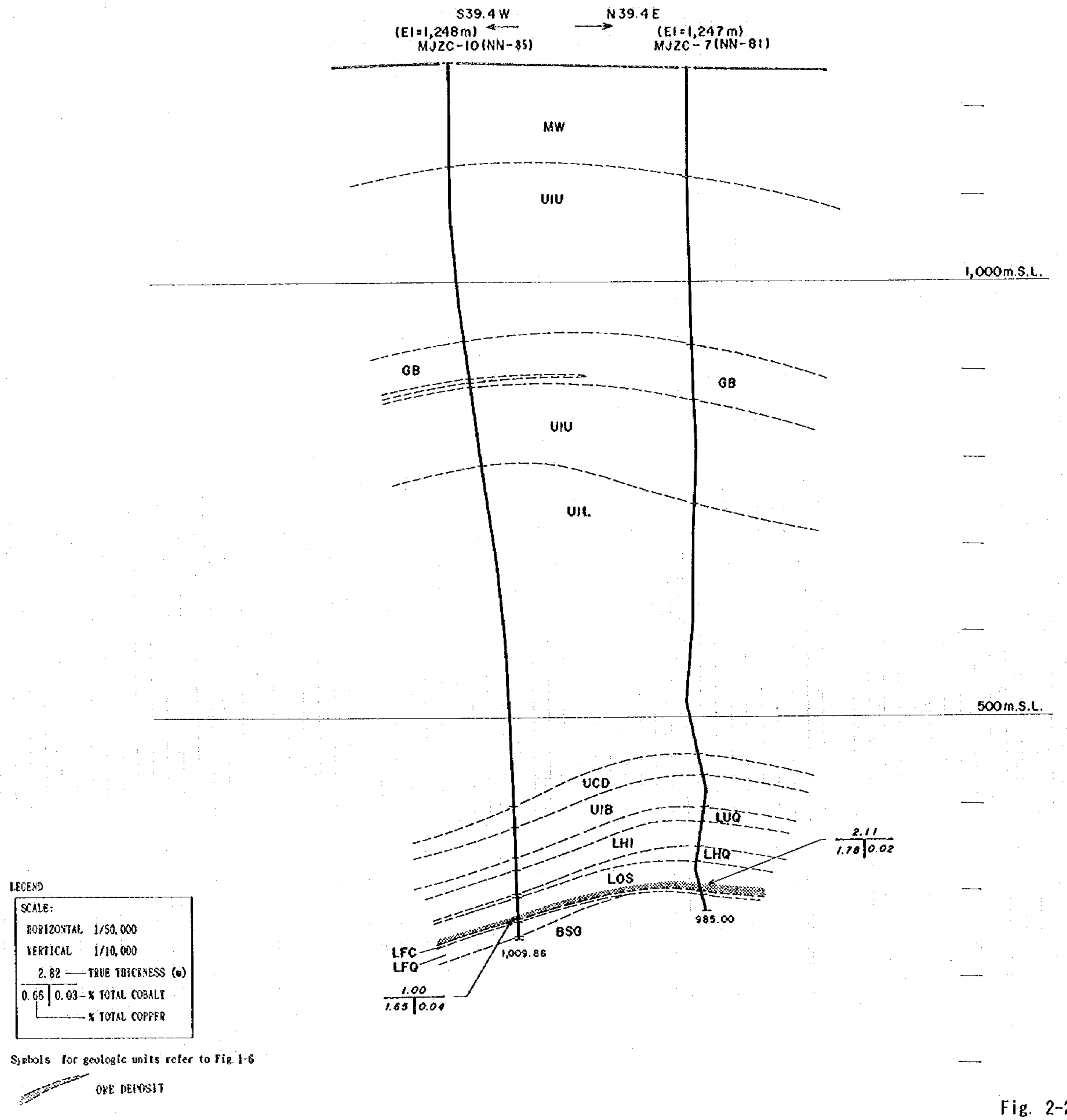


Fig. 2-2-2 Geological Profile of Drill Hole (MJZC-10)

drilled in the site of MJZC-9, and the tanker was transported to MJZC-10 by a tractor.

At 813.90m depth drilled, spindle bearing of drilling machine (Strata) was broken, and the machine was replaced by L-44 due to a long time to get exchange parts.

Borehole deviation was surveyed at 60m intervals. Surveying showed north-northeastward deviation (Appendices).

2-2 Geology and Mineralization

The geologic log is appended. The geology of this borehole compared to that of the survey area described in 3-2 of PART I, lacks the "Intermediate Conglomerate", "Feldspathic Quartzite and Grit" and "Basal Conglomerate" of the Footwall Formation, but otherwise it agrees well. Geological description of the borehole is as follows.

"Basement": 1,007.80 to 1,009.86m. The rock is altered coarse-crystalline granite. Strong biotitization and argillization of feldspar are observed in this rock. Also, weak dissemination of minute pyrite grains occurs.

Lower Roan Group
"Footwall Quartzite": 988.40 to 1,007.80m. It mainly consists of gray argillaceous quartzite and greywacke with pelitic parts irregularly. Anhydrite- biotite rock and thin bed of biotite rock occur in the basal part of this formation. Dissemination of chalcopyrite is observed at 988.40-995.20m.

"Footwall Conglomerate": 987.40 to 988.40m. It is composed of conglomerate and pebbly dolomitic sandstone. The conglomerate consists of quartz and feldspar granules. Pyrite dissemination is observed in this formation.

"Ore Shale Horizon": 961.30 to 987.40m. The upper part mainly consists of black sandy argillite with thin lamination. The lower part is made up of gray to black dolomitic argillite, and rich in biotite. The interval of 961.30 to 971.50m is the pyritized zone and 971.50 to 974.90m is pyrite-pyrrhotite zone and 974.90 to 979.80m is pyrite-pyrrhotite-chalcopyrite zone and 979.80 to 982.50m is pyrrhotite-chalcopyrite zone and

982.50 to 987.40m is chalcopyrite-pyrite zone. The sulfides occur as dissemination at the bedding planes , the rim of dolomite concretions and patches or lenses of irregular shape. Results of ore assay are shown in Table 2-6-3. The cobalt mineral of this borehole was identified to be cobalt pentlandite (Table 2-5-2).

"Hangingwall Quartzite and Argillite": 957.90 to 961.30m. It mainly consists of siliceous greywacke, siliceous granule conglomerate, quartzite and pebbly argillite. Local weak dissemination of pyrite is observed.

"Interbedded Argillite and Quartzite": 927.70 to 957.90m. It is composed mainly of pelitic and dolomitic sandstone to greywacke with intercalation of thin dolomite, argillite and quartzitic lenses. Pyrite dissemination is observed in pelitic parts, and also, local anhydritization (lenses, patches) is observed.

"Upper Quartzite": 916.00 to 927.70m. It is composed of grayish white quartzite with pelitic bands. Pyrite dissemination is observed in the pelitic bands.

Upper Roan Group

"Interbedded Argillite, Dolomite and Quartzite": 879.00 to 916.00m. This is composed of thin-bedded alternation of pelitic sandstone, dolomite and argillite. The upper part is rich in sandstone, and the lower part is rich in dolomite and argillite.
Pyrite dissemination and silicification are locally observed in the basal part.

"Cherty Dolomite": 854.55 to 879.00m. It mainly consists of dolomite with anhydrite. In the upper part, dark green sandy argillite (Marker Shale) is intercalated. Weak dissemination of minute chalcopyrite-pyrite grains is observed between 869.70 and 878.00m.

"Arenite, Argillite and Dolomite with Anhydrite": 460.20 to 854.55m. The upper part mainly consists of dark gay thinly laminated argillite with small amount of thin local intercalation of dolomite and sandstone. The middle part mainly consists of an alternation zone of green to gray massive argillite and dolomite with small amount of thin quartzitic sandstone intercalation. The lower part is composed mainly of dark gray to black micaceous and sandy argillite with small amount of thin dolomite bed, thin sandstone bed, quartzite lens and grit. Contemporaneous brecciation and sheared zone are developed in the above argillite, and many fractures are filled with dolomite or quartz or green clay. The middle and lower part have been anhydritized (veinlets, patches, lenses) as a whole. Pyrite dissemination is observed frequently in the middle part.

"Interbedded Argillite and Dolomite with Tectono-Breccias": 115.00 to 316.50m, 361.90 to 364.80m, 368.00 to 460.20m. The upper part mainly consists of an alternation of dolomite and argillite with thin intercalation of sandy rock and conglomerate. The conglomerate is composed of dolomite and argillite pebbles. The lower part mainly consists of quartzite with local pebbles of pelitic sandstone. Weak pyrite dissemination is observed frequently in the upper part.

"Mwashia Group": 7.00 to 115.00m. It mainly consists of gray micaceous to dolomitic argillite and black dolomitic shale with intercalation of dolomite and thin sandstone bed. Dissemination and lenses to laminas of pyrite-pyrrhotite are observed in the black shale.

"Gabbro (Amphibolite)" 316.50 to 361.90m, 364.80 to 368.00m. The bodies are dark gray altered and massive and strongly carbonatized and biotized.

2-3 Discussions

This borehole is located on a limb of a basement high (Figs. 1-7, 2-2-2). It is inferred that this hole is located in the vicinity of palaeo-basement high at the start of "Ore Shale" deposition. The mineralized zone of this hole is developed from the "Ore Shale" horizon toward the footwall, and zonal distribution of sulfide minerals are observed. The Fe/Cu ratio generally increases upward from chalcopyrite zones of "Footwall Quartzite" and "Footwall Conglomerate" to pyrite zone of upper "Ore Shale". This is interpreted to indicate that; in this area, the sea rapidly became deeper after the start of the deposition of the "Ore Shale" and consequently the environment became chemically reducing. Therefore, it is considered that the oreshoot was formed in this area because of the formation of a deep local depression in a relatively short period of time after the start of "Ore Shale" deposition on the limb of a palaeo-basement high. Ore shoots were not encountered in this hole, but the existence of rich ore in the vicinity is a possibility.

Chapter 3 MJZC -11

3-1 Progress of Drilling

The location and the collar elevation of MJZC-11 are appended.

Summary of the drilling, record of the drilling operation and the drilling progress are shown in Tables 2-3-1 and 2-3-2, and Figure 2-3-1, respectively.

For the near surface zone to 36.00m, non-core drilling was made by 254mm percussion bit, and 219mm casing pipes were inserted to 33.00m. At 33.00 to 95.00m, non-core drilling was made by 203mm percussion bit, and 141mm casing pipes were inserted to 95.00m. Percussion drilling was continued by 114mm bit to 126m where percussion was given up due to the increase of water flow out from near 32m depth. Then the method was changed to skid-mounted WL, after 114mm casing pipes were inserted to 95m. Cuttings were collected at 1 m intervals during non-core drilling.

WL Coring was done by HQ bit to 174.00m, and NW casing pipes were inserted to 174.00m, drilled further to 852.87m by NQ bit and CHD rods. At 557.15m depth drilled, the machine (Sullvin-22) was replaced by L-44 due to a small capacity of drilling.

Rod grease, cutting oil and Drillprops were used in order to prevent vibration during operation.

Waters were supplied after pumping up from a water borehole drilled in the site of this hole.

Borehole deviation was surveyed at 60m intervals. Surveying showed north-northeastward deviation (Appendices).

3-2 Geology and Mineralization

The geologic log is appended. The geology of this borehole compared to that of the survey area described in 3-2 of PART I, lacks the "Basal Conglomerate" of the Footwall Formation, but otherwise it agrees well. Geological description of the bore-

Table 2-3-1 Summary of the Drilling Operation on MJZC-11

Operation	Survey Period: Period	Day	Work Day		Off Day	Total Man Day: Engineer	Worker
Preparation	23.07.1995~24.07.1995						
	28.07.1995						
	29.07.1995~06.08.1995						
	07.08.1995~08.08.1995						
	15.09.1995	14.5		5.5	9.0	35	78
Drilling	25.07.1995~27.07.1995						
	09.08.1995~13.09.1995		Drilling	42.5	4.0	164	376
	15.09.1995~25.09.1995	49.5	Recovering	3.0	0.0	12	51
Dismantling	14.09.1995						
	26.09.1995~04.10.1995	10.0		9.0	1.0	30	82
Total		74.0		60.0	14.0	243	592

Drilling Length	m		m
Length Planned	1100.00	Overburden	6.00
Increase/Decrease in Length	-247.13	Core Length	720.63
Length Drilled	852.87	Core Recovery	99.14
(N/C Drilling)	126.00		
(Core Drilling)	726.87		

Working Hours	h	%	%
Drilling	491.00	49.30	37.61
Other Working	414.00	41.57	31.71
Recovering	91.00	9.14	6.97
Subtotal	996.00	100.00	76.29
Reassemblage	46.00		3.52
Dismantlement	30.00		2.30
Water Supply	189.50		14.52
Road Construction	0.00		0.00
Transportation	44.00		3.37
Grand Total	1305.50		100.00

Casing Pipe Inserted

Size	Meterage (m)	Meterage / Drilling Length ×100 (%)	Recovery (%)
219mm	33.00	3.87	0.0
141mm	95.00	11.14	0.0
114mm	95.00	11.14	37.9
NW	174.00	20.40	65.5
BX	0.00	0.00	

Core Recovery of 100m Hole

Depth of Hole (m)	Core Recovery (%)	Core Recovery Cumulated (%)
0.00- 100.00	-	-
100.00- 200.00	95.07	95.07
200.00- 300.00	98.55	97.07
300.00- 400.00	100.00	98.14
400.00- 500.00	100.00	98.64
500.00- 600.00	100.00	98.92
600.00- 700.00	98.86	98.91
700.00- 800.00	100.00	99.07
800.00- 900.00	100.00	99.14

Efficiency of Drilling

Total Length / Drilling Period	m 852.87	day 49.5	m/day 17.23
Total Length / Total Drilling Shifts	m 852.87	shift 68	m/shift 12.54

Drilling Length / Each Bit (m)

Bit Size	Drilled Length	Core Length
254mm	36.00	N/C
203mm	59.00	N/C
114mm	31.00	N/C
HQ	48.00	44.39
NQ	678.87	676.24
BQ	0.00	0.00

Table 2-3-2 Record of the Drilling Operation on MJZC-11

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	shift 1	shift 2	Total Cumulated	Drilling Length	Core Length	Drilling	Total	Engineer	Worker
Jul 23	Pds	Day off	0.00	0.00	0.00	0.00	1.00	3.00	9.00
24	Reas	Day off	0.00	0.00	0.00	0.00	1.00	3.00	9.00
25	65.00	Day off	65.00	65.00	0.00	1.00	1.00	3.00	7.00
26	29.00	Day off	95.00	29.00	0.00	1.00	1.00	3.00	6.00
27	31.00	Day off	125.00	31.00	0.00	1.00	1.00	3.00	6.00
28	Drl-w/h	Day off	125.00	0.00	0.00	0.00	1.00	3.00	6.00
29	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
30	Day off	Day off	126.00	0.00	0.00	0.00	0.00	2.00	2.00
31	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
Aug 1	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
2	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
3	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
4	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
5	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
6	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
7	Tra-Reas-mac	Day off	125.00	0.00	0.00	0.00	1.00	3.00	13.00
8	Reas	Day off	125.00	0.00	0.00	0.00	1.00	3.00	13.00
9	Recov-cp	Day off	125.00	0.00	0.00	0.00	1.00	3.00	13.00
10	Recov-cp	Day off	125.00	0.00	0.00	0.00	1.00	3.00	13.00
11	Recov-cp	Day off	125.00	0.00	0.00	0.00	1.00	3.00	13.00
12	In-cp	Day off	125.00	0.00	0.00	0.00	1.00	3.00	13.00
13	Day off	Day off	125.00	0.00	0.00	0.00	0.00	2.00	2.00
14	Reas-cp	Day off	125.00	0.00	0.00	0.00	1.00	3.00	6.00
15	4.50	Recov-rd	130.50	4.50	4.28	1.00	1.00	3.00	6.00
16	1.59	Day off	132.09	1.59	1.50	1.00	1.00	3.00	6.00
17	4.10	3.21	139.40	7.31	7.26	2.00	2.00	4.00	10.00
18	6.75	5.08	151.23	11.83	10.83	2.00	2.00	4.00	10.00
19	5.73	3.10	160.06	8.83	7.33	2.00	2.00	4.00	10.00
20	3.54	5.85	169.46	9.40	8.90	2.00	2.00	4.00	10.00
21	Wait	4.54	174.00	4.54	4.29	1.00	2.00	4.00	10.00
22	In-cp	Ins-cp	174.00	0.00	0.00	0.00	2.00	4.00	10.00
23	In-rd	9.02	183.02	9.02	9.00	1.00	2.00	4.00	10.00
24	7.37	1.57	191.95	8.94	8.94	2.00	2.00	4.00	10.00
25	4.53	15.80	212.29	20.33	20.28	2.00	2.00	4.00	10.00
26	15.60	14.40	242.29	30.00	30.00	2.00	2.00	4.00	10.00
27	6.00	14.13	252.42	20.13	20.13	2.00	2.00	4.00	10.00
28	14.27	1.60	278.29	15.87	14.97	2.00	2.00	4.00	10.00
29	4.40	9.20	291.89	13.60	13.09	2.00	2.00	4.00	10.00
30	12.60	7.80	312.29	20.40	20.40	2.00	2.00	4.00	10.00
31	8.00	Day off	320.29	8.00	8.00	1.00	1.00	3.00	6.00
Sep 1	Day off	Day off	320.29	0.00	0.00	0.00	0.00	2.00	2.00
2	Day off	Day off	320.29	0.00	0.00	0.00	0.00	2.00	2.00
3	Day off	Day off	320.29	0.00	0.00	0.00	0.00	2.00	2.00
4	17.20	12.80	350.29	30.00	30.00	2.00	2.00	4.00	10.00
5	13.86	1.00	365.15	14.86	14.86	2.00	2.00	4.00	10.00
6	12.00	24.00	401.15	36.00	35.00	2.00	2.00	4.00	10.00
7	18.00	22.20	441.35	40.20	40.20	2.00	2.00	4.00	10.00
8	19.80	6.00	467.15	25.80	25.80	2.00	2.00	4.00	10.00
9	Exc-cable	6.00	473.15	6.00	5.00	1.00	2.00	4.00	10.00
10	Out-In-rd	12.00	485.15	12.00	12.00	2.00	2.00	4.00	10.00
11	17.00	11.85	514.00	28.85	28.85	2.00	2.00	4.00	10.00
12	Out-In-rd	9.35	523.35	9.35	9.35	2.00	2.00	4.00	10.00
13	15.80	18.00	557.15	33.80	33.80	2.00	2.00	4.00	10.00
14	Exc-mac	Day off	557.15	0.00	0.00	0.00	1.00	3.00	11.00
15	Reas	13.20	570.35	13.20	13.20	1.00	2.00	4.00	15.00
16	16.70	Day off	587.05	16.70	16.70	1.00	1.00	3.00	5.00
17	12.00	2.02	601.07	14.02	14.02	2.00	2.00	4.00	10.00
18	Recov-rd	2.60	603.57	2.60	1.45	1.00	2.00	4.00	10.00
19	19.48	17.90	641.05	37.38	37.38	2.00	2.00	4.00	10.00
20	20.30	19.00	680.35	39.30	39.30	2.00	2.00	4.00	10.00
21	20.70	23.00	724.05	43.70	43.70	2.00	2.00	4.00	10.00
22	17.70	Exc-bt	741.75	17.70	17.70	2.00	2.00	4.00	10.00
23	11.25	20.05	773.05	31.30	31.30	2.00	2.00	4.00	10.00
24	17.00	18.00	809.05	35.00	35.00	2.00	2.00	4.00	4.00
25	21.90	21.92	852.87	43.82	43.82	2.00	2.00	4.00	4.00
26	Surv	Day off	852.87	0.00	0.00	0.00	1.00	3.00	3.00
27	Recov-cp	Day off	852.87	0.00	0.00	0.00	1.00	3.00	9.00
28	Recov-cp	Day off	852.87	0.00	0.00	0.00	1.00	3.00	9.00
29	Recov-cp	Day off	852.87	0.00	0.00	0.00	1.00	3.00	9.00
30	Recov-cp	Day off	852.87	0.00	0.00	0.00	1.00	3.00	9.00
Oct 1	Day Off	Day off	852.87	0.00	0.00	0.00	0.00	2.00	2.00
2	Dism	Day off	852.87	0.00	0.00	0.00	1.00	4.00	11.00
3	Tra	Day off	852.87	0.00	0.00	0.00	1.00	4.00	11.00
4	Dism	Day off	852.87	0.00	0.00	0.00	1.00	2.00	8.00
Total	495.67	357.20	852.87	852.87	720.69	68.00	94.00	243.00	592.00

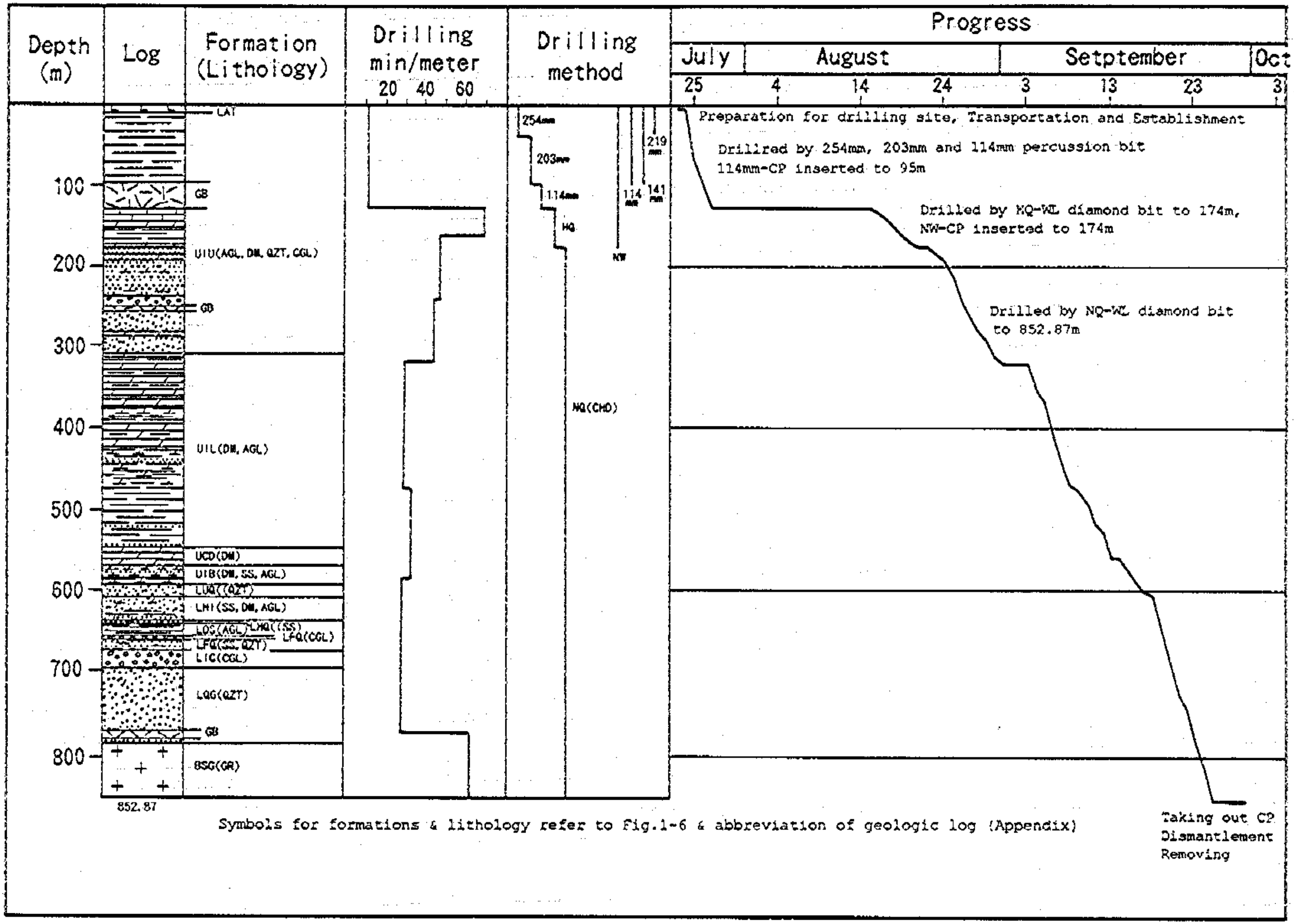
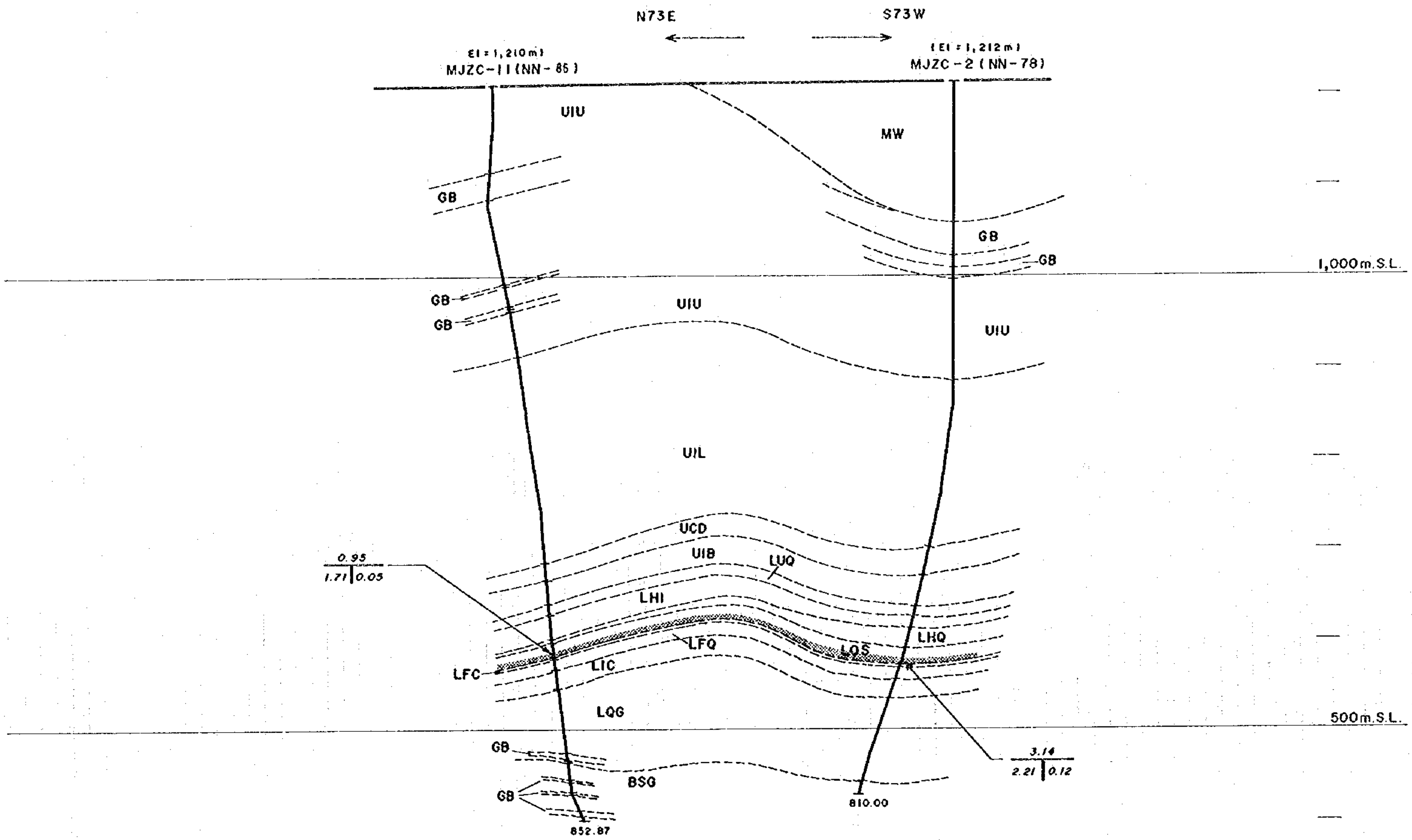


Fig. 2-3-1 Drilling Progress of MJZC-11



LEGEND

SCALE:
HORIZONTAL 1/50,000
VERTICAL 1/10,000
2.82 — TRUE THICKNESS (m)
0.66 | 0.03 — % TOTAL COBALT
└ % TOTAL COPPER

Symbols for geologic units refer to Fig.1-6

ORE DEPOSIT

Fig. 2-3-2 Geological Profile of Drill Hole (MJZC-11)

hole is as follows.

"Basement": 785.70 to 852.87m. The rock is altered granite. Strong silicification or bleaching occur locally. Thin amphibolites are intercalated frequently in this rock. This amphibolite seems to be mafic intrusive rock.

Lower Roan Group

"Feldspathic Quartzite and Grit": 697.00 to 771.60m, 782.10 to 785.70m. It mainly consists of white to gray quartzite. Pebbly quartzite and thin conglomerate bed are intercalated in the middle part. Thin beds of gritty and pelitic sandstone are intercalated in the lower part. The quartzite contains bands or dissemination of biotite. Also, amphibolite supposed to be mafic intrusive rock occurs in th lower part.

"Intermediate Conglomerate": 672.70 to 697.00m. It mainly consists of conglomerate with intercalation of small amount of thin quartzite bed in the lower part. The conglomerate contains various types of pebbles of rounded to subangular shape such as quartzite, sandstone, biotized argillite, chert, quartz, potash feldspar, granite and schist.

"Footwall Quartzite": 658.70 to 672.70m. It mainly consists of argillaceous to biotized quartzite and pelitic sandstone with many pelitic bands. Dissemination of chalcopyrite-bornite is observed in this formation.

"Footwall Conglomerate": 656.60 to 658.70m. It is composed of conglomerate with rounded to subangular pebbles. The nature of pebbles are quartzite, argillite, sandstone and small amount of granite.

"Ore Shale Horizon": 637.20 to 656.60m. It mainly consists of gray dolomitic argillite with intercalation of carbonaceous argillite in the lower part. Also, thin bed of dolomite and sandstone occurs in the basal part. The interval of 637.2 to 642.6m is the pyritized zone and 642.6 to 656.4m is pyrite-pyrrhotite-chalcopyrite zone. The sulfides occur as dissemination at the bedding planes , the rim of dolomite concretions, patches or lenses and veinlets. Results of ore assay are shown in Table 2-6-3. The cobalt mineral of this borehole was identified to be cobalt pentlandite (Table 2-5-2).

"Hangingwall Quartzite and Argillite": 636.80 to 637.20m. It consists of white quartzitic sandstone with pelitic bands.

"Interbedded Argillite and Quartzite": 606.80 to 636.80m. The major rock of this unit is dolomitic or pelitic sandstone with many thin intercalations of dolomite and argillite. The sandstone is locally quartzitic. This formation contains patches to lenses of anhydrite.

"Upper Quartzite": 594.20 to 606.80m. This unit consists of pinkish gray quartzite with pelitic to micaceous bands.

Upper Roan Group

"Interbedded Argillite, Dolomite and Quartzite": 566.70 to 594.20m. The upper part is composed mainly an alternation of dolomite and pelitic sandstone with intercalation of small amount of pelitic bands and thin quartzite beds. The lower part is composed of an alternation of dolomite and sandy argillite.

"Cherty Dolomite": 545.30 to 566.70m. The main component of this unit is white massive dolomite and green sandy argillite (Marker Shale) is intercalated in the upper part. This unit contains anhydrite patches. Also, minute chalcopyrite-pyrite grains is faintly disseminated in th lower part.

"Arenite, Argillite and Dolomite with Anhydrite": 306.70 to 545.30m. The upper part mainly consists of an alternation of micaceous dolomite and micaceous to dolomitic argillite with thin intercalation of sandstone to quartzite. The lower part is composed of argillite with grit. Anhydritization (patches, veinlets, lenses) occurs throughout the unit and limonitization by weathering is commonly observed in cavity of dolomite in the upper part.

"Interbedded Argillite and Dolomite with Tectono-Breccias": 6.00 to 96.00m, 126.00 to 222.70m, 224.50 to 247.60m, 254.30 to 306.70m. The upper part consists of micaceous or shaly or dolomitic argillite, limestone and dolomite. Lamina to dissemination is observed in a part of the shale. The major component of the lower part is quartzite with intercalation of dolomite and conglomeratic rocks in some localities. The conglomeratic rock consists of dolomite, quartzite and micaceous argillite pebbles of subrounded shape. Some gabbro bodies occur in this unit. Also, limonitization by weathering occur frequently in this unit, and limonite-dolomite-quartz veinlets which filled fractures of quartzite are considerably developed in the lower part.

"Gabbro (Amphibolite)" 96.00 to 126.00m, 222.70 to 224.50m, 247.60 to 254.30m. The bodies are dark green altered with platy cleavages developed and strongly carbonatized and biotized. Also, in the lower part of this hole, thin amphibolites similar to this rock are developed in the "Feldspathic Quartzite and Grit" of Lower Roan Group and basement granite.

3-3 Discussions

The mineralized zone occurs in the "Ore Shale" in this borehole. The ores belong to the pyrite-pyrrhotite-chalcopyrite zone and pyrite zone. The location of this borehole was offshore far from the coast at the time of ore deposition and is inferred to have been unfavorable for copper precipitation.

Existence of a basement high is inferred to the west of this hole from the basement surface contour map (Fig. 1-10), but it is believed that this basement high was formed by folding after the deposition of the "Upper Roan Group" because all the beds of the "Lower and Upper Roan Groups" occur in harmony with the basement.

Chapter 4 MJZC -12

4-1 Progress of Drilling

The location and the collar elevation of MJZC-12 are appended.

Summary of the drilling, record of the drilling operation and the drilling progress are shown in Tables 2-3-1 and 2-3-2, and Figure 2-3-1, respectively.

For the near surface zone to 43.00m, non-core drilling was made by 254mm percussion bit, and 219mm casing pipes were inserted to 34.00m. At 43.00 to 72.00m, non-core drilling was made by 203mm percussion bit, and 177mm casing pipes were inserted to 48.00m. Percussion drilling was continued by 139mm bit to 180m where percussion was given up due to the increase of water flow out from near 67m depth. Then the method was changed to skid-mounted WL after 114mm casing pipes were inserted to 180m. Cuttings were collected at 1 m intervals during non-core drilling.

After NW casing pipes were inserted to 180.00m, WL Coring was done by NQ bit and CHD rods to 782.28m. At 550.51m depth drilled, the machine (Sullvin-22) was replaced by L-44 of MJZC-9 due to a small capacity of drilling.

Rod grease, cutting oil and Drillprops were used in order to prevent vibration during operation.

Waters were pumped up into a tanker from a water borehole drilled in the site of MJZC-11, and the tanker was transported to MJZC-12 by a tractor.

Borehole deviation was surveyed at 100m intervals. Surveying showed north-northwestward deviation (Appendices).

4-2 Geology and Mineralization

The geologic log is appended. The geology of this borehole compared to that of the survey area described in 3-2 of PART I, it agrees well. Geological description of the borehole is as

Table 2-4-1 Summary of the Drilling Operation on MJZC-12

Operation	Survey Period: Period	Survey Period: Day	Work Day		Off Day	Total Man Day: Engineer	Total Man Day: Worker
Preparation	17.07.1995~18.07.1995 23.07.1995~25.07.1995 17.09.1995~23.09.1995 23.09.1995	12		6	6	31	67
Drilling	19.07.1995~22.07.1995 26.07.1995~15.09.1995 24.09.1995~05.10.1995	68	Drilling	44	8	158	315
			Recovering	3	13	35	43
Dismantling	16.09.1995 06.10.1995~10.10.1995	6		5	1	18	55
Total		86		58	28	242	480

Drilling Length	m		m
Length Planed	1100.00	Overburden	29.00
Increase/Decrease in Length	-317.72	Core Length	594.05
Length Drilled	782.28	Core Recovery	98.63
(N/C Drilling)	180.00		
(Core Drilling)	602.28		

Working Hours	h	%	%
Drilling	340.00	47.16	36.64
Other Working	313.00	43.41	33.73
Recovering	68.00	9.43	7.33
Subtotal	721.00	100.00	77.69
Reassemblage	24.00		2.59
Dismantlement	18.00		1.94
Water Supply	111.00		11.96
Road Construction	12.00		1.29
Transportation	42.00		4.53
Grand Total	928.00		100.00

Casing Pipe Inserted: Size	Meterage (m)	Meterage/Drilling Length ×100 (%)	Recovery (%)
219mm	34.00	4.35	0.00
177mm	48.00	6.14	0.00
114mm	180.00	23.01	0.00
NW	180.00	23.01	76.60
BX	0.00	0.00	

Core Recovery of 100m Hole: Depth of Hole (m)	Core Recovery (%)	Core Recovery Cumulated (%)
0.00- 100.00	-	-
100.00- 200.00	99.78	99.78
200.00- 300.00	99.39	99.46
300.00- 400.00	97.94	98.77
400.00- 500.00	97.36	98.33
500.00- 600.00	100.00	98.73
600.00- 700.00	98.50	98.68
700.00- 800.00	98.32	98.63

Efficiency of Drilling			
Total Length / Drilling Period	m 782.28	day 68	m/day 11.50
Total Length / Total Drilling Shifts	m 782.28	shift 53	m/shift 14.76

Drilling Length / Each Bit (m): Bit Size	Drilled Length	Core Length
254mm	43.00	N/C
203mm	29.00	N/C
139mm	108.00	N/C
HQ	0.00	0.00
NQ	602.28	594.05
BQ	0.00	0.00

Table 2-4-2 Record of the Drilling Operation on MJZC-12

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	shift 1	shift 2	Total Cumulated	Drilling Length	Core Length	Drilling	Total	Engineer	Worker
Jul 17	Rd-con	Day off	0.00	0.00	0.00	0.00	1.00	3.00	8.00
18	Tra-Ress	Day off	0.00	0.00	0.00	0.00	1.00	4.00	11.00
19	72.00	Day off	72.00	72.00	0.00	1.00	1.00	3.00	7.00
20	47.00	Day off	119.00	47.00	0.00	1.00	1.00	3.00	6.00
21	41.00	Day off	160.00	41.00	0.00	1.00	1.00	3.00	8.00
22	20.00	Day off	180.00	20.00	0.00	1.00	1.00	3.00	6.00
23	Tra-Ress	Day off	180.00	0.00	0.00	0.00	1.00	3.00	9.00
24	Ress	Day off	180.00	0.00	0.00	0.00	1.00	3.00	8.00
25	In-cp	Day off	180.00	0.00	0.00	0.00	1.00	3.00	8.00
26	23.03	Day off	203.03	23.03	22.89	1.00	1.00	3.00	5.00
27	10.94	Day off	213.97	10.94	10.94	1.00	1.00	3.00	6.00
28	Day off	Day off	213.97	0.00	0.00	0.00	0.00	2.00	2.00
29	Day off	Day off	213.97	0.00	0.00	0.00	0.00	2.00	2.00
30	Day off	Day off	213.97	0.00	0.00	0.00	0.00	2.00	2.00
31	10.06	Day off	224.03	10.06	10.05	1.00	1.00	3.00	5.00
Aug 1	24.00	Day off	248.03	24.00	23.95	1.00	1.00	3.00	6.00
2	21.00	Day off	269.03	21.00	20.74	1.00	1.00	3.00	5.00
3	20.45	Day off	289.48	20.45	20.16	1.00	1.00	3.00	5.00
4	Main	Day off	289.48	0.00	0.00	0.00	1.00	3.00	5.00
5	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
6	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
7	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
8	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
9	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
10	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
11	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
12	Main	Day off	289.48	0.00	0.00	0.00	1.00	3.00	8.00
13	Day off	Day off	289.48	0.00	0.00	0.00	0.00	2.00	2.00
14	9.55	Day off	299.03	9.55	9.55	1.00	1.00	3.00	8.00
15	12.00	Day off	311.03	12.00	12.00	1.00	1.00	3.00	8.00
16	5.98	Day off	317.01	5.98	5.98	1.00	1.00	3.00	6.00
17	12.02	Day off	329.03	12.02	11.66	1.00	1.00	3.00	6.00
18	24.00	Day off	353.03	24.00	24.00	1.00	1.00	3.00	8.00
19	18.88	Day off	371.91	18.88	17.23	1.00	1.00	3.00	8.00
20	20.12	Day off	392.03	20.12	19.77	1.00	1.00	3.00	8.00
21	8.40	Day off	400.43	8.40	8.40	1.00	1.00	3.00	8.00
22	12.10	Day off	412.53	12.10	12.10	1.00	1.00	3.00	8.00
23	15.50	Day off	428.03	15.50	15.50	1.00	1.00	3.00	8.00
24	12.00	Day off	440.03	12.00	12.00	1.00	1.00	3.00	8.00
25	1.58	Day off	441.61	1.58	1.39	1.00	1.00	3.00	6.00
26	Out-In-rd	Day off	441.61	0.00	0.00	0.00	1.00	3.00	8.00
27	19.42	Day off	461.03	19.42	16.97	1.00	1.00	3.00	8.00
28	9.28	Day off	470.31	9.28	9.26	1.00	1.00	3.00	8.00
29	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
30	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
31	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
Sep 1	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
2	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
3	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
4	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
5	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
6	Day off	Day off	470.31	0.00	0.00	0.00	0.00	2.00	2.00
7	2.72	Day off	473.03	2.72	2.72	1.00	1.00	3.00	8.00
8	6.00	Day off	479.03	6.00	6.00	1.00	1.00	3.00	8.00
9	12.00	Day off	491.03	12.00	12.00	1.00	1.00	3.00	8.00
10	12.00	Day off	503.03	12.00	12.00	1.00	1.00	3.00	8.00
11	6.00	Day off	509.03	6.00	6.00	1.00	1.00	3.00	8.00
12	15.25	Day off	524.28	15.25	15.25	1.00	1.00	3.00	8.00
13	8.55	Day off	532.83	8.55	8.55	1.00	1.00	3.00	8.00
14	12.22	Day off	545.05	12.22	12.22	1.00	1.00	3.00	8.00
15	5.46	Day off	550.51	5.46	5.46	1.00	1.00	3.00	8.00
16	Disa-Tra	Day off	550.51	0.00	0.00	0.00	1.00	3.00	11.00
17	Day off	Day off	550.51	0.00	0.00	0.00	0.00	2.00	2.00
18	Day off	Day off	550.51	0.00	0.00	0.00	0.00	2.00	2.00
19	Day off	Day off	550.51	0.00	0.00	0.00	0.00	2.00	2.00
20	Day off	Day off	550.51	0.00	0.00	0.00	0.00	2.00	2.00
21	Day off	Day off	550.51	0.00	0.00	0.00	0.00	2.00	2.00
22	Day off	Day off	550.51	0.00	0.00	0.00	0.00	2.00	2.00
23	Main	Day off	550.51	0.00	0.00	0.00	1.00	3.00	11.00
24	Out-In-rd	20.42	570.93	20.42	20.42	2.00	2.00	4.00	10.00
25	21.77	6.00	598.70	27.77	27.77	2.00	2.00	4.00	10.00
26	16.76	1.00	616.46	17.76	17.76	2.00	2.00	4.00	10.00
27	18.24	15.16	649.86	33.40	33.40	2.00	2.00	4.00	10.00
28	20.59	14.64	685.09	35.23	33.73	2.00	2.00	4.00	10.00
29	19.27	2.34	706.70	21.61	21.61	2.00	2.00	4.00	10.00
30	12.06	Day off	718.76	12.00	12.00	1.00	1.00	3.00	8.00
Oct 1	Day off	Day off	718.76	0.00	0.00	0.00	0.00	2.00	2.00
2	22.21	1.79	742.76	24.00	23.80	2.00	2.00	4.00	10.00
3	12.00	3.60	758.39	15.66	14.58	2.00	2.00	4.00	10.00
4	3.53	4.79	766.70	8.32	8.32	2.00	2.00	4.00	10.00
5	15.58	Surv	782.28	15.58	15.40	1.00	2.00	4.00	10.00
6	Surv	Day off	782.28	0.00	0.00	0.00	2.00	4.00	12.00
7	Disa-Tra	Day off	782.28	0.00	0.00	0.00	1.00	4.00	11.00
8	Day off	Day off	782.28	0.00	0.00	0.00	0.00	2.00	2.00
9	Tra	Day off	782.28	0.00	0.00	0.00	1.00	3.00	11.00
10	Disa	-	782.28	0.00	0.00	0.00	1.00	2.00	8.00
Total	712.46	69.82	782.28	782.28	757.05	53.00	69.00	242.00	480.00

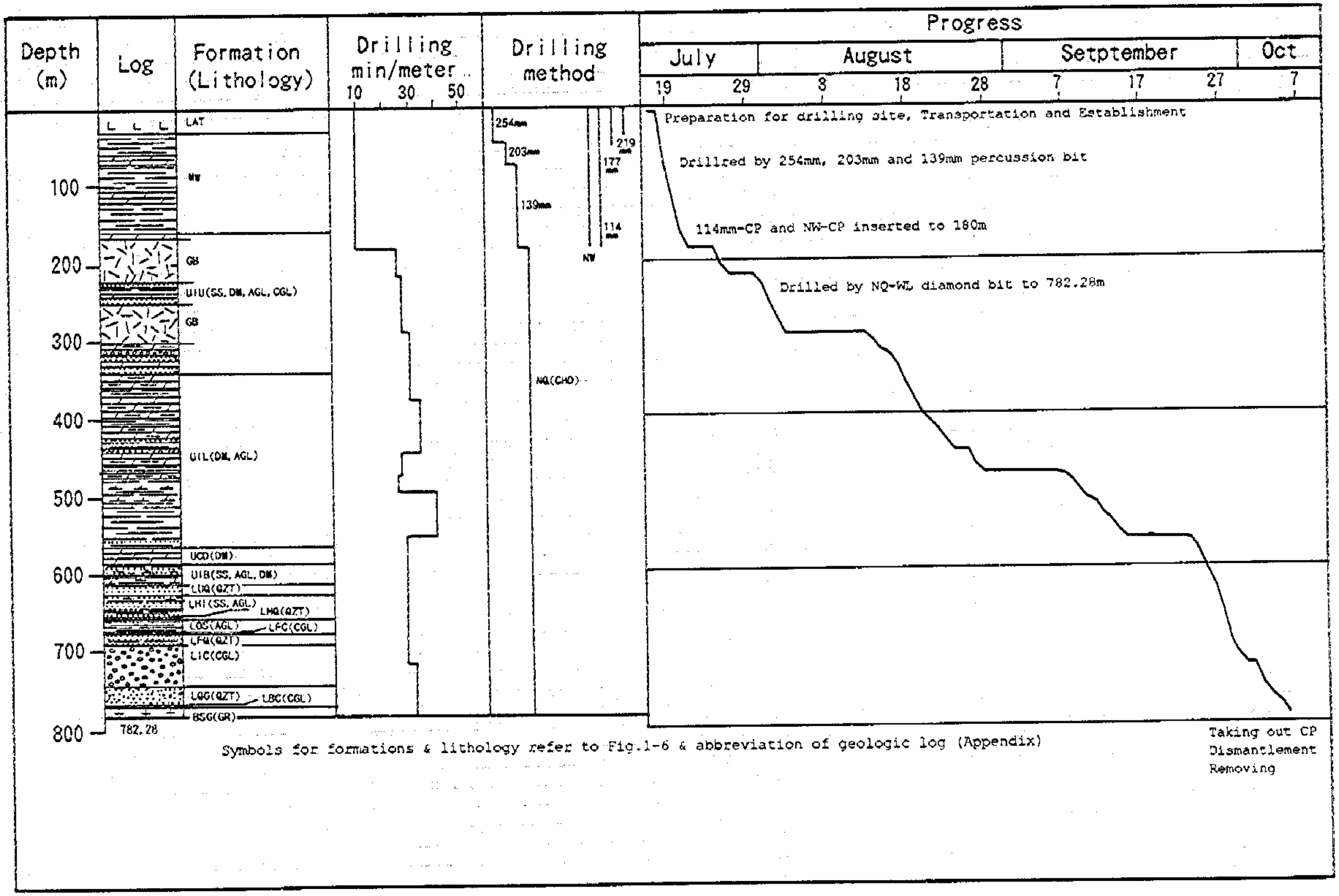


Fig. 2-4-1 Drilling Progress of MJZC-12

follows.

"Basement": 769.60 to 782.28m. The rock is coarse-crystalline granite and rich in secondary quartz and biotite. Strong silicification and a large amount of mica occur in the top part. Thin mafic rocks occur in this rock.

Lower Roan Group
"Basal Conglomerate": 768.70 to 769.60m. Conglomerate with boulders of granite and fragments of potash feldspar.

"Feldspathic Quartzite and Grit": 743.70 to 768.70m. It is composed of pinkish grey quartzite with local pebbly quartzite, and contains bands or patches of biotite.

"Intermediate Conglomerate": 692.00 to 743.70m. It mainly consists of conglomerate with subangular pebbles, and contains locally granule conglomerate or pebbly quartzite. The nature of pebbles are rich in quartzite, chert, argillite, granite, quartz, schist and potash feldspar in the upper part, and rich in biotite schist, spotted mica schist and quartzite in the lower part.

"Footwall Quartzite": 675.50 to 692.00m. It mainly consists of pebbly sandstone, pebbly quartzite and pelitic sandstone, and many pelitic bands are intercalated in a state of thin-bedded alternation in the sandstone.

"Footwall Conglomerate": 674.10 to 675.50m. It is composed of conglomerate with subangular to rounded pebbles. The most abundant pebbles are granite, followed by quartzite and biotite schist.

"Ore Shale Horizon": 655.40 to 674.10m. It mainly consists of black to gray sandy argillite with local dolomitic argillite. Also, thin bed of pelitic sandstone occurs in the basal part. The interval of 655.4 to 661.4m is the pyritized zone and 661.4 to 672.1m is pyrite-pyrrhotite-chalcopyrite zone and 672.1 to 674.0m is bornite-chalcopyrite zone. The sulfides occur as dissemination to lamination at the bedding planes , patches to lenses of irregular shape. Results of ore assay are shown in Table 2-6-3. The cobalt minerals of this borehole were identified to be cobalt pentlandite and carrollite (Table 2-5-2).

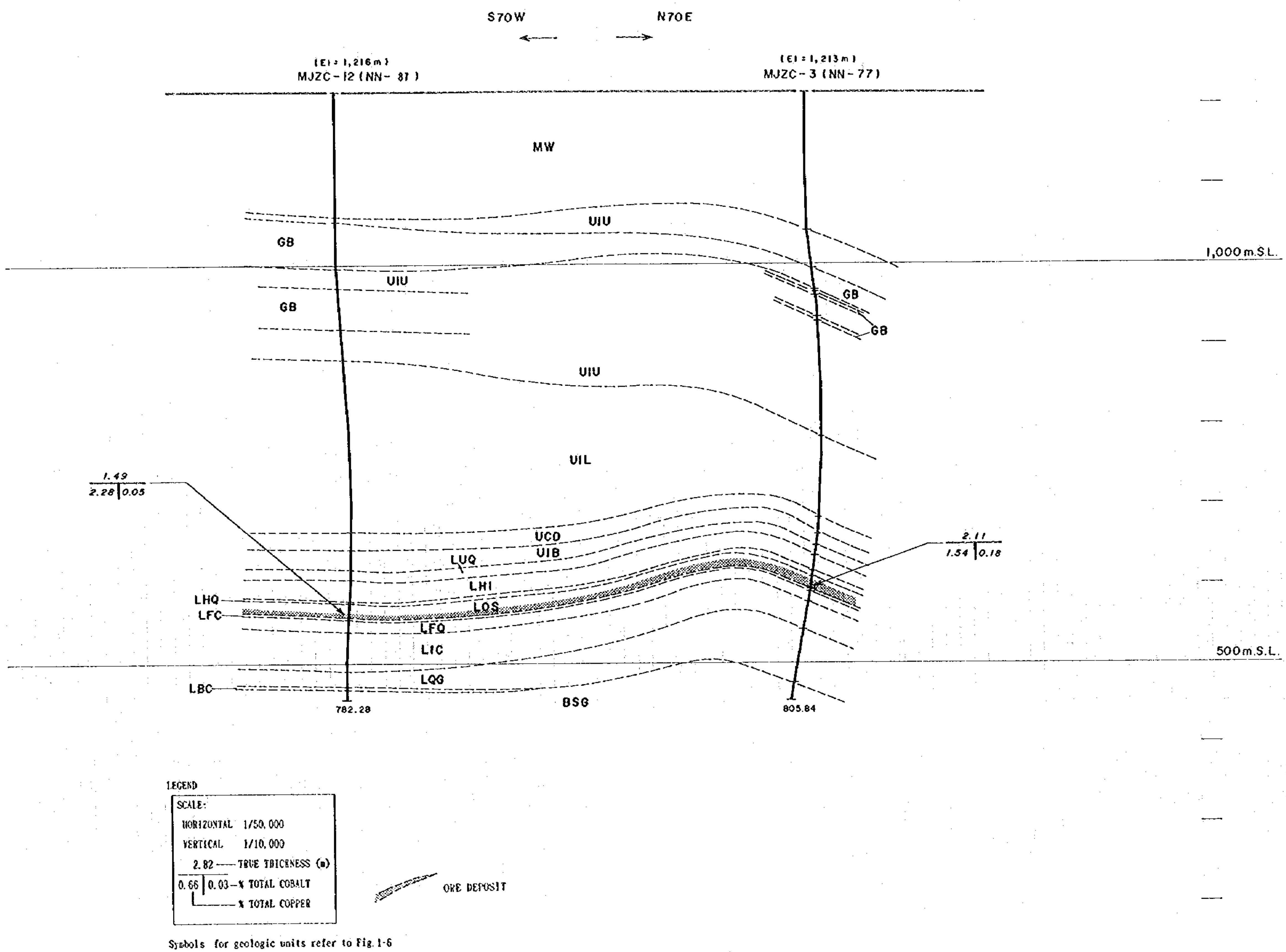


Fig. 2-4-2 Geological Profile of Drill Hole (MJZC-12)

"Hangingwall Quartzite and Argillite": 654.00 to 655.40m. It consists of pink to white quartzite with pelitic bands.

"Interbedded Argillite and Quartzite": 624.00 to 654.00m. It is composed mainly of an alternation of pelitic sandstone, quartzite and argillite, and thin beds of dolomite are intercalated in this unit. Anhydrite lenses occur commonly in this unit.

"Upper Quartzite": 612.20 to 624.00m. This unit consists of white to pink quartzite with pelitic and micaceous bands.

Upper Roan Group

"Interbedded Argillite, Dolomite and Quartzite": 584.70 to 612.20m. This unit is composed of thin-bedded alternation of dolomite, argillite, pelitic sandstone and quartzite.

"Cherty Dolomite": 562.70 to 584.70m. The main component of this unit is white massive dolomite with anhydrite. Micaceous and dolomitic argillite (Marker Shale) is intercalated in the upper part.

"Arenite, Argillite and Dolomite with Anhydrite": 339.00 to 562.70m. The upper part mainly consists of an alternation of dolomite and greenish grey argillite, and contains locally intercalations of pelitic sandstone. The lower part is composed mainly of green sandy to gritty argillite with thin intercalations of small amount of dolomite and sandstone. Anhydritization (patches, veinlets, lenses) occurs throughout the unit and limonitization by weathering is observed in the upper part.

"Interbedded Argillite and Dolomite with Tectono-Breccias": 157.00 to 164.50m, 220.50 to 247.60m, 300.20 to 339.00m. The upper part consists of an alternation of dolomite and argillite, and contains intercalations of sandstone. The lower part is composed mainly of an alternation of quartzite and dolomite, and contains intercalation of conglomerate. The conglomerate consists of pebbles of dolomite and argillite. Some gabbro bodies occur in this unit. Also, limonitization by weathering occur generally this unit.

"Mwashia Group": 29.00 to 157.00m. It is composed mainly of dark grey to black shaly argillite with intercalation of dolomite. Dissemination of pyrite is observed locally in the argillite.

"Gabbro (Amphibolite)" 164.50 to 220.50m, 247.60 to 300.20m. The bodies are dark green to black altered, massive. Generally, strong biotitization and carbonatization occur and silicification is observed locally.

4-3 Discussions

The mineralized zone occurs in the "Ore Shale" of this borehole and vertical zoning of sulfide minerals is observed. In the "Ore Shale", bornite-chalcopyrite zone occurs at the bottom and the mineral assemblage changes upwards through pyrite-pyrrhotite-chalcopyrite zone to pyrite zone. This fact indicates that this site was located in the vicinity of the palaeo-basement high at the beginning of "Ore Shale" deposition. But subsequently the sea rapidly became deeper and the environment became chemically reducing and thus unfavorable for copper precipitation.

Although this borehole is inferred to be located over a basement high from the basement surface contour map (Fig. 1-10), the units of the "Lower and Upper Roan" Groups occur in harmony with the basement complex. Thus this basement high is considered to have formed by folding after the deposition of the "Upper Roan Group". The occurrence of palaeo-basement high in this basement high became a possibility as above mentioned. If, therefore, deep depressions were formed locally on the limb of the palaeo-basement high during the beginning of "Ore Shale" deposition, ore shoots could have been formed.

Table 2-5-1 Results of Microscopic Observation of Thin Sections

Sample No.	Locality Depth (m)	Forma-tion	Rock Name	Phenocryst/ Crystal Fragment																	Texture
				Qz	Kf	Pl	Ca	Anh	Bi	Mc	Rut	To	Ti	Ap	Ep	Ch	Zr	Op	All	others	
T901	MJZC-9, 1132.50	LFQ	anh rock	△	○	△		◎	○							△		△			granular
T902	MJZC-9, 1144.00	LFQ	meta-ss	◎			○	○	◎	△		·		·			·	△			granular
T1001	MJZC-10, 1007.30	LFQ	Bi schist	◎				○	◎	○		△		·		△	·	·	·		schistose
T1101	MJZC-11, 827.00	BSG	metagranite	◎	◎	◎			△	○		·	·					·	·		granular
T1102	MJZC-11, 852.80	BSG	metagranite	◎	◎	◎	△		○	○						·			△		granular
T1201	MJZC-12, 701.20	LIC	meta-ss	◎	◎	○	·		◎	○				·				·	·		granular
T1202	MJZC-12, 723.50	LIC	Bi-Ch rock	△	○			○	◎							◎		△			schistose
T1203	MJZC-12, 732.00	LIC	mica schist	◎				·	○	◎							·	△		Ba(△)	schistose
T1204	MJZC-12, 750.00	LOG	meta-ss	◎		◎		○	·			·					·	·	·		granular
T1205	MJZC-12, 782.00	BSG	metagranite	◎	◎	◎	△		·	◎		·		·		·		·	·		granular

Abbreviations

Abundance of minerals: ◎ : abundant, ○ : common, △ : a few, · : trace

Rock : ss:Sandstone,

Mineral : Qz:Quartz, Kf:Alkali feldspar, Pl:Plagioclase, Ca:Carbonate, Anh:Anhydrite, Bi:Biotite, Mc:Muscovite, Rut:Rutile, To:Tourmaline, Ti:Titanite, Ap:Apatite, Ep:Epidote, Ch:Chlorite, Zr:Zircon, Op:Opaque minerals All:Allanite, Ba:Barite

Table 2-5-2 Results of Microscopic Observation of Polished Thin Sections (1)

sample No.	Locality, Depth (m)	Forma-tion	Description	Ore Mineral									Gangue Mineral														
				Cp	Py	Po	Bo	Co	Gn	BS	SP	others	Qz	Kf	Pl	Ca	Bi	Mc	Rut	To	Ti	Ap	Ep	Ch	Zr	All	others
P-901	MJZC-9, 1087.90	LOS	Cp diss in dol Arg	◎	○							Ba(・)	○	○	△	◎	◎	○	・			・				△	REE(・), Mon(・)
P-902	MJZC-9, 1109.40	LOS	Cp bleb rich in dol Arg	◎				○cat	・		・		◎		○	○	○	◎	・			・					
P-903	MJZC-9, 1111.90	LOS	Cp patch rich in sch Arg	◎	△				・				◎				○	◎	・					△			
P-904	MJZC-9, 1112.40	LFO	Cp diss in mic Ss	△				◎cat ・car	・				◎	△		○	◎	○		・							Xen(・)
P-905	MJZC-9, 1114.20	LFO	Cp diss in pebbly QZT	◎								Th(・)	◎	○	△	○	◎		・	・	・				・		
P-906	MJZC-9, 1120.00	LFO	Cp, Co diss in QZT	◎			◎		・				◎	△	◎	○	○	△	・				・		・		
P-1001	MJZC-10, 965.50	LOS	Py diss in Arg		◎							Th(・)		○	◎	○	・	○	・								Mon(・)
P-1002	MJZC-10, 974.60	LOS	Py-Po diss in bedding plane and rim of dol spot	△	◎	○		・pent					△		○	◎	◎	○							・		
P-1003	MJZC-10, 983.30	LOS	Cp-Po irr lens in Arg	◎	○	△		・co pent	・	・			◎			○	◎			・		・			・		
P-1004	MJZC-10, 986.60	LOS	Cp-Py diss in Arg	◎	○			・co pent	・				◎	△	△	◎	◎			・							
P-1005	MJZC-10, 992.40	LFO	Cp-diss in QZT	◎					・			Ba(・)	◎	◎	△	○	○	○				・		・	・		
P-1101	MJZC-11, 643.30	LOS	Py-Po>Cp diss in dol Arg	・	◎	◎		○co pent					◎		△	◎	○		・		・						
P-1102	MJZC-11, 648.00	LOS	Po-Cp-Py spot in Arg	○	◎	◎		・co pent		・		Th(・)	◎		△	◎	△	△	・						・		
P-1103	MJZC-11, 651.30	LOS	Cp-Py-Po-dol lens/spot/vlt in carb Arg	◎	◎	・			・		・		◎			△	△	○						△			
P-1104	MJZC-11, 656.30	LOS	Py>Cp-Po diss in dol-arg Ss	◎	○	△		・co pent				Ura(・)	◎	◎		○	◎		・								
P-1201	MJZC-12, 661.50	LOS	Cp-Py-Po-dol diss in Arg	◎	◎	○		・co pent	・				○		◎	○	○	○		・			・				
P-1202	MJZC-12, 664.00	LOS	Cp-Py-Po-dol lamina/spot	◎	◎	△							◎			○	・	○	・				・		・		Mon(・)
P-1203	MJZC-12, 670.50	LOS	Cp irr lens in Arg	◎	◎	◎		・co pent			・		◎			○		○		・				○			
P-1204	MJZC-12, 671.10	LOS	Qz-Cp-Py-Po lens in Arg	◎	◎	◎		・co pent	・		・		◎			△		◎	・	・				・			
P-1205	MJZC-12, 673.30	LOS	Bo patch/lens/lam & diss in mic Ss	◎	・		◎	・car					◎		○	◎	△	○				・					

Abbreviations

Abundance of minerals: ◎ : abundant, ○ : common, △ : a few, ・ : trace

Rock : dol:dolomitic, Arg:argillite, QZT:quartzite, ss:sandstone, sch:schistose, mic:micaceous, carb:carbonaceous

Mineral : Bo:Bornite, Cp:Chalcopyrite, Po:Pyrrhotite, Py:Pyrite, Gn:Galena, BS:Native Bismuth, SP:Sphalerite, diss:dissemination
Cat:Cattierite, Car:Carrollite, Pen:Pentlandite, Co pen:Cobalt pentlandite, Ba:Barite, Th:Thorite, Ura:Uraninite,
Qz:Quartz, Kf:Alkali feldspar, Pl:Plagioclase, Ca:Carbonate, Anh:Anhydrite, Bi:Biotite, Mc:Muscovite,
Rut:Rutile, To:Tourmaline, Ti:Titanite, Ap:Apatite, Ep:Epidote, Ch:Chlorite, Zr:Zircon, Op:Opaque minerals
All:Allanite, Mon:Monazite, Xen:Xenotime, REE:REEcarbonate, vlt:veinlet

Table 2-5-2 Results of Microscopic Observation of Polished Thin Sections (2)

Mineral compositions (wt%)

No.	mineral	S	Fe	Cu	Co	Zn	Ni	As	Total
P-902	cattierite	50.32	13.32	0.07	35.09	0.00	0.40	0.00	99.21
P-904	cattierite	46.75	21.59	0.00	26.21	0.00	0.04	4.48	99.06
P-904	carrollite	39.26	2.08	14.32	44.38	0.00	0.13	0.01	100.17
P-1101	co pentlandi	30.94	2.52	0.00	63.98	0.00	2.00	0.00	99.44
P-1204	co pentlandi	30.86	3.50	0.00	64.07	0.14	1.54	0.00	100.12
P-1205	carrollite	40.24	0.02	14.63	44.48	0.00	0.37	0.00	99.74

Atomic ratio

No.	mineral	S	Fe	Cu	Co	Zn	Ni	As	Total
P-902	cattierite	65.08	9.89	0.05	24.69	0.00	0.28	0.00	100.00
P-904	cattierite	62.05	16.45	0.00	18.93	0.00	0.03	2.55	100.00
P-904	carrollite	54.60	1.66	10.05	33.58	0.00	0.10	0.00	100.00
P-1101	co pentlandi	45.31	2.11	0.00	50.97	0.00	1.60	0.00	100.00
P-1204	co pentlandi	44.95	2.93	0.00	50.79	0.10	1.23	0.00	100.00
P-1205	carrollite	55.86	0.02	10.25	33.60	0.00	0.28	0.00	100.00

Analysis by EPMA of JEOL.

Table 2-5-3 Results of Chemical Analysis of Ore Samples (1)

MJZC－9

Sample No	Depth (m)	T-Cu (%)	AS-Cu (%)	T-Co (%)
KC12701	1077.45 ～ 1077.95	0.02	<0.01	<0.01
KC12702	1077.95 ～ 1078.45	<0.01	<0.01	<0.01
KC12703	1078.45 ～ 1079.00	<0.01	<0.01	0.01
KC12704	1079.00 ～ 1079.50	<0.01	<0.01	0.01
KC12705	1079.50 ～ 1079.67	0.05	<0.01	<0.01
KC12706	1079.67 ～ 1080.17	0.05	<0.01	<0.01
KC12707	1080.17 ～ 1080.67	0.09	<0.01	<0.01
KC12708	1080.67 ～ 1081.17	0.06	<0.01	<0.01
KC12709	1081.17 ～ 1081.67	0.05	<0.01	<0.01
KC12710	1081.67 ～ 1082.17	0.12	<0.01	<0.01
KC12711	1082.17 ～ 1082.67	0.17	<0.01	0.01
KC12712	1082.67 ～ 1083.17	0.15	<0.01	<0.01
KC12713	1083.17 ～ 1083.67	0.15	<0.01	0.01
KC12714	1083.67 ～ 1084.27	0.22	<0.01	<0.01
KC12715	1084.27 ～ 1084.68	0.32	<0.01	0.01
KC12716	1084.68 ～ 1085.18	0.45	<0.01	0.01
KC12717	1085.18 ～ 1085.68	0.52	<0.01	<0.01
KC12718	1085.68 ～ 1086.18	1.45	<0.01	<0.01
KC12719	1086.18 ～ 1086.68	2.44	<0.01	0.01
KC12720	1086.68 ～ 1087.18	2.56	0.01	0.01
KC12721	1087.18 ～ 1087.75	2.59	0.01	0.01
KC12722	1087.75 ～ 1088.25	2.35	<0.01	0.01
KC12723	1088.25 ～ 1088.75	0.18	<0.01	0.02
KC12724	1088.75 ～ 1089.25	0.70	<0.01	0.01
KC12725	1089.25 ～ 1089.50	1.53	<0.01	<0.01
KC12726	1089.50 ～ 1090.00	0.02	<0.01	0.02
KC12727	1090.00 ～ 1090.50	0.19	<0.01	0.02
KC12728	1090.50 ～ 1091.00	0.79	0.01	0.03
KC12729	1091.00 ～ 1091.50	0.69	0.01	0.02
KC12730	1091.50 ～ 1092.00	0.33	<0.01	0.02
KC12731	1092.00 ～ 1092.50	0.03	<0.01	0.03
KC12732	1092.50 ～ 1093.00	0.02	<0.01	0.02
KC12733	1093.00 ～ 1093.50	0.01	<0.01	0.02
KC12734	1093.50 ～ 1094.00	0.02	<0.01	0.02
KC12735	1094.00 ～ 1094.50	0.02	<0.01	0.02
KC12736	1094.50 ～ 1095.00	0.01	<0.01	0.02
KC12737	1095.00 ～ 1095.35	0.06	<0.01	0.02
KC12738	1095.35 ～ 1095.85	0.20	<0.01	0.03
KC12739	1095.85 ～ 1096.35	0.23	<0.01	0.03
KC12740	1096.35 ～ 1096.85	0.21	<0.01	0.01
KC12741	1096.85 ～ 1097.35	0.25	<0.01	0.01
KC12742	1097.35 ～ 1097.85	0.20	<0.01	0.02
KC12743	1097.85 ～ 1098.35	0.25	<0.01	0.02
KC12744	1098.35 ～ 1098.85	0.02	<0.01	0.02
KC12745	1098.85 ～ 1099.35	0.27	<0.01	0.02
KC12746	1099.35 ～ 1099.85	0.05	<0.01	0.03
KC12747	1099.85 ～ 1100.35	0.39	<0.01	0.02
KC12748	1100.35 ～ 1100.85	0.42	<0.01	0.01
KC12749	1100.85 ～ 1101.35	0.01	<0.01	0.02
KC12750	1101.35 ～ 1101.85	0.01	<0.01	0.02
KC12751	1101.85 ～ 1102.35	0.01	<0.01	0.02
KC12752	1102.35 ～ 1102.85	0.01	<0.01	0.03
KC12753	1102.85 ～ 1103.35	0.01	<0.01	0.03
KC12754	1103.35 ～ 1103.85	0.01	<0.01	0.04
KC12755	1103.85 ～ 1104.35	0.01	<0.01	0.05
KC12756	1104.35 ～ 1104.85	0.41	<0.01	0.05
KC12757	1104.85 ～ 1105.35	0.08	<0.01	0.09
KC12758	1105.35 ～ 1105.76	0.06	<0.01	0.07
KC12759	1105.76 ～ 1106.26	0.07	<0.01	<0.01
KC12760	1106.26 ～ 1106.76	0.07	<0.01	0.05
KC12761	1106.76 ～ 1107.26	0.05	<0.01	0.05
KC12762	1107.26 ～ 1107.76	0.11	<0.01	0.04
KC12763	1107.76 ～ 1108.16	0.03	<0.01	0.04
KC12764	1108.16 ～ 1108.36	0.83	<0.01	0.05
KC12765	1108.36 ～ 1108.86	2.65	<0.01	0.02
KC12766	1108.86 ～ 1109.36	1.99	<0.01	0.01
KC12767	1109.36 ～ 1109.86	2.88	<0.01	0.02
KC12768	1109.86 ～ 1110.35	1.99	0.01	0.02
KC12769	1110.35 ～ 1110.86	3.23	<0.01	0.07
KC12770	1110.86 ～ 1111.36	3.15	0.01	0.03
KC12771	1111.36 ～ 1111.76	4.07	<0.01	0.04
KC12772	1111.76 ～ 1112.26	9.59	0.01	0.25
KC12773	1112.26 ～ 1112.76	1.88	0.01	0.01
KC12774	1112.76 ～ 1113.26	1.97	0.01	0.04
KC12775	1113.26 ～ 1113.76	2.57	<0.01	0.14
KC12776	1113.76 ～ 1114.26	1.38	<0.01	0.02
KC12777	1114.26 ～ 1114.76	0.77	<0.01	0.01
KC12778	1114.76 ～ 1115.26	0.87	<0.01	0.02
KC12779	1115.26 ～ 1115.76	0.75	<0.01	0.01
KC12780	1115.76 ～ 1116.26	0.79	<0.01	0.01
KC12781	1116.26 ～ 1116.76	0.38	<0.01	<0.01
KC12782	1116.76 ～ 1117.00	0.45	<0.01	<0.01
KC12783	1117.00 ～ 1117.50	1.06	<0.01	<0.01
KC12784	1117.50 ～ 1118.00	1.47	<0.01	<0.01
KC12785	1118.00 ～ 1118.50	0.62	<0.01	0.01
KC12786	1118.50 ～ 1119.00	0.33	<0.01	0.01
KC12787	1119.00 ～ 1119.50	0.77	<0.01	<0.01
KC12788	1119.50 ～ 1120.00	1.03	<0.01	0.06
KC12789	1120.00 ～ 1120.50	0.73	<0.01	0.03
KC12790	1120.50 ～ 1120.76	0.32	<0.01	0.01
KC12791	1120.76 ～ 1121.26	0.41	<0.01	0.01
KC12792	1121.26 ～ 1121.76	0.10	<0.01	<0.01
KC12793	1121.76 ～ 1122.26	0.04	<0.01	<0.01
KC12794	1122.26 ～ 1122.76	0.04	<0.01	0.01
KC12795	1122.76 ～ 1123.25	0.02	<0.01	<0.01
KC12796	1123.25 ～ 1123.76	0.07	<0.01	<0.01
KC12797	1123.76 ～ 1124.26	0.03	<0.01	0.01
KC12798	1124.26 ～ 1124.76	0.01	<0.01	0.01
KC12799	1124.76 ～ 1125.26	0.01	<0.01	0.01
KC12800	1125.26 ～ 1125.76	0.03	<0.01	0.01
KC15101	1125.76 ～ 1126.26	0.01	<0.01	0.01
KC15102	1126.26 ～ 1126.76	0.02	<0.01	0.01

Width (m)	Depth (m)	T-Cu (%)	AS-Cu (%)	T-Co (%)
2.58	1085.68 ～ 1088.26	2.29	<0.01	<0.01
5.90	1108.36 ～ 1114.26	3.12	<0.01	0.08
6.24	1114.26 ～ 1120.50	0.78	<0.01	<0.02

Table 2-5-3 Results of Chemical Analysis of Ore Samples (2)

MJZC-10

Sample No	Depth (m)	T-Cu (%)	As-Cu (%)	T-Co (%)
KC12222	953.70 ~ 954.70	0.01	<0.01	0.03
KC12223	954.70 ~ 955.70	<0.01	<0.01	<0.01
KC12224	955.70 ~ 956.70	0.01	<0.01	<0.01
KC12225	956.70 ~ 957.70	<0.01	<0.01	<0.01
KC12226	957.70 ~ 958.70	<0.01	<0.01	<0.01
KC12227	958.70 ~ 959.70	<0.01	<0.01	<0.01
KC12228	959.70 ~ 960.70	<0.01	<0.01	<0.01
KC12229	960.70 ~ 961.33	<0.01	<0.01	<0.01
KC12230	961.33 ~ 961.83	<0.01	<0.01	<0.01
KC12231	961.83 ~ 962.33	<0.01	<0.01	<0.01
KC12232	962.33 ~ 962.70	<0.01	<0.01	<0.01
KC12233	962.70 ~ 963.20	<0.01	<0.01	<0.01
KC12234	963.20 ~ 963.70	0.01	<0.01	<0.01
KC12235	963.70 ~ 964.20	<0.01	<0.01	<0.01
KC12236	964.20 ~ 964.70	0.01	<0.01	<0.01
KC12237	964.70 ~ 965.20	0.03	<0.01	0.01
KC12238	965.20 ~ 965.70	<0.01	<0.01	0.02
KC12239	965.70 ~ 966.20	<0.01	<0.01	0.01
KC12240	966.20 ~ 966.70	<0.01	<0.01	0.01
KC12241	966.70 ~ 967.20	<0.01	<0.01	0.01
KC12242	967.20 ~ 967.70	<0.01	<0.01	0.01
KC12243	967.70 ~ 968.20	0.01	<0.01	0.01
KC12244	968.20 ~ 968.70	<0.01	<0.01	<0.01
KC12245	968.70 ~ 969.20	0.01	<0.01	0.01
KC12246	969.20 ~ 969.70	<0.01	<0.01	<0.01
KC12247	969.70 ~ 970.20	<0.01	<0.01	<0.01
KC12248	970.20 ~ 970.70	0.07	<0.01	<0.01
KC12249	970.70 ~ 971.20	0.01	<0.01	<0.01
KC12250	971.20 ~ 971.70	<0.01	<0.01	0.01
KC12251	971.70 ~ 972.20	0.01	<0.01	0.01
KC12252	972.20 ~ 972.70	<0.01	<0.01	0.01
KC12253	972.70 ~ 973.20	0.01	<0.01	0.01
KC12254	973.20 ~ 973.62	0.02	<0.01	0.01
KC12255	973.62 ~ 974.12	0.03	<0.01	0.03
KC12256	974.12 ~ 974.62	0.03	<0.01	0.03
KC12257	974.62 ~ 975.12	0.18	<0.01	0.03
KC12258	975.12 ~ 975.62	0.22	<0.01	0.04
KC12259	975.62 ~ 976.15	0.08	<0.01	0.02
KC12260	976.15 ~ 976.66	0.11	<0.01	0.02
KC12261	976.66 ~ 977.15	0.23	<0.01	0.02
KC12262	977.15 ~ 977.66	0.32	<0.01	<0.01
KC12263	977.66 ~ 978.16	0.12	<0.01	0.01
KC12264	978.16 ~ 978.66	0.10	<0.01	0.01
KC12265	978.66 ~ 979.16	0.12	<0.01	0.01
KC12266	979.16 ~ 979.66	0.05	<0.01	0.01
KC12267	979.66 ~ 980.16	0.06	<0.01	0.01
KC12268	980.16 ~ 980.70	0.05	<0.01	0.01
KC12269	980.70 ~ 981.20	0.06	<0.01	0.01
KC12270	981.20 ~ 981.70	0.08	<0.01	0.01
KC12271	981.70 ~ 982.20	0.11	<0.01	0.02
KC12272	982.20 ~ 982.70	1.77	<0.01	0.04
KC12273	982.70 ~ 983.20	1.52	<0.01	0.03
KC12274	983.20 ~ 983.70	0.80	<0.01	0.03
KC12275	983.70 ~ 984.20	0.23	<0.01	0.04
KC12276	984.20 ~ 984.70	<0.01	<0.01	0.03
KC12277	984.70 ~ 985.20	0.15	<0.01	<0.01
KC12278	985.20 ~ 985.70	0.05	<0.01	0.04
KC12279	985.70 ~ 986.20	0.05	<0.01	0.07
KC12280	986.20 ~ 986.70	0.79	<0.01	0.03
KC12281	986.70 ~ 987.20	0.11	<0.01	0.02
KC12282	987.20 ~ 987.55	0.34	<0.01	0.02
KC12283	987.55 ~ 988.06	0.29	0.01	<0.01
KC12284	988.06 ~ 988.56	0.54	0.01	<0.01
KC12285	988.56 ~ 989.06	0.47	0.01	<0.01
KC12286	989.06 ~ 989.70	0.24	<0.01	<0.01
KC12287	989.70 ~ 990.20	0.21	<0.01	<0.01
KC12288	990.20 ~ 990.70	0.39	<0.01	<0.01
KC12289	990.70 ~ 991.20	0.25	0.01	<0.01
KC12290	991.20 ~ 991.88	0.05	<0.01	<0.01
KC12291	991.88 ~ 992.38	0.25	<0.01	<0.01
KC12292	992.38 ~ 992.88	0.22	0.01	<0.01
KC12293	992.88 ~ 993.56	0.41	0.03	<0.01
KC12294	993.56 ~ 994.06	0.34	0.01	<0.01
KC12295	994.06 ~ 994.56	0.32	<0.01	<0.01
KC12296	994.56 ~ 995.06	0.35	<0.01	<0.01
KC12297	995.06 ~ 995.56	0.19	0.01	<0.01
KC12298	995.56 ~ 996.06	0.18	0.08	<0.01
KC12299	996.06 ~ 996.56	0.10	0.01	<0.01
KC12300	996.56 ~ 997.06	0.09	0.02	<0.01
KC13302	997.06 ~ 997.56	0.09	<0.01	<0.01

Width (m)	Depth (m)	As-Cu (%)	T-Co (%)
1.00	982.20 ~ 983.20	<0.01	0.04

MJZC-11

Sample No	Depth (m)	T-Cu (%)	AS-Cu (%)	T-Co (%)
KC15103	635.05 ~ 635.55	<0.01	<0.01	<0.01
KC15104	635.55 ~ 636.05	<0.01	<0.01	0.01
KC15105	636.05 ~ 636.55	<0.01	<0.01	0.01
KC15106	636.55 ~ 637.05	<0.01	<0.01	<0.01
KC15107	637.05 ~ 637.55	<0.01	<0.01	0.01
KC15108	637.55 ~ 638.05	<0.01	<0.01	0.02
KC15109	638.05 ~ 638.55	<0.01	<0.01	0.05
KC15110	638.55 ~ 639.05	<0.01	<0.01	0.03
KC15111	639.05 ~ 639.55	<0.01	<0.01	0.02
KC15112	639.55 ~ 640.05	<0.01	<0.01	0.02
KC15113	640.05 ~ 640.55	<0.01	<0.01	0.02
KC15114	640.55 ~ 641.05	0.01	<0.01	0.02
KC15115	641.05 ~ 641.55	<0.01	<0.01	0.02
KC15116	641.55 ~ 642.05	<0.01	<0.01	0.02
KC15117	642.05 ~ 642.55	<0.01	<0.01	0.03
KC15118	642.55 ~ 642.75	<0.01	<0.01	0.02
KC15119	642.75 ~ 643.25	0.02	<0.01	0.05
KC15120	643.25 ~ 643.75	0.02	<0.01	0.14
KC15121	643.75 ~ 644.25	0.01	<0.01	0.07
KC15122	644.25 ~ 644.75	0.01	<0.01	0.03
KC15123	644.75 ~ 645.25	0.02	<0.01	0.02
KC15124	645.25 ~ 645.75	0.01	<0.01	0.02
KC15125	645.75 ~ 646.25	0.05	<0.01	0.02
KC15126	646.25 ~ 646.75	0.08	<0.01	0.02
KC15127	646.75 ~ 647.05	0.18	<0.01	0.02
KC15128	647.05 ~ 647.55	0.28	<0.01	0.02
KC15129	647.55 ~ 648.05	0.53	<0.01	0.02
KC15130	648.05 ~ 648.55	0.28	<0.01	0.01
KC15131	648.55 ~ 649.05	0.21	<0.01	0.01
KC15132	649.05 ~ 649.55	0.33	<0.01	0.01
KC15133	649.55 ~ 650.05	0.21	<0.01	0.02
KC15134	650.05 ~ 650.55	0.27	<0.01	0.01
KC15135	650.55 ~ 651.05	0.49	0.01	0.02
KC15136	651.05 ~ 651.55	0.43	0.01	0.02
KC15137	651.55 ~ 652.05	0.13	<0.01	0.01
KC15138	652.05 ~ 652.55	0.13	<0.01	0.01
KC15139	652.55 ~ 653.05	0.24	<0.01	0.02
KC15140	653.05 ~ 653.35	0.17	<0.01	0.01
KC15141	653.35 ~ 653.85	0.22	<0.01	0.02
KC15142	653.85 ~ 654.35	0.44	0.01	0.02
KC15143	654.35 ~ 654.85	1.89	<0.01	0.04
KC15144	654.85 ~ 655.30	1.55	<0.01	0.06
KC15145	655.30 ~ 655.80	0.57	<0.01	0.07
KC15146	655.80 ~ 656.30	0.24	<0.01	0.07
KC15147	656.30 ~ 656.70	0.70	<0.01	0.06
KC15148	656.70 ~ 657.20	<0.01	<0.01	<0.01
KC15149	657.20 ~ 657.70	<0.01	<0.01	<0.01
KC15150	657.70 ~ 658.20	<0.01	<0.01	<0.01
KC15151	658.20 ~ 658.70	<0.01	<0.01	<0.01
KC15152	658.70 ~ 659.05	0.01	<0.01	<0.01

Width (m)	Depth (m)	T-Cu (%)	AS-Cu (%)	T-Co (%)
1355.82	654.35 ~ 655.30	1.71	<0.01	0.05
1.40	655.30 ~ 656.70	0.49	<0.01	0.07

Table 2-5-3 Results of Chemical Analysis of Ore Samples (3)

MJZC－12

Sample No.	Depth (m)	T-Cu (%)	AS-Cu (%)	T-Co (%)
KC16153	652.37 ～ 652.87	<0.01	<0.01	<0.01
KC16154	652.87 ～ 653.37	<0.01	<0.01	<0.01
KC16155	653.37 ～ 653.87	<0.01	<0.01	<0.01
KC16156	653.87 ～ 654.37	<0.01	<0.01	<0.01
KC16157	654.37 ～ 654.87	0.09	<0.01	<0.01
KC16158	654.87 ～ 655.17	<0.01	<0.01	<0.01
KC16159	655.17 ～ 655.67	<0.01	<0.01	<0.01
KC16160	655.67 ～ 656.17	<0.01	<0.01	<0.01
KC16161	656.17 ～ 656.67	<0.01	<0.01	<0.01
KC16162	656.67 ～ 657.17	<0.01	<0.01	<0.01
KC16163	657.17 ～ 657.67	<0.01	<0.01	<0.01
KC16164	657.67 ～ 658.37	<0.01	<0.01	0.04
KC16165	658.37 ～ 658.87	<0.01	<0.01	0.03
KC16166	658.87 ～ 659.37	<0.01	<0.01	0.02
KC16167	659.37 ～ 659.87	<0.01	<0.01	0.01
KC16168	659.87 ～ 660.37	<0.01	<0.01	0.01
KC16169	660.37 ～ 660.87	<0.01	<0.01	0.01
KC16170	660.87 ～ 661.46	<0.01	<0.01	0.04
KC16171	661.46 ～ 661.95	1.49	<0.01	0.11
KC16172	661.96 ～ 662.46	0.01	<0.01	0.02
KC16173	662.46 ～ 662.96	0.33	<0.01	0.02
KC16174	662.96 ～ 663.46	0.29	<0.01	0.01
KC16175	663.46 ～ 663.96	0.18	<0.01	0.01
KC16176	663.96 ～ 664.37	0.29	<0.01	0.02
KC16177	664.37 ～ 664.87	0.07	<0.01	0.01
KC16178	664.87 ～ 665.37	0.12	<0.01	0.02
KC16179	665.37 ～ 665.87	0.18	<0.01	0.02
KC16180	665.87 ～ 666.37	0.12	<0.01	0.01
KC16181	666.37 ～ 666.87	0.14	<0.01	0.01
KC16182	666.87 ～ 667.37	0.13	<0.01	0.01
KC16183	667.37 ～ 667.87	0.29	<0.01	0.01
KC16184	667.87 ～ 668.37	0.03	<0.01	0.02
KC16185	668.37 ～ 668.87	0.28	<0.01	0.01
KC16186	668.87 ～ 669.14	0.34	<0.01	0.02
KC16187	669.14 ～ 669.64	1.19	<0.01	0.03
KC16188	669.64 ～ 670.14	0.54	<0.01	0.01
KC16189	670.14 ～ 670.45	0.50	<0.01	0.02
KC16190	670.45 ～ 670.95	0.65	<0.01	0.03
KC16191	670.95 ～ 671.45	0.66	<0.01	0.01
KC16192	671.45 ～ 671.95	0.85	<0.01	0.01
KC16193	671.95 ～ 672.24	0.98	<0.01	0.02
KC16194	672.24 ～ 672.74	2.86	<0.01	0.02
KC16195	672.74 ～ 673.24	1.30	<0.01	0.02
KC16196	673.24 ～ 673.74	2.68	<0.01	0.10
KC16197	673.74 ～ 674.14	0.46	<0.01	0.02
KC16198	674.14 ～ 674.64	0.01	<0.01	<0.01
KC16199	674.64 ～ 675.14	<0.01	<0.01	<0.01

Sample No.	Depth (m)	T-Cu (%)	AS-Cu (%)	T-Co (%)
KC16200	675.14 ～ 675.64	<0.01	<0.01	<0.01
KC12201	675.64 ～ 676.14	<0.01	<0.01	<0.01
KC12202	676.14 ～ 676.46	<0.01	<0.01	<0.01
KC12203	676.46 ～ 676.96	<0.01	<0.01	<0.01
KC12204	676.96 ～ 677.46	<0.01	<0.01	<0.01
KC12205	677.46 ～ 677.96	<0.01	<0.01	<0.01
KC12206	677.96 ～ 678.76	<0.01	<0.01	<0.01

Width (m)	Depth (m)	T-Cu (%)	AS-Cu (%)	T-Co (%)
3.10	669.14 ～ 672.24	0.77	<0.01	0.06
1.50	672.24 ～ 673.74	2.28	<0.01	0.05

Chapter 5 Ore Reserve Calculation

5-1 Objective

The objective of the ore reserve calculation is to assess the mineral potential of the survey area.

5-2 Method

The calculation was carried out by ZCCM using LYNX computer of Canadian LYNX GEOSYSTEM INC.

Kriging method, Inverse Distance Squared method and manual calculation on orebody sections were studied for the ore reserve calculation. In the Kriging, borehole data points may not be enough for constructing a reliable semi-variogram, while the manual calculation overestimated the tonnage and the grade in the part of low density of borehole. Consequently Inverse Distance Squared method was adopted to the ore reserve calculation of the area.

In the Inverse Distance Squared method the grade of a block is calculated that:

$$X = \sum_{i=1}^{N}(xi/di^2) \;/\; \sum_{i=1}^{N}(1/di^2)$$

X : block grade
xi: grade composite value of neighbouring sample point (intersection grade of drill hole etc.)
di: distance between centre of block and sample point
i : neighbouring sample point
N : number of samples used for the estimation

Inverse Distance Squared method was used under the following conditions.

3D GRID MODEL DIMENSIONS: 150 x 150 x 1300 (m)
SEARCH ELLIPSOID DIMENSIONS: 800 x 800 x 800 (m)
CUT-OFF GRADE: 1% T-Cu
ORE DENSITY: 2.67

Assay results of gold and silver for the intersections of drill holes are listed in the appendices. These results are generally low (in the order of ppb). However, there are several relatively high grade ores in some part of the Southern Area Shoot, Northern Area Shoot and in the western part of the survey area. The matter how to treat these gold and silver assays in the calculation of ore reserves are now being discussed by ZCCM.

5-3 Results

68 boreholes were found to have intersections of 1% Cu mineralization.

The orebody being mostly gentle slope lying, each 3D Grid cell created one orebody intersection as seen in the plan.

Figures and tables of various kinds on the results of the calculation are shown in appendices.

ZCCM has made a policy not to use the word ore unless an economic evaluation has been made, and concluded that the tonnage and grade of the results be expressed under two headings:

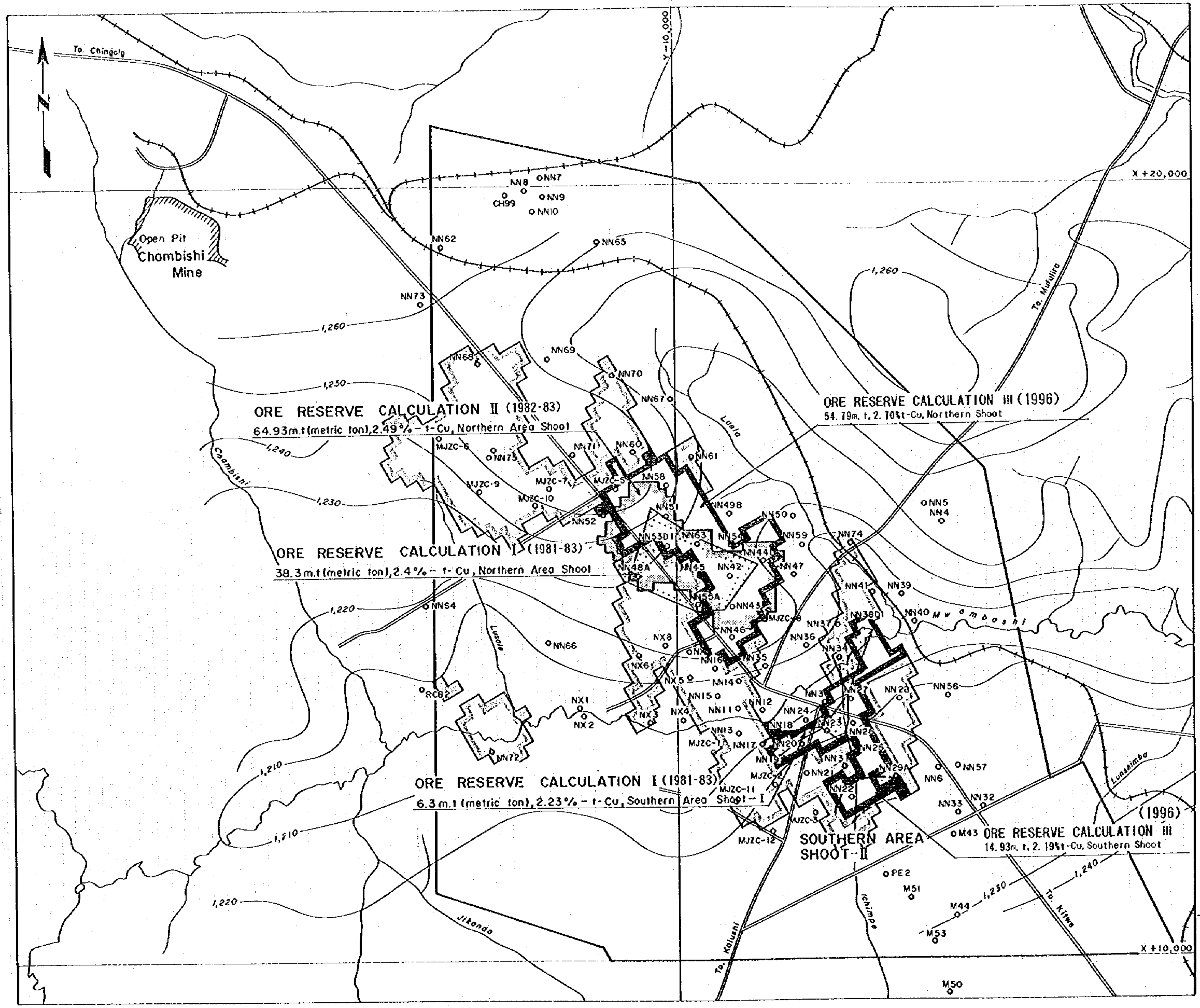
(A) Potentially Economic Mineralization: This will be summation of blocks which have a minimum true thickness of 3m and a minimum block grade of 2% T-Cu. The blocks should also be connected with each other making a minable body. This criterion was used to quantify the Northern Area Shoot and the Southern Area Shoot.

(B) Subeconomic mineralization: The grade and tonnage of the remaining blocks of the 1% Cut-Off mineralization.

The areas around NN-75, MJZC-9(NN-84) and RCB-2 were purposely left out from the Potentially Economic Mineralization as those are separated from the Northern Area Shoot and require further drilling to firm up the block grades and tonnages. However those areas are regarded as of considerable promise for location of economic mineralization.

The tonnages and grades of the survey area are as follows.

POTENTIALLY ECONOMIC MINERALIZATION;
NORTHERN AREA SHOOT: 54,793,000 tons, 2.70% T-Cu, 0.13% T-Co
SOUTHERN AREA SHOOT: 14,934,000 tons, 2.19% T-Cu, 0.13% T-Co



LEGEND

o Drilling Holes

Topographic Elevation Contour in Metre (1,260 / 1,250)

Survey Area

ORE RESERVE CALCULATION III (1996)

Subeconomic Blocks, 10.91m.t, 1.83%t-Cu

Northern Area Shoot

	True Thickness (m)	Total Cu%	Total Co%
NN58	22.92	2.21	0.09
51	14.21	2.68	0.06
48-B	4.67	2.07	0.02
53-D1	4.92	2.15	0.05
63	18.41	2.11	0.21
45	10.39	2.32	0.06
42	16.27	2.29	0.10
44-D1	15.90	2.86	0.18
55-A	3.02	2.04	0.04
43	12.02	2.93	0.09

Southern Area Shoot-I

	True Thickness (m)	Total Cu%	Total Co%
NN11	5.49	1.88	0.04
NN18	4.48	2.81	0.07
20	5.06	1.92	0.13
23	4.75	2.62	0.27
26	4.63	1.87	0.12
27	5.12	2.31	0.28
38-D1	3.90	2.98	0.01
40	9.78	2.17	0.04

Southern Area Shoot-II

	True Thickness (m)	Total Cu%	Total Co%
NN22	5.61	2.37	0.13
29	9.08	1.75	0.17

Nothwestern Area

	True Thikness (m)	Total Cu%	Total Co%
NN75	10.72	2.11	0.09
MJZC-9	5.79	3.12	0.08

Fig. 2-5-1 Ore Reserve Calculation

SUBECONOMIC MINERALIZATION (includes isolated patches of 2% Cu and 3m true thickness blocks):

107,909,000 tons, 1.83% T-Cu, 0.03% T-Co

PART III

CONCLUSIONS AND RECOMMENDATIONS

PART III Conclusions and Recommendations

CHAPTER 1 Conclusions

Drilling was carried out during the third phase of the Chambishi Southeast survey. All four holes drilled (MJZC-9, -10, -11, -12) this year accomplished their objective by penetrating the ore horizon. Of these four, three reached the basement. The results of these work clarified considerably the geology and mineralization of the western and southern parts of the survey area and the following conclusions were attained.

1. MJZC-9 drilled in the western part of the area confirmed the existence of high-grade ores (i. width 5.90m, grade T-Cu 3.12%, T-Co 0.08%; ii. width 2.58m, grade T-Cu 2.29%, T-Co <0.01%). These ores are considered to be continuous to the shoot confirmed to the north of this hole (NN-75). Thus it is now clear that an ore shoot of considerable scale exists in this area. It is inferred that this ore shoot is emplaced over a basement depression which is elongated in the NE-SW direction and it is deemed possible that this shoot is developed further southward or westward.

2. Relatively low-grade copper ores rich in pyrrhotite were confirmed by MJZC-10 drilled on the eastern side of MJZC-9 and MJZC-11 · -12 drilled in the southern part of the area. In these mineralized zones, the rich ore probably deposited during a relatively short period of time before or after the start of deposition of the "Ore Shale", because Fe/Cu ratio tends to increase upward.

3. Small scale bornite-chalcopyrite mineralization was confirmed in the basal part of the "Ore Shale" in MJZC-12. It is inferred that this mineralized zone lies over a basement-rise which extends southward. Palaeo-basement highs probably existed in parts of this rise at the time of ore deposition. Therefore, palaeo-basement highs occurred in relatively shallow parts and there are possibilities of ore shoots occurring on their limbs.

4. A basement depression extending in the NE-SW direction is considered to exist between MJZC-11 and -12. This should be noted as MJZC-2 with relatively high grade ores is located on

the northeastern extension of this depression.

5. Ore reserve estimation was carried out to asses the mineral potential of the survey area with the following results.

POTENTIALLY ECONOMIC MINERALIZATION;
NORTHERN AREA SHOOT: 54,793,000 tons, 2.70% T-Cu, 0.13% T-Co
SOUTHERN AREA SHOOT: 14,934,000 tons, 2.19% T-Cu, 0.13% T-Co
SUBECONOMIC MINERALIZATION (includes isolated patches of 2% Cu and 3m true thickness blocks):
107,909,000 tons, 1.83% T-Cu, 0.03% T-Co

CHAPTER 2 Recommendations for Future Exploration

Significant amounts of ore were confirmed in this survey area by drilling during this year. The ore deposits of this area, however, occur in relatively deep zones, the major deposits probably occurs at 550 to 1,050m below the surface. Therefore, in order to develop this deposit, it is necessary to further increase the ore reserves. The western and southern parts of the survey area have not been explored and the potential is considered to be promising.

It is now clear, from the results of the present survey, that a deposit which was hitherto unknown occurs in the western part of the area. Also borehole RCB-2 which previously confirmed ores is located far south of MJZC-9 which also confirmed ores. From the above it is strongly recommended that efforts be concentrated as follows to confirming new ore reserves and to exploring the vicinity. First drill at sites where the depth of the ore deposits can be estimated at shallow depths, namely near the two boreholes which encountered ores (MJZC-9, NN-75), then drill at sites where the depth of the ore is considered to become deeper, namely south and west of MJZC-9.

The possibility of ore shoots still remain in the southern part of the area and thus it is recommended that drilling be carried out in the area to the south of MJZC-12.

Also in order to accurately determine the ore reserves of the Northern Area Shoot, the main deposit, drilling should be carried out near the peripheries of the deposit.

REFERENCES

R E F E R E N C E S

Fleischer, V.D., Garlick, W.G. and Haldane, R. 1976. Geology of the Zambian Copperbelt, Handbook of Strata-bound and Stratiform Ore Deposits (K. H. Wolf, ed.), Elsevier, Amsterdam, vol.6, p.223-350

Fleischer, V.D. 1983. Discovery of a New Copper-Cobalt Sulphide Occurrence in the Chambishi Basin, Zambia, Central Africa. Paper presented at "Proterozoic '83", Lusaka, Zambia

Garlick, W.G. 1964. Association of Mineralization and Algal Reef Structures on Northern Rhodesian Copperbelt, Katanga, and Australia. Econ. Geol., vol.59, p.416-427.

Lowe, D. R. 1975. Water escape structures in coarse-grained sediments. Sedimentology, vol.22, p.157-204.

Malan, S.P. 1964. Stromatolites and Other Algal Structures at Mufulira, Northern Rhodesia. Econ. Geol., vol.59, p.397-415.

Mendelsohn, F. 1961. The Geology of the Northern Rhodesian Copperbelt, ed. F. Mendelsohn. Macdonald and Co. London. 523 pages.

Sugawara, M., Sato, K., Sato, S. and Nagasaki, N. 1982a. Mode of Occurrence of the Shakanai Kuroko Deposits with Special Reference to Some Sedimentological and Diagenetic Features - Studies on Diagenesis of Kuroko Deposits (Description). Mining Geology, vol.32, p.305-322 (in Japanese).

.... 1982b. An Attempt to Reconstruct the Diagenetic Evolution History of the Shakanai Kuroko Deposits - Studies on Diagenesis of Kuroko Deposits (Discussion). Mining Geology, vol.32, p.405-415 (in Japanese).

Zambia Consolidated Copper Mines Limited 1993. Proposal for a Mineral Exploration Project to be Carried out by the Metal Mining Agency of Japan and the Japan International Co-operation Agency on the Chambishi Southeast Deposit, Copperbelt Province, Republic of Zambia.