Chapter 2 MJZC-3

2-1 Progress of Drilling

The location and collar elevation of MJZC-3 are as follows.

Latitude	Longitude	Co-ordinates		Collar Elevation	Drilling Length	Incli-nation
		X	Y			
12°44′40″S	28°07′20″E	+11,850.15	-8,249.40	1,213.2 m	805.84 m	-90°

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

For the near surface zone to 4.00 m, non-core drilling was made by 165 mm tricone bit, and 165 mm guide pipes were inserted to 4.00 m. At 4.00 to 90.00m, non-core drilling was made by 150 mm tricone bit, and HW casing pipes were inserted to 84.00 m. At 90.00 to 102.00 m, non-core drilling was made by 130 mm tricone bit, and NW casing pipes were inserted to 102.00 m. At 102.00 to 534.00m, core drilling was made by NQ bit, and BX casing pipes were inserted to 534.00 m. From 534.00 m to the bottom depth of 805.84 m, core drilling was made by BQ bit. Cuttings were collected at 1 m interval for non-core drilling.

The circulating water was completely lost at 87.00 to 91.00 m. Despite injection of Drillprops, which is a high viscosity liquid similar to bentonite, the total water loss did not stop. Casing pipes were inserted to 102.00 m, and the hole recovered. Also the circulating water was lost at 428.00 m and 458.50m, and injection of Drillprops stopped the total water loss. Depths of the circulating water loss were in dolomites, and small vugs were recognized near 428.00 m.

This hole was jammed by drill rod damage at 706.84 m. Therefore, wedging (1.5°) was conducted at 640.00 to 805.84 m.

Borehole deviation was measured every 100 m as shown in Appendix-6, and it was shown that the borehole deviated northwestward similar to those of previous holes in the vicinity.

2-2 Geology and Mineralization

The geologic log is appended. Basal conglomerate is not developed immediately over the basement rocks at this hole. But the geology of the drill

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

	Survey Period			Total man day	
	Period	Days	Work day / Off day	Engineer	Worker
Operation			days / days	man	man
Preparation	24.11.1993～05.12.1993	12	9 / 3	10	48
Drilling	16.12.1993～17.01.1993	43	Drilling 29 / 5 Recovering 7 / 2	93 19	242 60
Dismantling	18.01.1994～19.01.1994	2	2 / 0	4	8
Total	24.11.1993～19.01.1994	57	47 / 10	126	358

Drilling length			
Length planed	805.00 m	Overburden	12.00 m
Increase or Decrease in length	− m	Core length	679.62 m
Length drilled	805.84 m	Core recovery	96.6 % 679.62 /703.84

Working hours	h	%	%
Drilling	454°00′	61.6	38.5
Other working	193°00′	26.2	16.3
Recovering	90°00′	12.2	7.6
Total	737°00′	100.0	62.5
Reassemblage	40°00′		3.4
Dismantlement	48°00′		4.1
Water transportation	178°00′		15.1
Road construction and transportation	177°00′		15.0
G.Total	1180		100.0

Casing pipe inserted		Meterage/ drilling length × 100	Recovery
Size	Meterage (m)	(%)	(%)
165mm	4.00	0.5	0
HW	84.00	10.4	0
NW	102.00	12.7	82.4
BX	534.00	66.3	100.0

Core recovery of 100 m hole

Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0.00 ～ 100.00	N/C	−
100.00 ～ 200.00	93.4	93.4
200.00 ～ 300.00	98.6	96.0
300.00 ～ 400.00	99.7	97.3
400.00 ～ 500.00	89.4	95.3
500.00 ～ 600.00	95.2	95.3
600.00 ～ 700.00	99.7	96.0
700.00 ～ 800.00	99.6	96.5
800.00 ～ 900.00	100.0	96.6

Efficiency of Drilling	
Total m/work period(m/day)	805.84 m/ 57 days (14.14 m/day)
Total m/drilling work shift(m/shift)	805.84m/ 68 shift (11.85 m/shift)

Drilling length/bit (each sized bit)

Bit size	165mm	150mm	130mm	NQ	BQ
Drilled length	4.00 m	86.00 m	12.00 m	432.00 m	271.84 m
Core length	N/C	N/C	N/C	413.30 m	266.32 m

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

	Drilling length			Daily Total		Number of Shift		Number of Person	
	shift 1	shift 2	Total Cumulated	Drilling	Core length	Drilling	Total	Engineer	Worker
November	m	m	m	m	m	shift	shift	man	man
24	Tra-Reas						1	1	5
25	—								
26	—								
27	—								
28	Trans						1		1
29	Trans						1		1
30	Trans						1		1
December									
1	Trans						1		1
2	Tra-Reas						1	2	11
3	Reas						1	2	10
4	Reas						1	2	10
5	Reas						1	3	8
6	36.85	26.40		63.25	0.00	2	2	3	8
7	26.75	0.00	90.00	26.75	0.00	2	2	3	8
8	1.00	1.45	92.45	2.45	0.00	2	2	3	8
9	9.20	0.35	102.00	9.55	0.00	2	2	3	8
10	14.20	11.60	127.80	25.80	25.60	2	2	3	8
11	10.40	19.20	157.40	29.60	29.60	2	2	3	8
12	Day off	7.80	165.20	7.80	5.48	1	1	2	4
13	2.43	12.87	180.50	15.30	11.77	2	2	3	8
14	23.50	23.20	227.20	46.70	46.31	2	2	3	8
15	32.80	30.00	290.00	62.80	61.84	2	2	3	8
16	12.00	18.00	320.00	30.00	29.52	2	2	3	8
17	33.00	18.00	371.00	51.00	50.84	2	2	3	8
18	18.00	20.00	409.00	38.00	37.90	2	2	3	8
19	Day off	9.00	418.00	9.00	8.90	1	1	2	4
20	19.50	14.50	452.00	34.00	28.04	2	2	3	8
21	2.00	11.00	465.00	13.00	10.50	2	2	3	8
22	3.00	5.00	473.00	8.00	6.50	2	2	3	8
23	0.00	24.00	497.00	24.00	23.50	2	2	3	8
24	2.00	Day off	499.00	2.00	2.00	1	1	2	4
25	—	Day off	499.00	0.00	0.00	0	0	1	2
26	—	Day off	499.00	Day off	Day off	0	0	1	2
27	34.00	1.00	534.00	35.00	35.00	2	2	3	8
28	Ins-C.P	2.00	536.00	2.00	2.00	2	2	3	8
29	5.84	12.00	553.84	17.84	13.25	2	2	3	8
30	36.00	7.88	597.72	43.88	43.88	2	2	3	8
31	0.00	0.98	598.70	0.98	0.98	2	2	3	8
January									
1	42.14	0.00	640.84	42.14	41.94	2	2	3	8
2	21.67	11.33	673.84	33.00	32.77	2	2	3	8
3	9.00	24.00	706.84	33.00	32.90	2	2	3	8
4	0.00	0.00	706.84	0.00	0.00	2	2	3	8
5	Main-Rd	-	706.84	0.00	0.00	0	1	2	8
6	Main-Rd	-	706.84	0.00	0.00	0	1	2	8
7	Main-Rd	-	706.84	0.00	0.00	0	1	2	8
8	Main-Rd	-	706.84	0.00	0.00	0	1	2	8
9	Day off	-	706.84	0.00	0.00	0	0	1	2
10	Day off	-	706.84	0.00	0.00	0	0	1	2
11	0.00	0.00	706.84	0.00	0.00	2	2	3	8
	R-D(3.84)	R-D(10.00)		R-D(13.84)					
12	0.00	0.00	706.84	0.00	0.00	2	2	3	8
	R-D(5.65)	R-D(20.35)		R-D(26.00)					
13	0.00	9.00	715.84	9.00	9.00	2	2	3	8
	R-D(24.00)	R-D(3.00)		R-D(27.00)					
14	7.70	22.30	745.84	30.00	30.00	2	2	3	8
15	12.00	6.00	763.84	18.00	17.60	2	2	3	8
16	Day off	Day off	763.84	0.00	0.00	0	0	1	2
17	24.00	18.00	805.84	42.00	42.00	2	2	3	8
18	Dismant	Out-C.P	—	—	—	2	2	2	4
19	Out-CP	Dismant	—	—	—	1	2	2	4
Total	419.28	366.86	805.84	805.84	679.62	68	82	126	358

Abbreviation

Pds	: Preparation for drilling site	Ins-C.P	: Inserting casing pipe
Trans	: Transportation	Out-C.P	: Taking out casing pipe
Tra-Reas	: Transportation and Reassemblage	Road-con	: Road construction
Reassemb	: Reassemblage	Repair	: Repair work on a road
Dismant	: Dismantlement	With-cyc	: Withdrowal suspension due to the cyclone
Main-mac	: Maintenance of machines	Tra-pack	: Transportation and packing of equipment
R-D	: Redrilling		

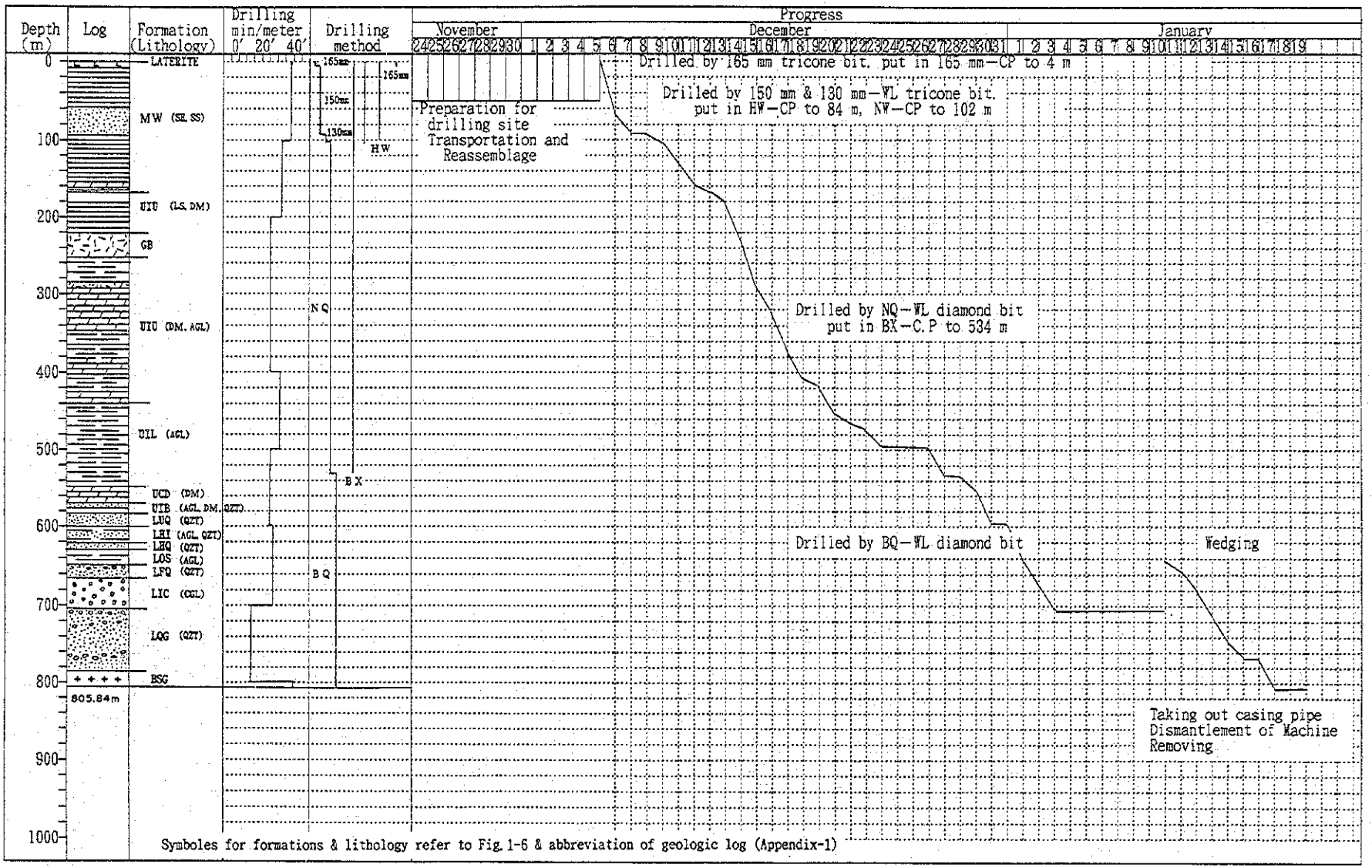


Fig.2-2-1 Drilling Progress of MJZC-3

hole is nearly similar to that of the survey area, which is described in 3-2 of PART I . Description of the drill hole is as follows.

Basement : 780.80 to 805.84 m. The basement consists of pinkish gray granites. The grain size of quartz, feldspar and biotite is 3 to 5 mm. Silicification and sericitization are generally recognized in granites, and veinlets of anhydrite and quartz are developed.

Lower Roan Group

"Feldspathic Quartzite and Grits": 705.70 to 780.80 m. It is composed of grayish to pinkish white quartzites with intercalations of conglomerate, argillite lamina and quartzite including fragments. These are intensely silicified in general. Anhydrite and quartz veinlets are dispersed.

"Intermediate Conglomerate": 666.30 to 705.70 m. It is composed of compact gray to dark green conglomerates with intercalations of sandstone and pebbly quartzite. The conglomerates consists of granite, sandstone, quartzite, schist, chert, gneiss and argillite pebbles. Anhydrite and quartz veinlets are dispersed.

"Footwall Quartzite": 652.10 to 664.80 m. It consists of pinkish gray micaceous quartzites with intercalations of argillite. Quartz veins are developed near the unit boundary.

"Footwall Conglomerate": 649.70 to 651.30 m. It is composed of compact gray conglomerates with dolomitic sandstones at the upper part. The conglomerates consists of granite, chert, schist, sandstone and quartzite pebbles, however, the detailed lithology is not clear because of intense silicification. A dish structure is observed in pyrite-disseminated sandstones of the upper part.

"Ore Shale Horizon": 632.40 to 649.70 m. It consists of sandy and dolomitic argillites with dark gray indistinct lamina. A mineralized zone which is composed of Cu-bearing sulfide minerals, is developed at 635.10 to 649.70 m, and the Cu-high grade part is at 644.70 to 649.70 m. Chalcopyrite is concentrated parallel to the bedding planes into thin lenses, and irregular veinlets of quartz, chalcopyrite, pyrite and pyrrhotite occur in the high grade part. At 636.00 to 636.70 m, chalcopyrite lamina which very fine-grained chalcopyrite concentrates at bedding planes are formed. At 636.70 to 644.70 m, spotted small dolomitic concretions are fringed with chalcopyrite and pyrite assemblages.

Chalcopyrite is contained in concretions composed of siliceous dolomites near 649 m. Results of ore assay are shown in Table 2-4-4.

"Hangingwall Quartzite and Argillite": 622.10 to 632.40 m. It consists of dark gray pelitic and dolomitic quartzites with many pelitic bands.

"Interbedded Argillite and Quartzite": 600.50 to 622.10 m. It is composed of dark gray pelitic, dolomitic, micaceous sandstones and grayish white dolomitic quartzites with intercalations of dolomite and argillite.

"Upper Quartzite": 586.5 to 600.50 m. It is composed of pinkish to brownish white dolomitic quartzites with many pelitic bands.

Upper Roan Group

"Interbedded Argillte, Dolomite and Quartzite": 570.30 to 586.50 m. This unit is divided to upper and lower parts. The former is of dark gray dolomitic, micaceous and quartzose sandstones with intercalations of dolomite and argillite, and the latter of alternation of dark gray pelitic dolomites and thin argillites.

"Cherty Dolomite": 547.30 to 570.30 m. It mainly consists of massive white dolomites and locally with silicified parts. A massive green argillite (Marker Shale) is intercalated in the upper part. While, the lower part consists of dark gray pelitic dolomites and alternations of dolomite and micaceous argillite. Generally, lenses and patches of anhydrite are contained. A copper mineralization is observed at 556.80 to 562.60 m, where flat and small concentrations of chalcopyrite are dispersed in silicified parts, dolomites and anhydrites. Also chalcopyrite-bearing quartz veins occur at these depths.

"Arenite, Argillite and Dolomite with Anhydrite": 440.00 to 547.30 m. This unit is divided to upper and lower parts. The former is of green dolomitic and micaceous argillites intercalated with thin dolomites, and the latter of green argillites and alternations of argillite and thin sandstone in which dish structures, pillar structures and sandstone dikes formed by liquefaction are developed. From about 475 m down to the bottom depth of the unit, strong anhydritization (lens, veinlet and patch) is generally observed.

"Interbedded Argillite and Dolomite with Tectono-Breccias":171.30 to 440.00m. It consists of white to gray dolomites with intercalations of green argillite. Limestones are developed at the upper part, and thin layers and lenses of cherty rocks are intercalated in carbonate rocks and argillites. Pebbly conglomerates

and argillites brecciated by shear forces are distributed at 289.7 to 290.50 m and about 323.70 m, respectively. Fractures and stylolites are developed in dolomites at 290.50 to 342 m and 350 to 422 m, respectively. Limonites are attached to vugs, and fractures broadly observed in dolomites. Transparent quartz veins occur near the uppermost part.

"Mwashia Group": 12.00 to 166.00 m. It consists of black shales, grayish white dolomites, dark green calcareous and dolomitic argillites, arkosic sandstones and olive gray argillites. Black shales are carbonaceous, and pyrite bands with thickness of 0.5 to 1 cm, which is accompanied by quartz, hematite and dolomite, are well developed parallel to bedding planes in the shales, showing boudinage structure. Veinlets branch out from the bands in some parts.

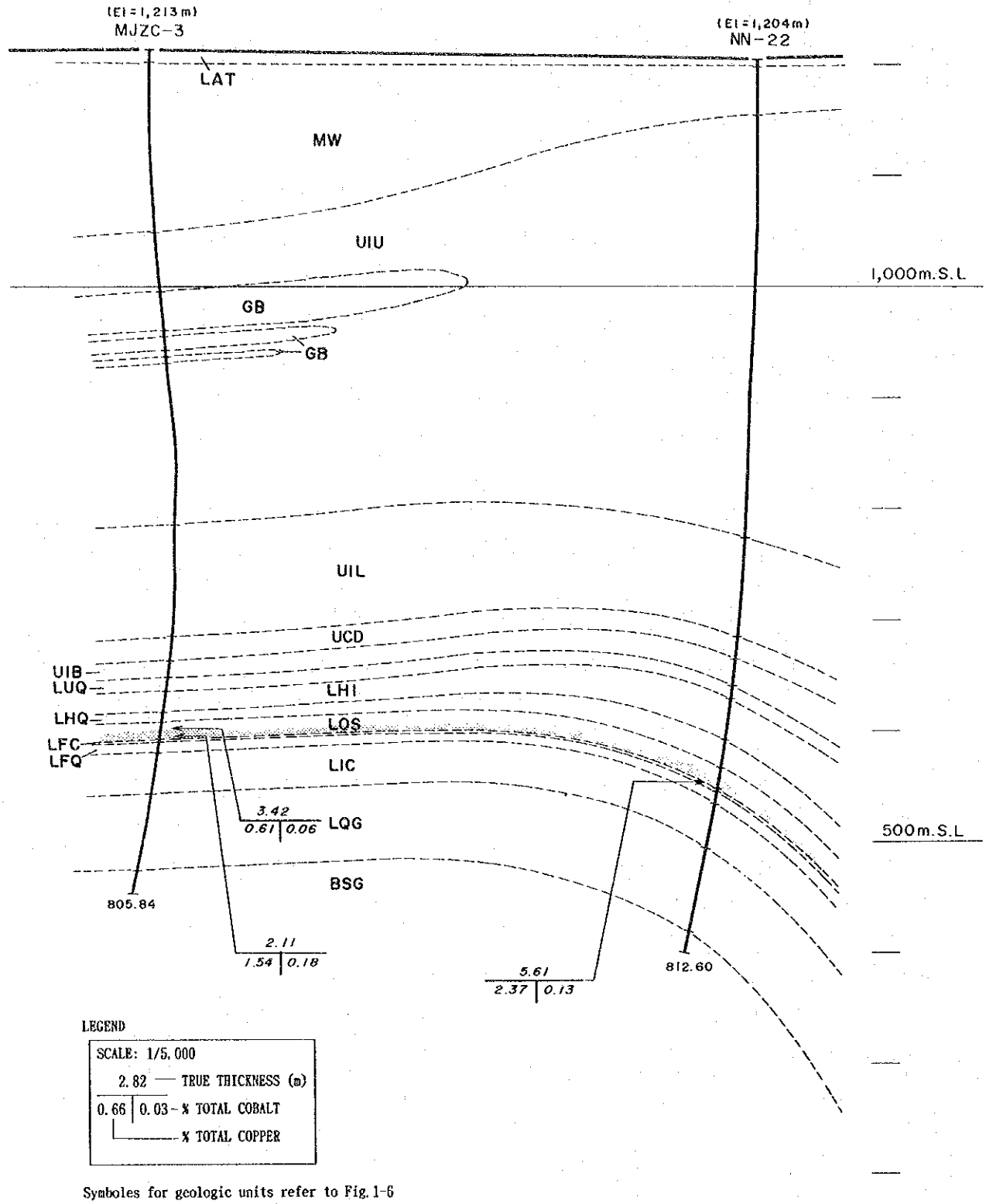
"Gabbro": Massive, dark green and white altered rocks mainly consisting of plagioclase, biotite, hornblende and carbonate minerals occur at 179.00 to 179.70 m, 220.50 to 249.90 m, 252.4 to 256.1 m and 285.00 to 289.70 m. Also dark green pelitic altered rocks occur at 263.3 to 283.6 m. These rocks are intensely carbonitized and white argillized, therefore, their lithologies are not clear.

2-3 Disccusions

The geological setting at this hole is very concordant with that at NN-22 as shown in geological sections (Fig. 2-2-2). The mineralized zone in the Ore Shale confirmed in this hole is located on a basement high. The mineralization is not very intense relative to the Southern Area Shoot-I and II, but the ore grade is similar to that of NN-21 located immediately to the north. The relatively high grade of cobalt in the mineralized zone is noted.

Very fine-grained chalcopyrite lamina which is considered to be primary, occur in the Ore Shale. The high-grade part, however, consists of lenses, veins and concretions of chalcopyrite assemblages, therefore, it is believed that migration and recrystallization of copper metal during diagenesis and metamorphism played important roles in the formation of the ore shoot.

It is generally believed that ore deposits of the Copperbelt occur on depressions of the basements, and those on basement highs are barren or low-garde. Therefore, the conditions of this hole are harmonious with the general



Symboles for geologic units refer to Fig.1-6

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

trend. However, there are exceptions such as that recognized at NN-23 located in the South Area Shoot-I (Fig. 1-7, K-K' Section). Here, the western half of the Shoot occurs at higher horizon than the top of the basement rise and below thin gabbro. Now, if the western extension of South Area Shoot-II was formed by the same process as South Area Shoot-I, the high grade part would continue to MJZC-2 along the rim of the gabbroic body and the basement limb to the south of this hole (Figs. 1-10 and 1-11).

The results of microscopic study of the major mineralized zones confirmed in this hole are shown in Table 2-4-2. It is seen that monazite occurs in every mineralized zone, xenotime occurs in the black shale of Mwashia Group and thorite in the Ore Shale. This indicates that source materials for all mineralized zones in the Mwashia, Upper Roan and Lower Roan Groups derived from granitic rocks.

Chapter 3 MJZC-4

3-1 Progress of Drilling

The location and collar elevation of MJZC-4 are as follows.

Latitude	Longitude	Co-ordinates		Collar Elevation	Drilling Length	Incli-nation
		X	Y			
12°41′49″S	28°05′56″E	+15,300.04	-10,749.74	1,234.2 m	1,051.00m	-90°

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 7.00 m, non-core drilling was made by 165 mm tricone bit, and 165 mm casing pipes were inserted to 7.00 m. At 7.00 to 72.00m, non-core drilling was made by 150 mm tricone bit, and HW casing pipes were inserted to 72.00 m. At 72.00 to 84.00 m, non-core drilling was made by 130 mm tricone bit, and NW casing pipes were inserted to 84.00 m. At 84.00 to 504.04 m, core drilling was made by NQ bit, and BX casing pipes were inserted to 504.04 m. From 504.04 m to the bottom depth of 1,051.00 m, core drilling was made by BQ bit. Cuttings were collected at 1 m interval for non-core drilling.

Because the circulating water was completely lost at 60.00 to 84.00 m, casing pipes were inserted to 84.00 m. Also the circulating water was completely lost at 137.02 m. Despite injection of Drillprops, the hole was not recovered. Therefore, casing pipes were inserted to 504.00 m after the completion of the drilling operation under conditions of water loss, and the hole recovered. The depth of 137.02 m where the circulating water was lost, was in small vug-dominant dolomites.

Because this hole was jammed at 708.66 m, wedging (1.5°) was conducted at 647.43 m, and the drilling operation was continued to 1,051.00 m.

Borehole deviation was measured every 100 m as shown in Appendix-6. It was shown that the borehole deviated northwestward similar to those of previous holes in the vicinity.

3-2 Geology and Mineralization

The geologic log is appended. The geology of the drill hole is nearly similar to that of the survey area, which is described in 3-2 of PART I , except

Table 2-3-1 Summary of the Drilling Operation on MJZC-4

	Survey Period					Total man day	
	Period		Days	Work day	Off day	Engineer	Worker
Operation				days	days	man	man
Preparation	23.11.1993～04.12.1993		12	9	3	19	45
Drilling	05.12.1993～10.02.1994		68	Drilling 51 Recovering 5	12 0	157 15	407 40
Dismantling	11.02.1994～15.02.1994		5	5	0	15	40
Total	23.11.1993～15.02.1994		85	70	15	206	532

Drilling length			
Length planed	1051.00 m	Overburden	12.00 m
Increase or Decrease in length	− m	Core length	945.37 m
Length drilled	1051.00 m	Core recovery	97.8 % 945.37 /967.00

Working hours	h	%	%
Drilling	562°00′	45.1	31.8
Other working	270°00′	21.6	15.3
Recovering	416°00′	33.3	23.6
Total	1248°00′	100.0	70.7
Reassemblage	40°00′		2.3
Dismantlement	36°00′		2.0
Water transportation	304°00′		17.2
Road construction and transportation	137°00′		7.8
G.Total	1765°00′		100.0

Casing pipe inserted		Meterage/ drilling length × 100	Recovery
Size	Meterage (m)	(%)	(%)
165mm	7.00	0.7	0
HW	72.00	6.9	100
NW	84.00	8.0	100
BX	504.00	48.0	95

Core recovery of 100 m hole		
Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0.00 ～ 100.00	93.7	93.7
100.00 ～ 200.00	91.8	92.2
200.00 ～ 300.00	97.1	94.5
300.00 ～ 400.00	98.8	95.8
400.00 ～ 500.00	99.5	96.7
500.00 ～ 600.00	98.6	97.1
600.00 ～ 700.00	95.4	96.8
700.00 ～ 800.00	99.7	97.2
800.00 ～ 900.00	98.9	97.4
900.00 ～1000.00	99.4	97.6
1000.00 ～1100.00	99.8	97.8

Efficirncy of Drilling	
Total m/work period(m/day)	1051.00 m/ 68days (15.46 m/day)
Total m/work shift(m/shift)	1051.00 m/ 98 shift (10.72 m/shift)

Drilling length/bit (each sized bit)

Bit size	165mm	150mm	130mm	NQ	BQ
Drilled length	7.00 m	65.00 m	12.00 m	420.04 m	546.96 m
Core length	0.00 m	0.00 m	0.00 m	406.44 m	538.93 m

Table 2-3-2 Record of the Drilling Operation on MJZC-4 (1)

	Drilling length			Daily Total		Number of Shift		Number of Person	
	shift 1	shift 2	Total Cumulated	Drilling	Core length	Drilling	Total	Engineer	Worker
November	m	m	m	m	m	shift	shift	man	man
23	Tra-Reas						1	1	5
24	—						0	0	0
25	—						0	0	0
26	—						0	0	0
27	Tra-Reas						1	1	5
28	Trans						1	0	1
29	Trans						1	0	1
30	Trans						1	0	1
December									
1	Trans						1	1	1
2	Tra-Reas						1	4	11
3	Reas						1	4	10
4	Reas						1	4	10
5	66.00	6.00		72.00	0.00	2	2	3	8
6	6.14	2.00	80.14	8.14	0.00	2	2	3	8
7	3.86	28.97	112.97	32.83	28.10	2	2	3	8
8	24.05	4.55	141.57	28.60	22.20	2	2	3	8
9	13.32	10.93	165.82	24.25	24.20	2	2	3	8
10	46.15	9.00	220.97	55.15	53.43	2	2	3	8
11	16.03	10.97	247.97	27.00	26.80	2	2	3	8
12	Day off	Day off	Day off	Day off	Day off	Day off	Day off	-	-
13	35.80	15.20	298.97	51.00	50.09	2	2	3	8
14	38.65	8.80	346.42	47.45	45.65	2	2	3	8
15	8.45	3.45	358.32	11.90	11.80	2	2	3	8
16	8.05	0.00	366.37	8.05	7.90	2	2	3	8
17	31.00	24.60	421.97	55.60	54.66	2	2	3	8
18	5.00	13.15	440.12	18.15	17.98	2	2	3	8
19	Day off	15.65	455.77	15.65	15.55	1	1	2	4
20	32.20	16.07	504.04	48.27	48.08	2	2	3	8
21	Ins-C.P	7.80	511.84	7.80	7.50	2	2	3	8
22	27.30	28.30	567.44	55.60	55.06	2	2	3	8
23	21.50	6.90	595.84	28.40	28.32	2	2	3	8
24	0.00	Day off	595.84	0.00	0.00	1	1	2	4
25	—	Day off	595.84	0.00	0.00	0	0	1	0
26	—	Day off	595.84	Day off	Day off	0	0	1	0
27	12.00	23.86	631.70	35.86	35.40	2	2	3	8
28	30.14	Day off	661.84	30.14	30.07	1	1	2	4
29	Main-Rd	Day off	661.84	0.00	0.00	0	1	1	4
30	Main-Rd	Day off	661.84	0.00	0.00	0	1	1	4
31	Main-Rd	Day off	661.84	0.00	0.00	0	1	1	4
January									
1	—	Day off	661.84	0.00	0.00	0	0	0	0
2	—	Day off	661.84	0.00	0.00	0	0	1	0
3	—	Day off	661.84	0.00	0.00	0	0	1	0
4	4.50	1.50	667.84	6.00	4.90	2	2	3	8
5	6.00	12.00	685.84	18.00	15.00	2	2	3	8
6	12.00	10.30	708.14	22.30	21.90	2	2	3	8
7	0.52	0.00	708.66	0.52	0.52	2	2	3	8
8	Main-Rd	0.00	708.66	0.00	0.00	2	2	3	8
9	Day off	Day off	708.66	0.00	0.00	0	0	1	2
10	Rod Jam	Rod Jam	708.66	0.00	0.00	2	2	3	8

Table 2-3-2 Record of the Drilling Operation on MJZC-4 (2)

	Drilling length			Daily Total		Number of Shift		Number of Person	
	shift 1	shift 2	Total Cumulated	Drilling	Core length	Drilling	Total	Engineer	Worker
11	Rod Jam	Rod Jam	708.66	0.00	0.00	2	2	3	8
12	Wedge	Wedge (1.57)	708.66	0.00 R-D(1.57)	0.00	2	2	3	8
13	Recover	Recover	708.66	0.00	0.00	2	2	3	8
14	R-D (3.20)	R-D (3.20)	708.66	0.00 R-D(6.40)	0.00	2	2	3	8
15	12.00 (6.05)	R-D (5.97)	708.66	0.00 R-D(12.02)	0.00	2	2	3	8
16	Day off	Day off	708.66	0.00	0.00	0	0	1	2
17	R-D (6.42)	R-D (14.10)	708.66	0.00 R-D(20.52)	0.00	2	2	3	8
18	1.28 (R-D20.72)	21.50	731.44	22.78	22.68 R-D(20.72)	2	2	3	8
19	20.50	7.90	759.84	28.40	28.16	2	2	3	8
20	4.10	6.00	769.94	10.10	10.10	2	2	3	8
21	18.00	24.00	811.94	42.00	42.00	2	2	3	8
22	15.00	17.00	843.94	32.00	32.00	2	2	3	8
23	Day off	Day off	843.94	0.00	0.00	0	0	1	2
24	16.00	5.10	865.04	21.10	21.06	2	2	3	8
25	2.13	0.00	867.17	2.13	2.13	2	2	3	8
26	4.67	8.86	880.70	13.53	12.51	2	2	3	8
27	11.24	16.00	907.94	27.24	27.24	2	2	3	8
28	12.00	5.25	925.19	17.25	16.90	2	2	3	8
29	10.80	16.95	952.94	27.75	27.54	2	2	3	8
30	Day off	12.00	964.94	12.00	12.00	1	1	2	5
31	6.00	11.20	982.14	17.20	17.20	2	2	3	8
February									
1	3.00	15.00	1000.14	18.00	17.98	2	2	3	8
2	3.80	12.00	1015.94	15.80	15.80	2	2	3	8
3	15.70	1.00	1032.64	16.70	16.70	2	2	3	8
4	4.30	12.00	1048.94	16.30	16.20	2	2	3	8
5	2.06	0.00	1051.00	2.06	2.06	2	2	3	8
6	Day off	Day off				-	-	1	2
7	Recov	Recov					2	3	8
8	Recov	Recov					2	3	8
9	Recov	Recov					2	3	8
10	Recov	Recov					2	3	8
11	Out-C.P						1	3	8
12	Out-C.P						1	3	8
13	Dismant						1	3	8
14	-Trans						1	3	8
15	Tra-pack						1	3	8
Total	599.24	451.76	1051.00	1051.00	945.37	98	123	206	532

Abbreviation

Pds	: Preparation for drilling site	Ins-C.P	: Inserting casing pipe
Trans	: Transportation	Out-C.P	: Taking out casing pipe
Tra-Reas	: Transportation and Reassemblage	Road-con	: Road construction
Reassemb	: Reassemblage	Repair	: Repair work on a road
Dismant	: Dismantlement	Recov	: Recovering
Main-mac	: Maintenance of machines	Tra-pack	: Transportation and packing of equipment
R-D	: Redrilling		

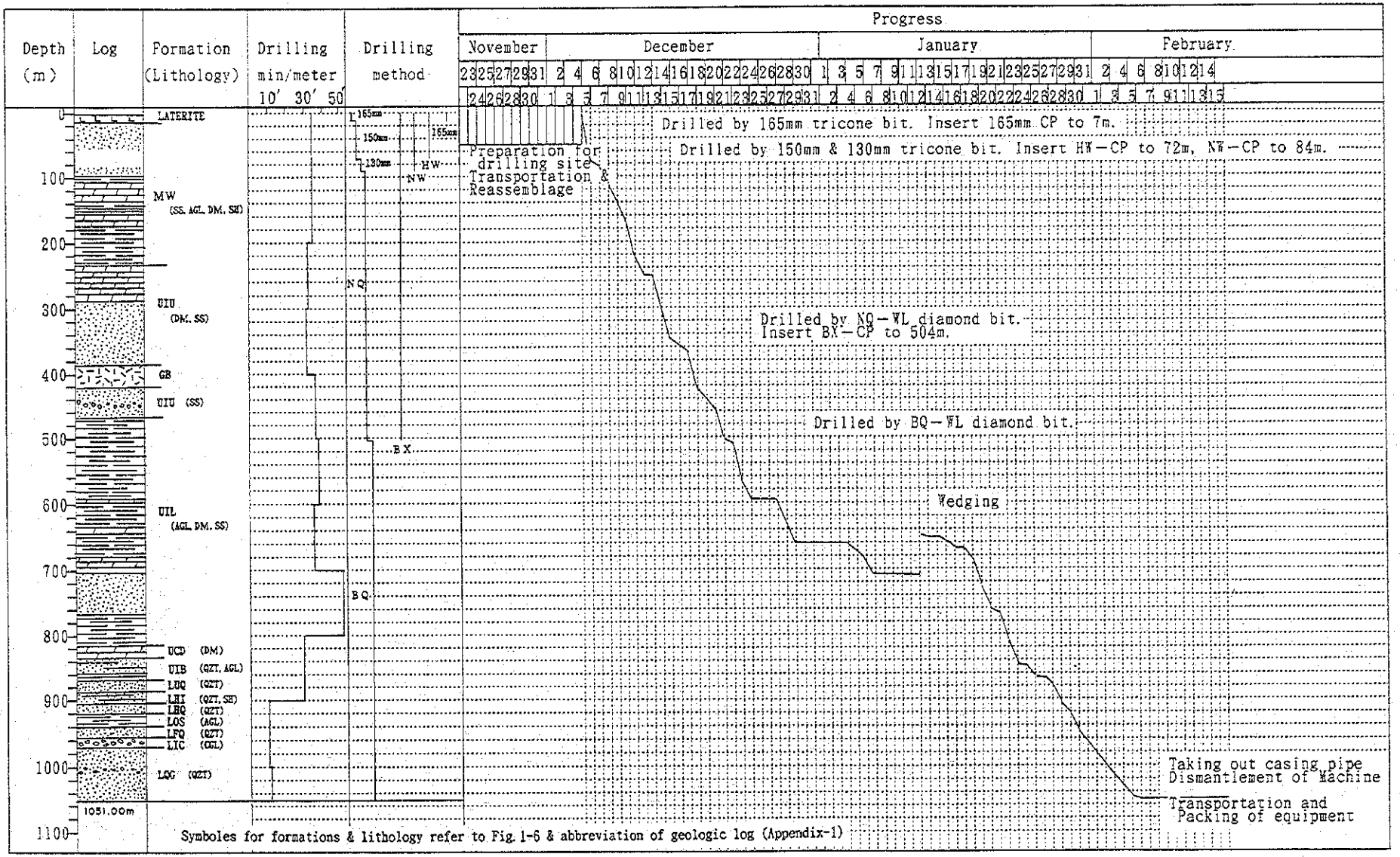


Fig.2-3-1 Drilling Progress of MJZC-4

for lacking of the Footwall Conglomerate under the ore horizon. Description of the drill hole is as follows.

Lower Roan Group

"Feldspathic Quartzite and Grits": 968.10 to 1,051.00 m. This unit is composed of pinkish gray and gray quartzites with intercalations of conglomerate, pebbly quartzite and pelitic bands. Anhydritization, biotitization and silicification are widely observed.

"Intermediate Conglomerate": 955.80 to 968.10 m. It is composed of compact green conglomerates intercalated with micaceous bands. The conglomerate consists of various types of pebbles such as granite with particularly large mineral grains, ultramafic rock and schist, many coarse-grained crystal fragments such as biotite, quartz and pale green altered feldspar, and anhydrite matrix in part. Anhydrite veins occur near the boundary between this unit and the Footwall Quartzite.

"Footwall Quartzite": 937.40 to 955.00 m. It mainly consists of gray pelitic quartzites with many pelitic bands. A pyrrhotite disseminated zone with minor amounts of chalcopyrite, which is continued from the above Ore Shale Horizon, is in micaceous quartzites at 937.40 to 938.60 m. Poorly disseminated pyrite zone occurs from 938.60 m downward, and anhydritization (patch and dissemination) is observed.

"Ore Shale Horizon": 919.40 to 937.40 m. Dark gray to gray argillites chiefly composed this unit are generally sandy or silty, and is micaceous or dolomitic in part. The basal part of the unit is intercalated with dolomites. Convolute lamination is developed in argillites and dolomitic rocks in part. Intervals of 919.40 to 925.40 m, 925.40 to 927.60 m, 927.60 to 930.60 m, 930.60 to 931.50 m and 931.50 to 937.40 m are a disseminated pyrite zone, disseminated pyrrhotite-pyrite zone, disseminated pyrrhotite-pyrite zone with minor amounts of chalcopyrite, comparative ore shoot composed of pyrrhotite-chalcopyrite-pyrite-dolomite thin lenses and disseminated pyrrhotite-pyrite zone with minor amounts of chalcopyrite, respectively. From this phenomenon, presence of ore arrangement with vertical symmetric is apparent. Dolomite concretions fringed with pyrite and mica occur relatively in the upper part. Also quartz veins with pyrrhotite and chalcopyrite are dispersed. Results of ore assay are shown in Table 2-4-4.

"Hangingwall Quartzite and Argillite": 903.70 to 919.40 m. It consists of gray and green pelitic and micaceous quartzites with many amounts of pelitic bands. The lower part is intercalated with granule conglomerates and dark gray shales. Anhydritization (lens, veinlet and dissemination) is observed.

"Interbedded Argillite and Quartzite": 884.00 to 903.70 m. It is mainly composed of dark gray to dark green pelitic, micaceous and dolomitic sandstones and quartzites with intercalations of dolomite and argillite. Anhydritization (lens and patch) is observed.

"Upper Quartzite": 869.00 to 884.00 m. It is composed chiefly of white quartzites with subordinate micaceous parts and minor amounts of pelitic band. Poorly disseminated pyrite is observed.

Upper Roan Group

"Interbedded Argillite, Dolomite and Quartzite": 833.70 to 869.00 m. This unit is divided to upper and lower parts. The former is of dark gray pelitic, micaceous and dolomitic sandstones and quartzites with intercalated silica lenses, dolomites and argillites. The latter is of an alternation of dark gray shale, grayish white sandy and micaceous dolomite and dolomitic sandstone.

"Cherty Dolomite": 816.20 to 833.70 m. It chiefly consists of massive, white slightly siliceous dolomites with intercalations of massive dark green argillite (Maker Shale), and dark gray pelitic bands and silica lenses at the upper and lower parts, respectively. Generally, lens and patch-shaped anhydrites are contained, and very fine grained chalcopyrites and pyrites are disseminated at 826.5 to 832.2 m.

"Arenite, Argillite and Dolomite with Anhydrite": 466.50 to 816.20 m. This unit is divided to upper and lower parts. The former is of green to gray argillites with many intercalations of dolomite. The argillites are sandy, dolomitic and micaceous in part. The latter is of dark gray to dark green pelitic and micaceous sandstones and green sandy argillites with minor amounts of dolomite thin layer. The argillites at the lower part are intercalated with many sandstones and quartzites, and show a thin alternation in part. Pillar structures are observed in this alternation. While, in the some thin layers of pelitic dolomite at the upper part, pelitic lamina broken by liquefaction are observed. At 674.20 to 689.70 m, a few dolomites contain hornblendes, and show hybrid rock-like lithofacies. Strong anhydritization (patch, veinlet and lens)

and veinlets formed by dolomite and mica are observed at depths from about 468 m downward and from about 700 m upward, respectively. Chalcopyrite-pyrite-mica-dolomite-quartz veinlets and disseminations, siliceous concretions with chalcopyrite in black shales, and intense silicification-disseminated pyrite zone are observed at 588.40 to 599.30 m, 598.00 to 599.00 m and 598.00 to 600.70m, respectively.

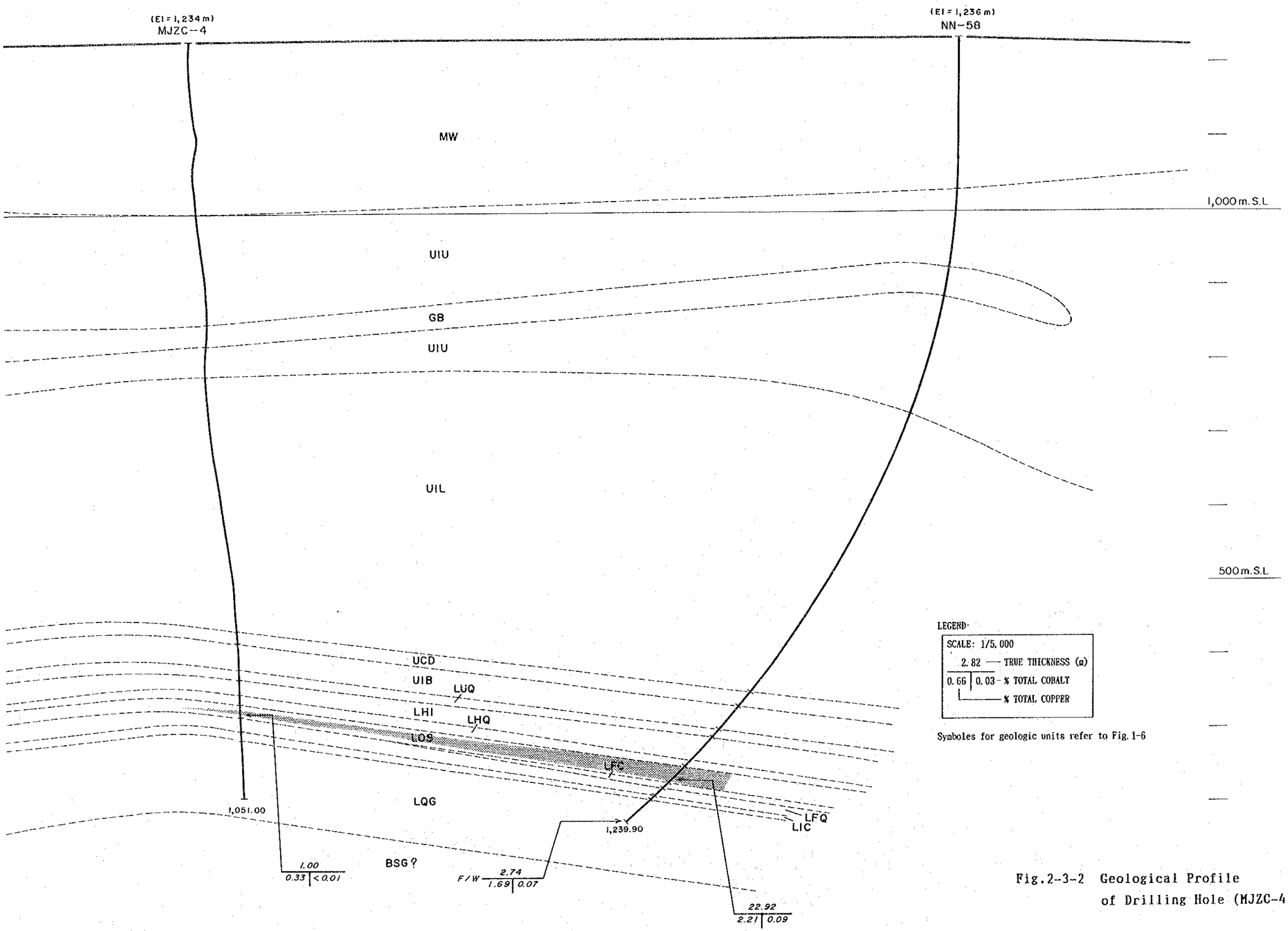
"Interbedded Argillite and Dolomite with Tectono-Breccias":236.00 to 466.50m. This unit is divided to upper and lower parts. The former is of white and gray dolomites, and the latter of gray and greenish gray graywackes. There is no alternation of argillite and dolomite, so the lithofacies of this formation caught by MJZC-4 is distinct from that of the typical formation. In the upper dolomites, development of silica concretions and stylolites is observed. Small vugs with quartz-carbonate minerals are partly present in dolomites. The lower sandstones contain pelitic bands, and show quartzite-like in part. At 442.60 to 451.80 m, the sandstones are intercalated with pink and dark yellow conglomerates. The conglomerates consist of quartzite and dolomitic pebbles and micaceous matrix. Veinlets, stockworks formed by quartz, carbonate minerals and mica, silicified zones and shears are developed in this formation.

"Mwashia Group": 12.00 to 236.00 m. It consists of grayish white dolomites, black shales, greenish gray calcareous to dolomitic argillites, white quartzites and sandstones. In the black shales, pyrite or silica bands parallel to bedding planes are developed in part, showing boudinage structure. Dolomites are pelitic and siliceous in part, and small vugs are locally present in dolomite. At 175.80 to 181.80 m, dolomites contain hornblendes, and show hybrid rock-like lithofacies.

"Gabbro": 386.50 to 419.40 m. The gabbro is black, massive, altered, and biotite and scapolite-dominant one. In this gabbro, dolomite-mica-pyrite stockworks are developed.

3-3 Discussions

It is seen from the cross sections (Figs. 2-3-2 and 1-7) that the strata deeper than the "Arenite, Argillite and Dolomite with Anhydrite" of the Upper Roan Group is higher in this hole than to the northeast and southwest. This fact



LEGEND·

SCALE: 1/5,000

2.82 — TRUE THICKNESS (m)

0.66 | 0.03 — % TOTAL COBALT

% TOTAL COPPER

Symboles for geologic units refer to Fig. 1-6

Fig.2-3-2 Geological Profile of Drilling Hole (MJZC-4)

indicates that this hole is located near the anticlinal axis.

The mineralized zone confirmed in this hole belongs to the chalcopyrite-pyrrhotite zone, and it is rich in pyrrhotite with low copper grade. It is therefore, inferred that this drill hole is relatively close to the pyrite-pyrrhotite zone which occur to the southwest.

Table 2-4-1 Results of Microscopic Observation of Thin Sections

Sample No.	Locality Depth(m)	Forma-tion	Rock Name	Phenocryst/ Crystal Fragment																		Texture
				Qz	Kf	Pl	Ca	Do	Bi	Mc	Hb	Sr	Ti	Tl	Ap	Sc	Cz	Ah	Cl	Zc	Cs	Op	
S301	MJZC-3. 121.00	MW	Phyllite	◎		○				◎			△	△	△							△	clastic to shisthose
S302	MJZC-3. 184.00	UIU	Arg-Dolomite	○		◎		◎	○	○					△							○	
S304	MJZC-3, 232.00	GB	Gabbro(?)			◎	○		◎		○	△	△		△		△					○	euhedral granular
S305	MJZC-3. 265.00	UIU	Argillite	◎		○	○		○	◎				△	△							△	
S306	MJZC-3. 414.00	UIU	Dolomite	○				◎		△					△							△	equigranular
S307	MJZC-3. 544.00	UIL	Argillite	◎		○	○		◎	○												○	
S308	MJZC-3. 558.30	UCD	Dolomite	○				◎		○								○	△			△	equigranular
S309	MJZC-3. 590.00	LUQ	Metasandstone	◎	◎	○	○		○	△				△								△	clastic to granular
S310	MJZC-3. 625.00	LHQ	Metasandstone	◎	◎	○	○		○	△				△								△	clastic to granular
S311	MJZC-3. 636.20	LOS	Argillite	◎		○	○		○	◎			△	△								○	metamorphosed siltstone
S312	MJZC-3. 642.00	LOS	Argillite	◎		○	○		○	◎			△	△								○	metamorphosed siltstone
S313	MJZC-3. 702.00	LIC	Argillite	◎		○	○			◎			△	△						△		△	
S402	MJZC-4. 178.00	MW	Green Skarn(?)	○		○		◎			◎					○					△		
S406	MJZC-4. 390.00	GB	Metamor-rock	○					◎				△		△	◎						△	

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

Abbreviations

Mineral: Qz;Quartz, Kf;Alkali feldspar, Pl;Plagioclase, Ca;Carbonate, Do;Dolomite, Bi;Biotite, Mc;Muscovite, Hb;Hornblende, Sr;Sericite, Ti;Titanite, Tl;Tourmaline, Ap;Apatite, Sc;Scapolite, Cz;Clinozoisite, Ah;Anhydrite, Cl;Chlorite, Zc;Zircon, Cs;Celestine, Op;Opaque mineral

Rock : Cal;Calcareous, Bi;Biotite, Arg;Argillaceous, Metamor;Metamorphosed

Table 2-4-2 Results of Microscopic Observation of Polished Sections

No.	Locality Depth(m)	Formation	Description	Cp	Gn	Bi	Ln	Co	Py	Xn	Mz	Zr	Th	Br	Sd	Re
P301	MJZC-3, 124.00	MW	Py with boudinage	○					◎	・	・				○	
P302	MJZC-3, 145.50	MW	Py-quartz vein	△					◎		・					
P303	MJZC-3, 181.00	UIU	Py dot in Do		・				△		・	・			△	
P304	MJZC-3, 559.70	UCD	Cp bleb in Do	△					△					・		
P305	MJZC-3, 635.50	LOS	fine Py-(bornite) diss.	・					○			・	・	・		・
P306	MJZC-3, 636.20	LOS	laminated fine Cp	○					○				・			・
P307	MJZC-3, 637.00	LOS	Cp inc. in Do spot	○					○				・			
P308	MJZC-3, 648.00	LOS	Cp inc. in sil. Do concretion	○					○		・					
P309	MJZC-3, 648.50	LOS	Cp Py pyrrhotite veinlet	○		・	・	△	△		・					
P402	MJZC-4, 262.00	MW	laminated fine Py in Do						○				・			
P403	MJZC-4, 597.50	UIL	Cp inc. in silica spot	△					○		・					
P404	MJZC-4, 588.50	UIL	Cp-Py-mica-Do vein	○					・	・						

Abbreviations:

Abundance of minerals: ◎ ; abundant, ○ ; common, △ ; small, ・ ; trace

Cp;Chalcopyrite, Gn;Galena, Bi;Bismuthinite, Ln;Linnaeite, Co;Cobaltite and Cobaltian Pyrite mixture, Py;Pyrite, Xn;Xenotime, Mz;Monazite, Zr;Zircon, Th;Thorite, Br;Barite, Sd;Siderite, Re;REE Carbonate, Do;Dolomite, diss.;dissemination, inc.;included, sil.;siliceous

Table 2-4-3 Results of X-ray Diffraction Analysis

Sample No	Location	Clay Minerals						Silica	Feldspar		Silicates								Carbonates			Sulfates		Sulfides	
		sm	mix	ch	kl	tk	pp	q	pl	or	ov	px	h	mc	bt	ph	gt	ad	mrl	ca	dol	mg	ah	gyp	cp	py
XR-301	MJZC-3 121.00m			▲?	▲			◎	○					◎			▲?									△
XR-302	173.00m						▲?		◎		▲															▲?
XR-303	177.00m						▲?	◎	◎		▲										◎					△?
XR-304	184.00m			▲				◎	◎					◎			▲?				◎					▲
XR-305	193.00m							○	◎					○							◎					
XR-306	215.00m			▲				○	◎		▲?			▲						○	◎					
XR-307	223.00m			▲					○		▲?			○			▲?		◎		○					
XR-308	265.00m			▲				◎	▲					◎		△?	▲?		▲							▲
XR-309	304.00m							◎	◎					△						▲?	○	◎				
XR-310	462.00m			○				◎		▲				◎	○	△?										△
XR-311	481.00m			▲										△							◎		◎	△		
XR-312	558.00m					▲		▲						▲							◎		◎			
XR-313	590.00m							◎	○	◎				▲						▲	◎					
XR-314	625.00m							◎		◎		▲?		○							△					▲?
XR-315	647.80m			▲				◎	▲?					◎	△	△?				▲	◎					▲
XR-316	702.00m							◎	○	○				○								▲?				
XR-401	MJZC-4 101.00m				▲?			◎	◎					◎	△?	△?										▲
XR-402	151.00m			▲				○	○					○	▲?						◎					▲?
XR-403	178.00m	▲						▲	○				◎							○	◎			○		
XR-404	208.00m							▲	▲?	○				▲						◎	○			▲?		
XR-405	248.00m					○		○						△				▲?		○	◎					
XR-406	321.00m	▲?		△				◎	△					◎	△				△	○						
XR-407	375.00m			▲				◎	▲					◎	○								▲?			
XR-408	390.00m							◎	○					◎	○				○							
XR-409	406.00m							◎						◎	○					○					△	○
XR-410	448.40m		△	○				◎						◎	○	△?									▲?	▲
XR-411	470.00m			▲		◎								○	○						◎	○	◎	○		
XR-412	532.00m							○	◎	△				◎	△						○		◎			▲
XR-413	575.50m					▲		○						◎	○	△					○				▲?	▲
XR-414	593.00m					▲		○	◎					▲							◎		◎			▲
XR-415	598.00m			▲				◎						△								○			▲	△

Remarks: Intensity of X-Ray Diffraction ; ◎ strong, ○ moderate, △ weak, ▲ very weak

Abbreviations: sm ; smectite mix; chlorite-montmorillonite mixed layer clay mineral ch ; chlorite
kl ; kaolinite tk ; talc pp ; pyrophyllite q ; quartz pl ; plagioclase or ; potash feldspar
ov ; olivine px ; pyroxene h ; amphibole mc ; muscovite bt ; biotite ph ; phlogopite
gt ; garnet ad ; andalusite ca ; calcite dol; dolomite mg ; magnesite ah ; anhydrite
gyp; gypsum cp ; chalcopyrite py ; pyrite
mrl; marialite[$(Na,Ca)_2(Si,Al)_6(O,OH)_{12}(Cl,CO_3)_{0.6}$] or mizzonite[$(Na,K)Ca(Si,Al)_6O_{12}Cl$], scapolite group

Table 2-4-4 Results of Chemical Analysis of Ore Samples (1)

MJZC-2

Sample No.	Depth (m)	T-Cu %	AS-Cu %	T-Co %	AS-Co %	Ni ppm	Zn ppm	Sample No.	Depth (m)	T-Cu %	AS-Cu %	T-Co %	AS-Co %	Ni ppm	Zn ppm
KC 15160	638.29-638.62	<0.01	<0.01	0.01	<0.01	50	21	KC 15195	655.33-655.83	3.13	<0.01	0.21	<0.01	40	149
KC 15161	638.62-639.12	<0.01	<0.01	0.02	<0.01	42	17	KC 15196	655.83-655.97	1.00	<0.01	0.09	<0.01	37	51
KC 15162	639.12-639.62	<0.01	<0.01	0.09	<0.01	44	8	KC 15197	655.97-656.47	0.83	<0.01	0.10	<0.01	35	55
KC 15163	639.62-640.12	<0.01	<0.01	0.04	<0.01	48	18	KC 15198	656.47-656.97	1.03	<0.01	0.21	<0.01	60	51
KC 15164	640.12-640.62	<0.01	<0.01	0.03	<0.01	47	9	KC 15199	656.97-657.25	0.77	<0.01	0.09	<0.01	33	39
KC 15165	640.62-641.12	<0.01	<0.01	0.02	<0.01	59	12	KC 15200	657.25-657.75	0.37	<0.01	0.03	<0.01	32	30
KC 15166	641.12-641.62	<0.01	<0.01	0.03	<0.01	52	11	KC 19784	657.75-658.25	0.07	<0.01	0.04	<0.01	22	24
KC 15167	641.62-642.12	0.01	<0.01	0.03	<0.01	44	9	KC 19785	658.25-658.43	0.46	<0.01	0.03	<0.01	29	28
KC 15168	642.12-642.62	<0.01	<0.01	0.02	<0.01	45	9	KC 19786	658.43-658.51	0.21	<0.01	0.12	<0.01	30	21
KC 15169	642.62-643.12	<0.01	<0.01	0.03	<0.01	48	10	KC 19787	658.51-659.01	<0.01	<0.01	<0.01	<0.01	27	12
KC 15170	643.12-643.62	<0.01	<0.01	0.02	<0.01	42	10	KC 19788	659.01-659.51	<0.01	<0.01	<0.01	<0.01	28	13
KC 15171	643.62-644.12	<0.01	<0.01	0.02	<0.01	47	13	KC 19789	659.51-660.01	<0.01	<0.01	<0.01	<0.01	23	13
KC 15172	644.12-644.62	<0.01	<0.01	0.04	<0.01	45	12	KC 19790	660.01-660.51	0.01	<0.01	<0.01	<0.01	23	11
KC 15173	644.62-645.12	<0.01	<0.01	0.03	<0.01	45	12	KC 19791	660.51-661.01	<0.01	<0.01	<0.01	<0.01	26	22
KC 15174	645.12-645.62	<0.01	<0.01	0.04	<0.01	45	13	KC 19792	661.01-661.51	<0.01	<0.01	<0.01	<0.01	30	20
KC 15175	645.62-646.12	0.05	<0.01	0.06	<0.01	39	11	KC 19793	661.51-661.97	<0.01	<0.01	<0.01	<0.01	18	18
KC 15176	646.12-646.62	0.02	<0.01	0.05	<0.01	48	8								
KC 15177	646.62-647.12	0.05	<0.01	0.06	<0.01	41	9								
KC 15178	647.12-647.62	0.07	<0.01	0.05	<0.01	39	10								
KC 15179	647.62-648.12	0.29	<0.01	0.02	<0.01	42	10								
KC 15180	648.12-648.62	0.47	<0.01	0.05	<0.01	41	18								
KC 15181	648.62-649.12	0.14	<0.01	0.01	<0.01	32	18								
KC 15182	649.12-649.62	0.46	<0.01	0.02	<0.01	43	33								
KC 15183	649.62-650.07	0.49	<0.01	0.03	<0.01	47	27								
KC 15184	650.07-650.57	0.28	<0.01	0.02	<0.01	38	22								
KC 15185	650.57-651.07	0.36	<0.01	0.03	<0.01	38	23								
KC 15186	651.07-651.57	0.64	0.01	0.02	<0.01	37	31								
KC 15187	651.57-652.07	0.66	<0.01	0.03	<0.01	38	97								
KC 15188	652.07-652.66	0.58	<0.01	0.05	<0.01	52	115								
KC 15189	652.66-652.83	1.62	<0.01	0.07	<0.01	45	139								
KC 15190	652.83-653.33	0.83	<0.01	0.05	<0.01	45	139								
KC 15191	653.33-653.83	0.49	<0.01	0.02	<0.01	28	115								
KC 15192	653.83-654.33	6.86	0.02	0.12	<0.01	70	335								
KC 15193	654.33-654.83	0.73	<0.01	0.04	<0.01	37	45								
KC 15194	654.83-655.33	1.02	<0.01	0.05	<0.01	33	56								

T-: Total, AS-: Acid Soluble

Table 2-4-4 Results of Chemical Analysis of Ore Samples (2)

MJZC-3

Sample No.	Depth (m)	T-Cu %	AS-Cu %	T-Co %	AS-Co %	Sample No.	Depth (m)	T-Cu %	AS-Cu %	T-Co %	AS-Co %
KC 19701	632.47-632.66	<0.01	<0.01	<0.01	<0.01	KC 19736	647.73-648.23	2.51	0.04	0.27	<0.01
KC 19702	632.66-633.13	<0.01	<0.01	<0.01	<0.01	KC 19737	648.23-648.73	1.38	0.01	0.12	<0.01
KC 19703	633.13-633.63	<0.01	<0.01	<0.01	<0.01	KC 19738	648.73-649.23	0.92	<0.01	0.20	<0.01
KC 19704	633.63-634.13	<0.01	<0.01	<0.01	<0.01	KC 19739	649.23-649.73	1.32	0.01	0.11	<0.01
KC 19705	634.13-634.63	<0.01	<0.01	<0.01	<0.01	KC 19740	649.73-649.84	1.62	0.02	0.31	<0.01
KC 19706	634.63-634.84	<0.01	<0.01	<0.01	<0.01	KC 19741	649.84-650.13	0.02	0.01	0.23	<0.01
KC 19707	634.84-635.03	<0.01	<0.01	<0.01	<0.01	KC 19742	650.13-650.42	<0.01	<0.01	0.01	<0.01
KC 19708	635.03-635.32	<0.01	<0.01	0.02	<0.01	KC 19743	650.42-650.71	<0.01	<0.01	0.02	<0.01
KC 19709	635.32-635.61	<0.01	<0.01	0.02	<0.01	KC 19744	650.71-651.19	<0.01	<0.01	<0.01	<0.01
KC 19710	635.61-635.94	<0.01	<0.01	0.03	<0.01	KC 19745	651.19-651.67	0.03	<0.01	<0.01	<0.01
KC 19711	635.94-636.31	0.80	<0.01	0.02	<0.01	KC 19746	651.67-652.15	<0.01	<0.01	<0.01	<0.01
KC 19712	636.31-636.81	1.16	<0.01	<0.01	<0.01	KC 19747	652.15-652.63	<0.01	<0.01	<0.01	<0.01
KC 19713	636.81-637.31	0.34	<0.01	0.02	<0.01	KC 19748	652.63-652.89	<0.01	<0.01	<0.01	<0.01
KC 19714	637.31-637.81	0.05	<0.01	0.01	<0.01						
KC 19715	637.81-638.31	0.06	<0.01	0,01	<0.01						
KC 19716	638.31-638.81	0.02	<0.01	0.01	<0.01						
KC 19717	638.81-639.31	<0.01	<0.01	<0.01	<0.01						
KC 19718	639.31-639.81	0.01	<0.01	<0.01	<0.01						
KC 19719	639.81-640.31	0.02	<0.01	0.01	<0.01						
KC 19720	640.31-640.66	<0.01	<0.01	0.01	<0.01						
KC 19721	640.66-640.84	0.02	<0.01	0.02	<0.01						
KC 19722	640.84-641.34	0.02	<0.01	0.03	<0.01						
KC 19723	641.34-641.84	0.03	<0.01	0.03	<0.01						
KC 19724	641.84-642.26	0.06	<0.01	0.03	<0.01						
KC 19725	642.26-642.79	0.30	<0.01	0.03	<0.01						
KC 19726	642.79-643.29	0.01	<0.01	0.03	<0.01						
KC 19727	643.29-643.80	0.01	<0.01	0.03	<0.01						
KC 19728	643.80-644.31	0.11	<0.01	0.08	<0.01						
KC 19729	644.31-644.74	0.80	0.01	0.09	<0.01						
KC 19730	644.74-645.24	1.09	0.01	0.06	<0.01						
KC 19731	645.24-645.72	0.22	<0.01	0.05	<0.01						
KC 19732	645.72-646.23	0.42	<0.01	0.05	<0.01						
KC 19733	646.23-646.73	0.78	<0.01	0.04	<0.01						
KC 19734	646.73-647.23	0.55	<0.01	0.07	<0.01						
KC 19735	647.23-647.73	0.45	<0.01	0.06	<0.01						

T-: Total, AS-: Acid Soluble

Table 2-4-4 Results of Chemical Analysis of Ore Samples (3)

MJZC-4

Sample No.	Depth (m)	T-Cu %	AS-Cu %	T-Co %	AS-Co %	Ni ppm	Zn ppm	Sample No.	Depth (m)	T-Cu %	AS-Cu %	T-Co %	AS-Co %	Ni ppm	Zn ppm
KC 15105	913.94-914.44	<0.01	<0.01	<0.01	<0.01	39	26	KC 15140	931.14-931.64	0.45	<0.01	<0.01	<0.01	42	54
KC 15106	914.44-914.94	<0.01	<0.01	<0.01	<0.01	35	22	KC 15141	931.64-932.14	0.13	<0.01	<0.01	<0.01	33	29
KC 15107	914.94-915.44	<0.01	<0.01	<0.01	<0.01	24	14	KC 15142	932.14-932.64	0.12	<0.01	<0.01	<0.01	45	24
KC 15108	915.44-915.94	<0.01	<0.01	<0.01	<0.01	30	19	KC 15143	932.64-933.14	0.12	<0.01	<0.01	<0.01	33	42
KC 15109	915.94-916.44	<0.01	<0.01	<0.01	<0.01	25	31	KC 15144	933.14-933.64	0.06	<0.01	<0.01	<0.01	32	31
KC 15110	916.44-916.94	<0.01	<0.01	<0.01	<0.01	19	12	KC 15145	933.64-934.14	0.11	<0.01	<0.01	<0.01	53	36
KC 15111	916.94-917.44	<0.01	<0.01	<0.01	<0.01	18	23	KC 15146	934.14-934.64	0.12	<0.01	<0.01	<0.01	54	32
KC 15112	917.44-917.94	<0.01	<0.01	<0.01	<0.01	34	26	KC 15147	934.64-934.94	0.04	<0.01	<0.01	<0.01	37	30
KC 15113	917.44-918.44	<0.01	<0.01	<0.01	<0.01	33	28	KC 15148	935.94-935.44	0.12	<0.01	<0.01	<0.01	47	41
KC 15114	918.44-918.94	<0.01	<0.01	<0.01	<0.01	43	38	KC 15149	935.44-935.99	0.50	<0.01	<0.01	<0.01	28	56
KC 15115	918.94-919.44	<0.01	<0.01	<0.01	<0.01	36	28	KC 15150	935.99-936.49	0.13	<0.01	0.02	<0.01	46	42
KC 15116	919.44-919.94	<0.01	<0.01	<0.01	<0.01	46	30	KC 15151	935.49-936.99	0.15	<0.01	0.01	<0.01	38	48
KC 15117	919.94-920.44	<0.01	<0.01	0.01	<0.01	74	28	KC 15152	936.99-937.49	0.41	<0.01	0.02	<0.01	48	87
KC 15118	920.44-920.94	<0.01	<0.01	<0.01	<0.01	63	30	KC 15153	936.49-937.99	0.15	<0.01	0.05	<0.01	46	38
KC 15119	920.94-921.44	<0.01	<0.01	<0.01	<0.01	56	32	KC 15154	937.99-938.49	0.02	<0.01	0.02	<0.01	34	44
KC 15120	921.44-921.94	<0.01	<0.01	<0.01	<0.01	56	29	KC 15155	938.49-938.99	0.01	<0.01	0.02	<0.01	30	43
KC 15121	921.94-922.44	<0.01	<0.01	<0.01	<0.01	54	33	KC 15156	938.99-939.49	0.02	<0.01	0.02	<0.01	27	16
KC 15122	922.44-922.94	<0.01	<0.01	<0.01	<0.01	48	40	KC 15157	939.49-939.99	<0.01	<0.01	0.01	<0.01	29	61
KC 15123	922.94-923.44	<0.01	<0.01	<0.01	<0.01	48	26	KC 15158	939.99-940.49	<0.01	<0.01	0.01	<0.01	36	16
KC 15124	923.44-923.94	<0.01	<0.01	<0.01	<0.01	59	36	KC 15159	940.49-940.94	<0.01	<0.01	0.01	<0.01	38	24
KC 15125	923.94-924.44	<0.01	<0.01	<0.01	<0.01	47	19								
KC 15126	924.44-924.94	<0.01	<0.01	<0.01	<0.01	41	17								
KC 15127	924.94-925.19	<0.01	<0.01	<0.01	<0.01	46	15								
KC 15128	925.19-925.69	<0.01	<0.01	<0.01	<0.01	43	16								
KC 15129	925.69-926.19	<0.01	<0.01	<0.01	<0.01	45	14								
KC 15130	926.19-926.69	<0.01	<0.01	<0.01	<0.01	41	13								
KC 15131	926.69-927.19	<0.01	<0.01	<0.01	<0.01	47	16								
KC 15132	927.19-927.69	<0.01	<0.01	<0.01	<0.01	48	14								
KC 15133	927.69-928.19	<0.01	<0.01	<0.01	<0.01	43	14								
KC 15134	928.19-928.69	0.02	<0.01	<0.01	<0.01	41	17								
KC 15135	928.69-929.19	<0.01	<0.01	<0.01	<0.01	36	13								
KC 15136	929.19-929.69	0.02	<0.01	<0.01	<0.01	41	16								
KC 15137	929.69-930.14	0.03	<0.01	<0.01	<0.01	39	13								
KC 15138	930.14-930.64	0.07	<0.01	<0.01	<0.01	36	14								
KC 15139	930.64-931.14	0.21	<0.01	0.02	<0.01	39	39								

T-: Total, AS-: Acid Soluble

PART III

CONCLUSIONS AND RECOMMENDATIONS

PART Ⅲ CONCLUSIONS AND RECOMMENDATIONS

Chapter 1 Conclusions

The first-phase survey of the Chambishi Southeast area comprised drilling, and compilation and interpretation of existing data. The following conclusions were obtained from the above.

1. The three holes drilled this year all confirmed the existence of shale-type copper deposits which is typical of the Copperbelt. Also, these holes were drilled to the basement or the proximity, and revealed relevant new information regarding the geology and mineralization of the project area.
2. MJZC-2 was drilled in the southern part of the area and confirmed relatively high-grade ores (width 3.14 m, T-Cu 2.21 %, T-Co 0.21 %). This indicates the possibility of a new ore shoot in this area.
3. It is inferred from distribution of the bioherm and thickness of the Footwall Formation that there was a palaeo-basement high at the ore-forming time in this area. The Northern Area Shoot which is the most important deposit of the area occurs in the depressions of the basement. And the horizon above the palaeo-basement high is of low grade or barren. This is inferred to be the result of the formation of environment favorable for deposition and preservation of sulfides in these submarine depressions by accumulation of heavy-metal-bearing dense solutions and formation of reduced biogenic sulfur in the stagnant sea water in these local troughs.
4. There are two types of present basement highs, namely those which coincide with the palaeo-basement highs and those which were formed by the apparent rise of the basement by folding after the deposition of the ores. Rich ore could occur higher than the top of the latter type highs.
5. The following is inferred from the gravity contour maps, geological maps, and drilling data. ① Parts of the high gravity anomalies reflect the gabbroic bodies in shallow subsurface zones. ② Parts of the gravity high anomalies reflect the basement highs such as the relative rise by folding and palaeo-basement highs. ③ High-grade ores most probably do not exist at gravity highs which coincide with thick gabbroic bodies. ④ The relatively thin and low-grade orebodies deposited over the tops and limbs of the palaeo-basement highs may turn out to be rich orebodies under relatively thin gabbroic

bodies.

6. The mode of occurrence of the rich orebodies indicate that diagenesis and metamorphism played important roles in the formation of ore shoots. Structures similar to dehydration structures of Kuroko (sulfide) deposits occur in these orebodies and the minute grain-sized sulfide proto-ore definitely migrated in conjunction with dehydration during the compaction after deposition.

Chapter 2 Recommendations for Second Phase Survey

It is concluded from the results of the drilling reported hitherto that the promising areas for further mineral exploration are; the area northwest of the Northern Area Shoot, and the area from the south to the west of MJZC-2.

The Northern Area Shoot, the most important deposit of the project area, however, has not been prospected sufficiently and drilling along the periphery of the deposit is necessary to clarify the areal extent of this deposit.

With the above consideration, drilling as shown in Figure 1-12 is recommended for the work of second and third phases. Namely, the project area are divided into two zones, which are the Northern Area Shoot and the northwest, and the south, and each zone is prioritized. The drilling depth will be, as a rule, to the basement complex, but where the basement depth is already known, the Footwall of the ore horizon would be sufficient.

It is recommended that confirmation of the northwestern extension of the Northern Area Shoot, the major orebody of this area, and thereby enlarging the ore reserves be the priority activity of the second phase (fiscal 1994) of this project and that drilling be carried out in accordance with this priority.

REFERENCES

REFERENCES

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.

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.

PHOTOGRAPHS

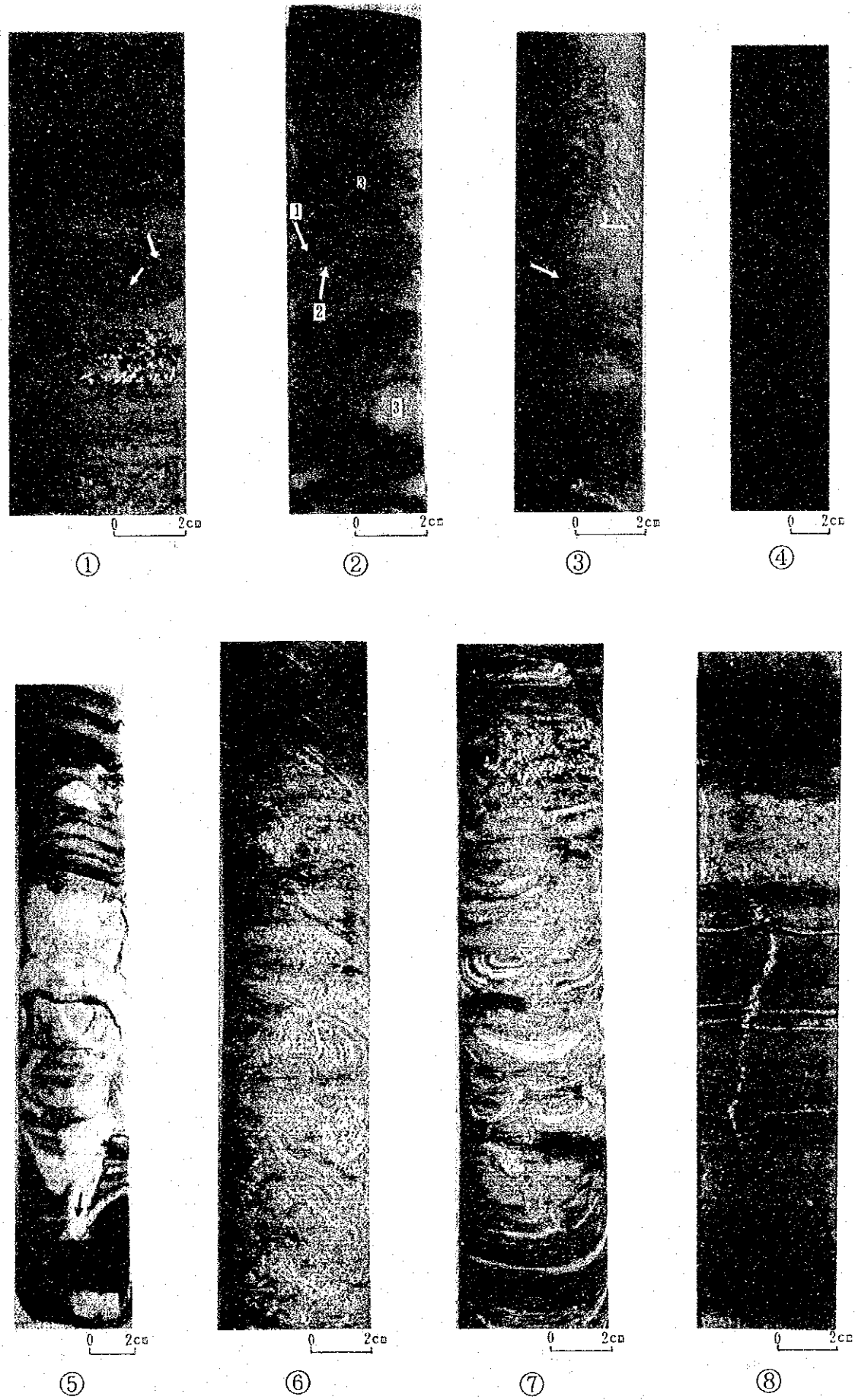
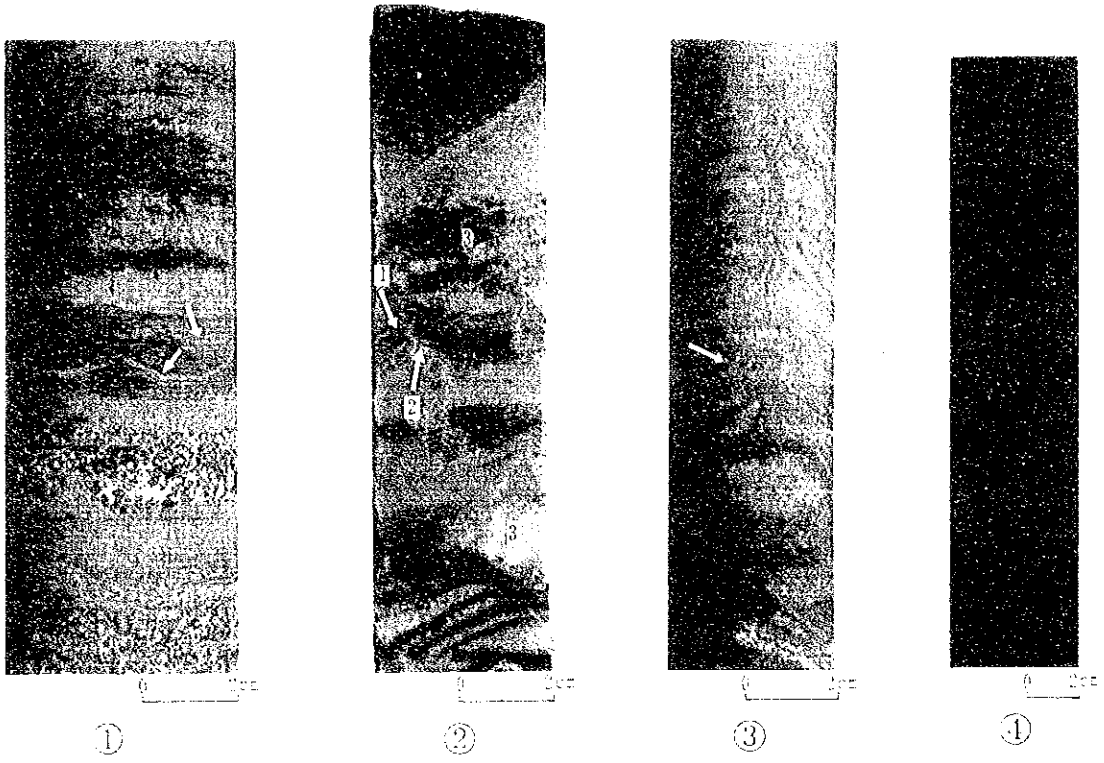


Photo 1 Photograph of Drilling Cores (1)



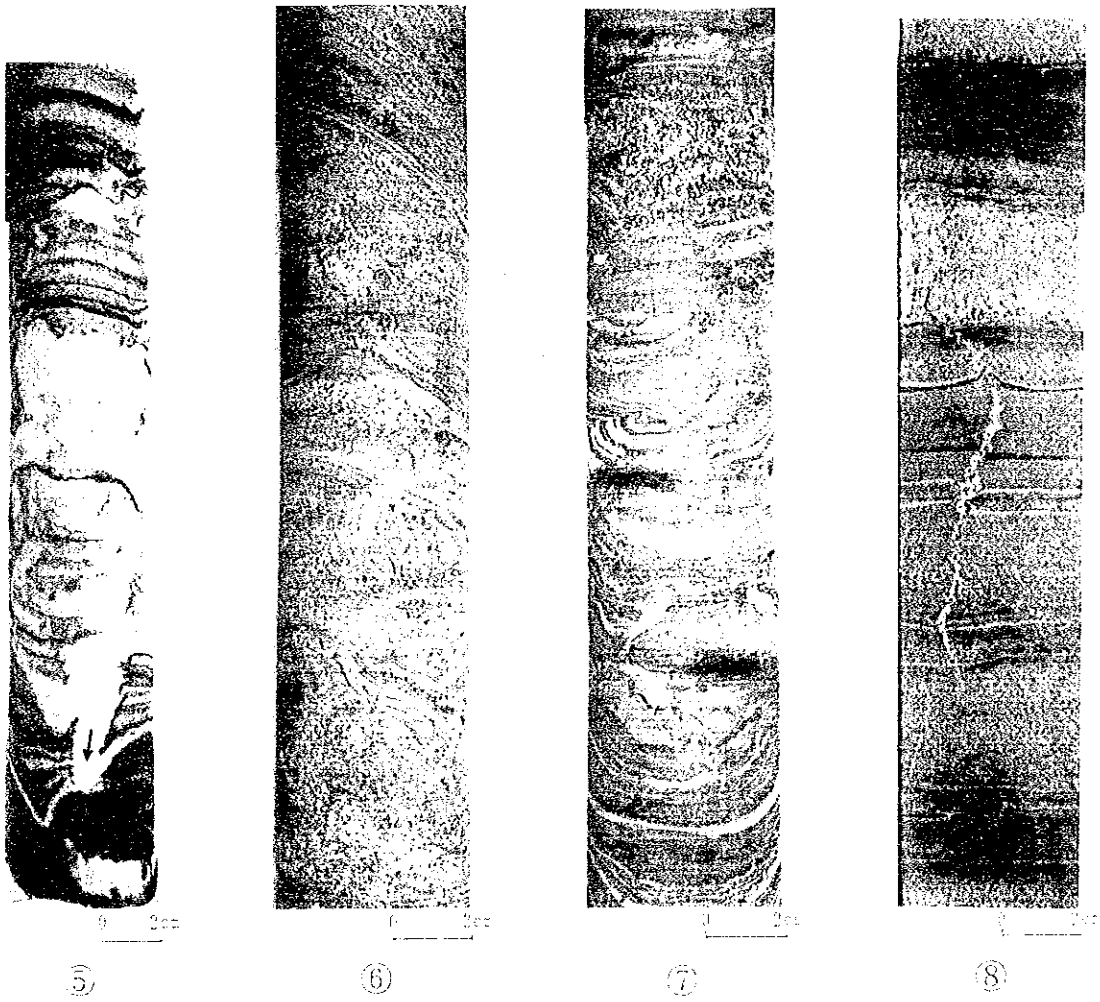


Photo 1 Photograph of Drilling Cores (1)

PHOTO CAPTIONS

① Dish structure (arrow) developed in thin alternation of psammitic and pelitic rocks (MJZC-3, 525.50m).

② Dish structure (arrow-1) developed in dolomitic sandstone immediately below Ore Shale; liquefied dolomitic to pelitic veins cutting through dark argillaceous laminae (arrow-2); dolomite concretion (arrow-3) (MJZC-3, 650.50m).

③ Sandstone pillar structure (arrow) developed in thin alternation of psammitic and pelitic rocks (MJZC-4, 773.00m).

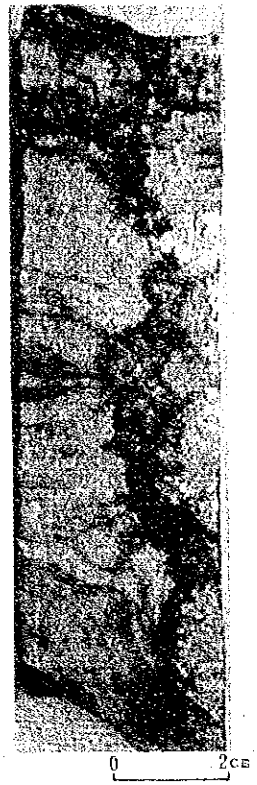
④ Irregular chalcopyrite veins (liquefied intrusion?) developed in Ore Shale (NN-13, 543m).

⑤ Type B pillar structure of dolomite (arrow) (Type B pillar and intrusion cutting upward through horizontal laminae are developed where water-escape rate is large; Lowe, 1975) (MJZC-4, 504.00m).

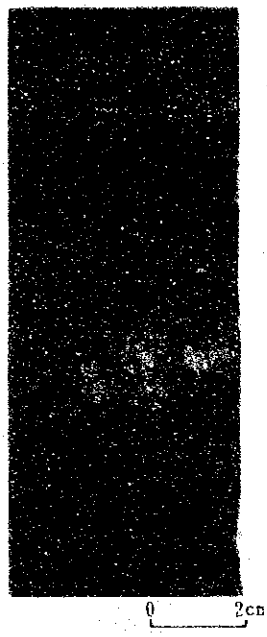
⑥ Liquefied intrusion structure of sandstone (arrow) developed in psammitic-pelitic rock alternation (MJZC-2, 494.90m).

⑦ Fracturing of bent laminae considered to be formed by rapid liqefaction by water escape (MJZC-2, 500.50m).

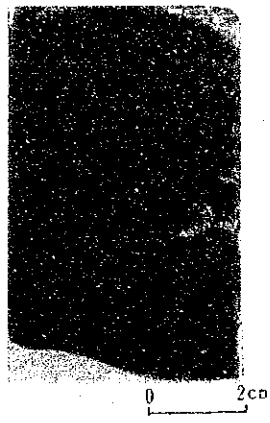
⑧ Liquefied intrusion of sandstone in Ore Shale horizon. Small dots of chalcopyrite occur in the vein (black dots, arrow) (NN-13, 548m).



⑨



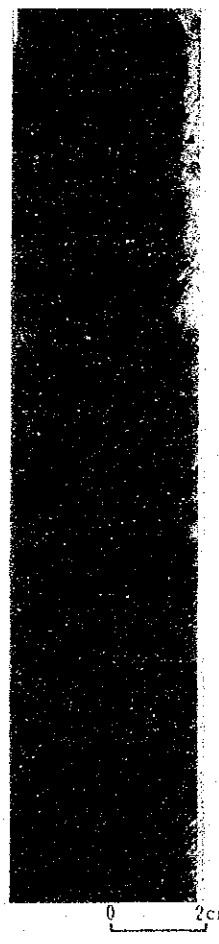
⑩



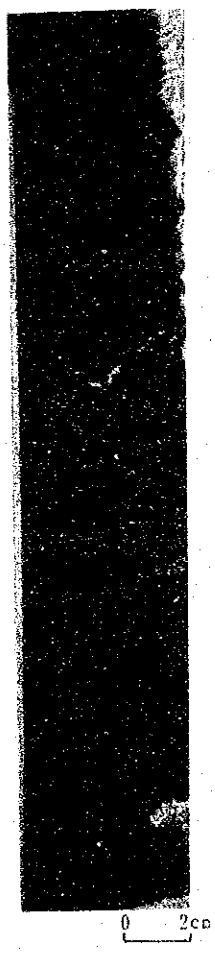
⑪

⑫

⑬

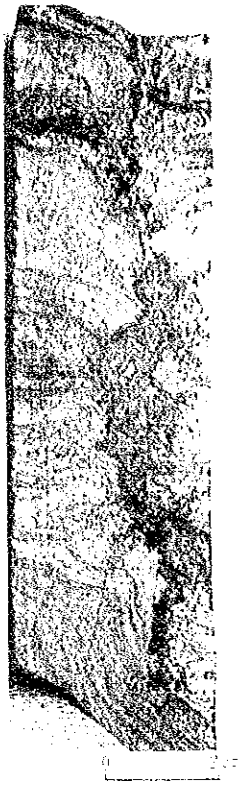


⑭

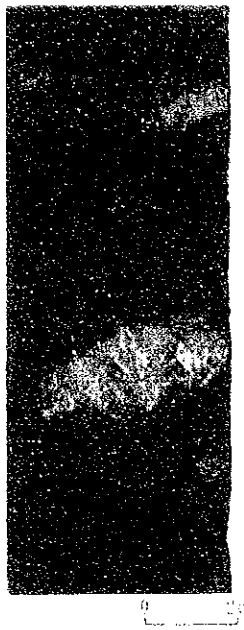


⑮

Photo 1 Photograph of Drilling Cores (2)

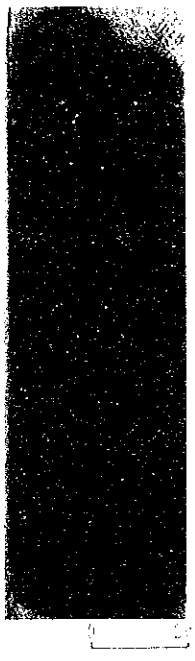


⑨



⑩

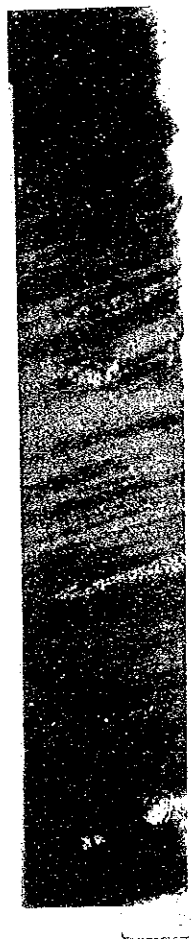
⑪



⑫

⑬

⑭



⑮

Photo 1 Photograph of Drilling Cores (2)

PHOTO CAPTIONS

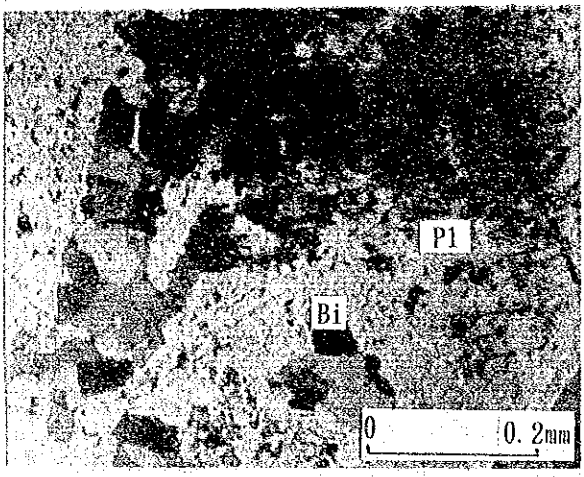
⑨ Irregular chalcopyrite(arrow-1)-pyrrhotite(arrow-2)-pyrite-dolomite vein in pelitic rock of Ore Shale horizon (MJZC-3, 648.50m).

⑩ Dolomite concretion with chalcopyrite-pyrrhotite rim in pelitic rock of Ore Shale horizon (MJZC-2, 649.30m).

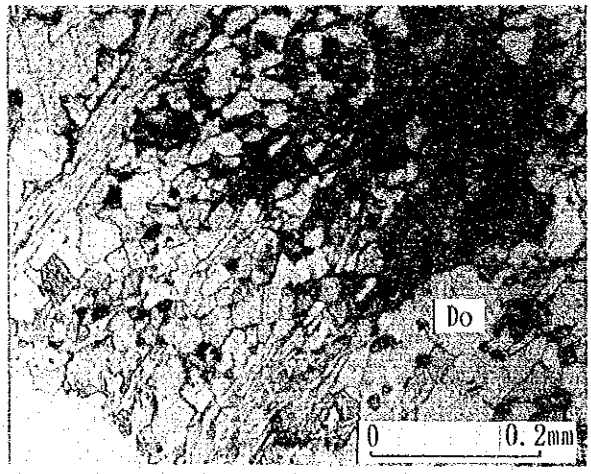
⑪ Dolomite concretion developed in pelitic rock of Ore Shale horizon. Note inclusion of chalcopyrite-pyrrhotite. Convoluted laminae are developed in the upper part (MJZC-2, 654.83m).

⑫ Laminae consisting of minute grains of chalcopyrite in pelitic rock of Ore Shale horizon (MJZC-3, 636.00m).

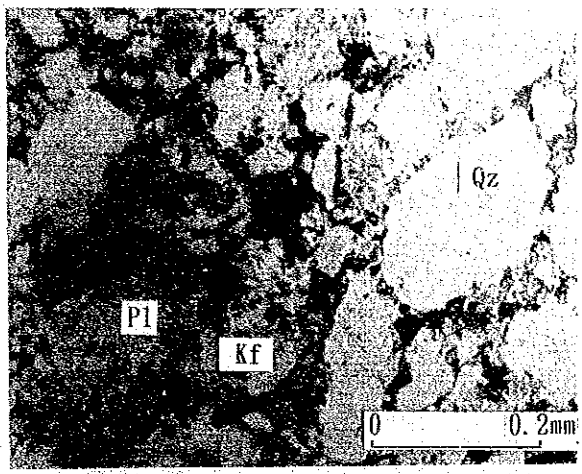
⑬,⑭,⑮ Bonanza ore in Ore Shale horizon. Thin lenses, dissemination and spots of chalcopyrite are developed parallel to the bedding (⑬ MJZC-2, 655.33m: ⑭ MJZC-3, 644.80m: ⑮ MJZC-2, 649.40m).



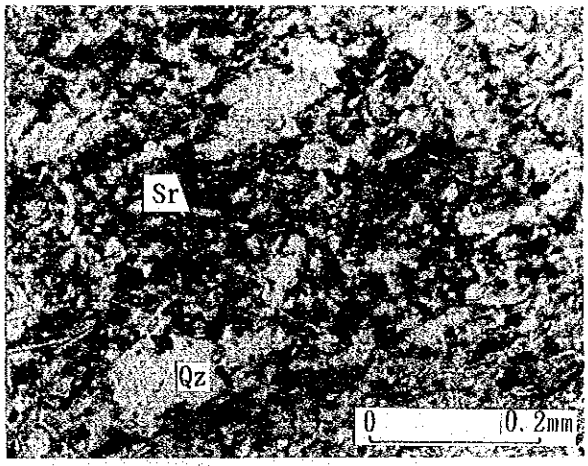
Sample No.:S304 Locality:MJZC-3, 232.00m
Rock Name:Gabbro(?)
Formation:Gabbro



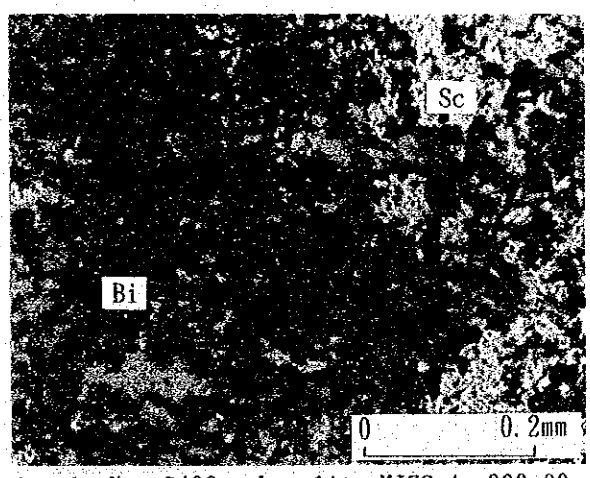
Sample No.:S308 Locality:MJZC-3, 558.30m
Rock Name:Dolomite
Formation:Cherty Dolomite



Sample No.:S309 Locality:MJZC-3, 590.00m
Rock Name:Metasandstone
Formation:Upper Quartzite



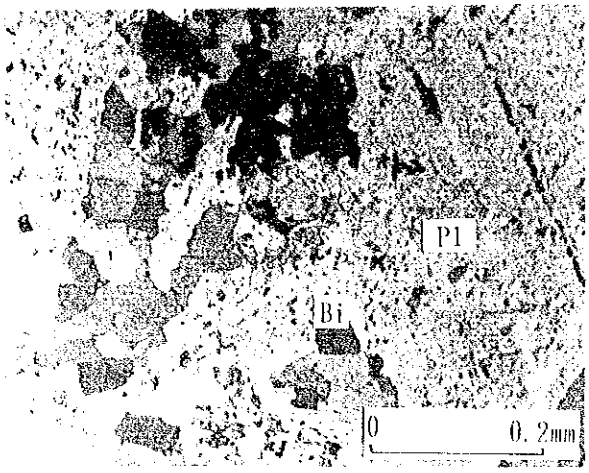
Sample No.:S312 Locality:MJZC-3, 642.00m
Rock Name:Argillite
Formation:Ore Shale Horizon



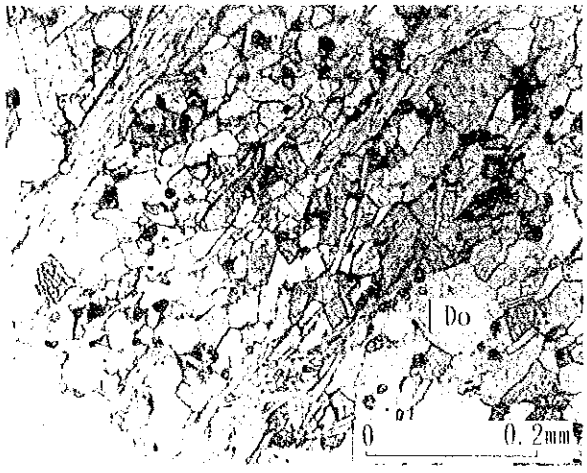
Sample No.:S406 Locality:MJZC-4, 390.00m
Rock Name:Metamorphosed Rock
Formation:Gabbro

Qz:Quartz
Pl:Plagioclase
Kf:Alkali Feldspar
Do:Dolomite
Bi:Biotite
Sr:Sericite
Sc:Scapolite

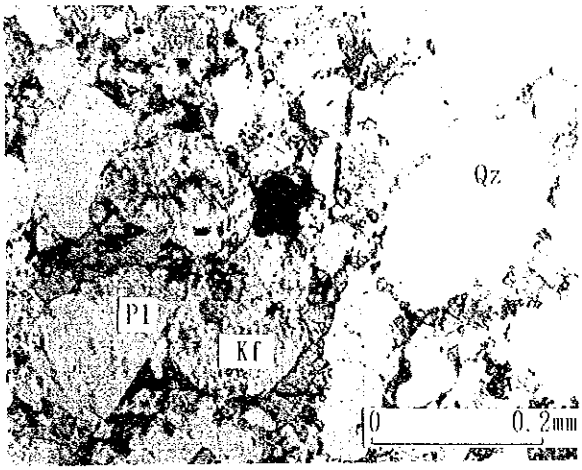
Photo 2 Microscopic Photograph of Thin Sections
(Open nicols)



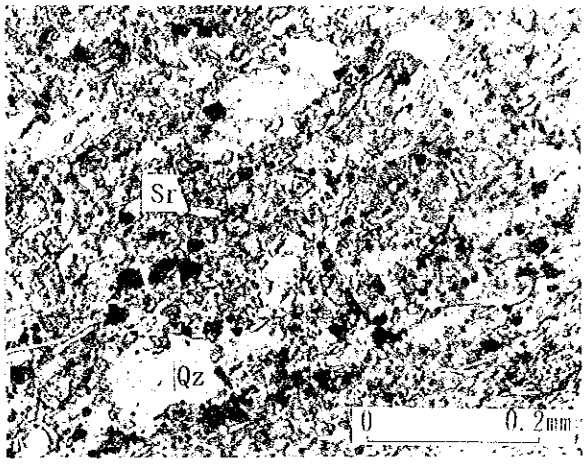
Sample No.:S304 Locality:MJZC-3, 232.00m
Rock Name:Gabbro(?)
Formation:Gabbro



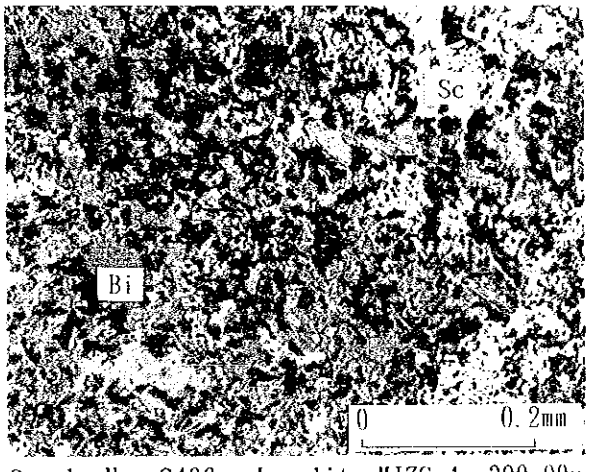
Sample No.:S308 Locality:MJZC-3, 558.30m
Rock Name:Dolomite
Formation:Cherty Dolomite



Sample No.:S309 Locality:MJZC-3, 590.00m
Rock Name:Metasandstone
Formation:Upper Quartzite



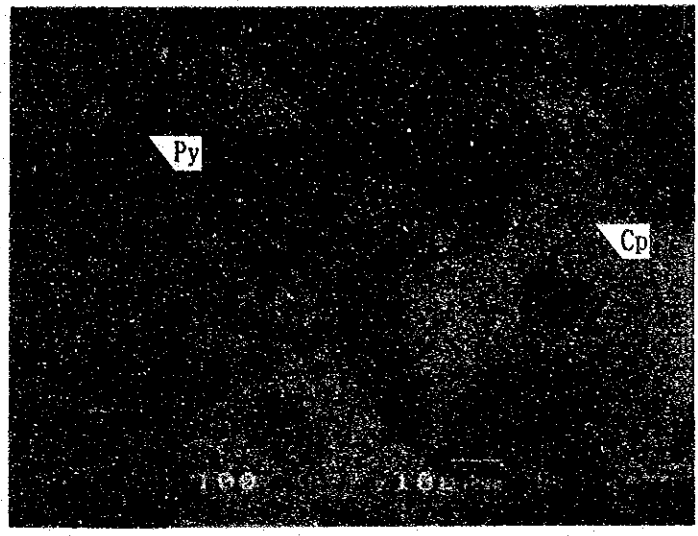
Sample No.:S312 Locality:MJZC-3, 642.00m
Rock Name:Argillite
Formation:Ore Shale Horizon



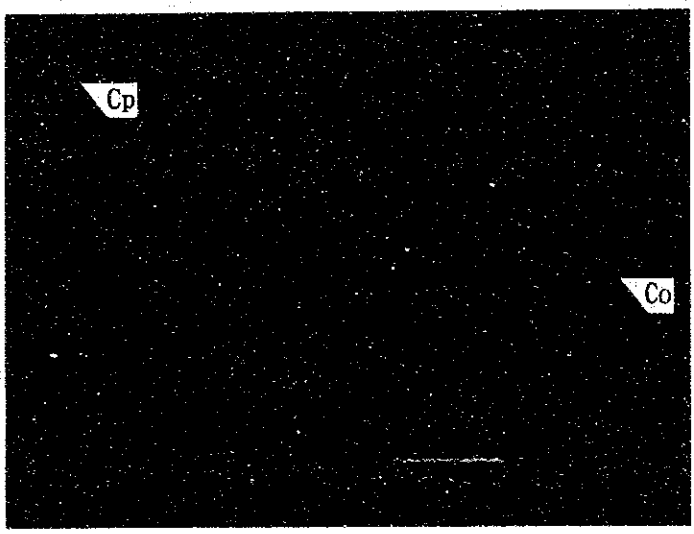
Sample No.:S406 Locality:MJZC-4, 390.00m
Rock Name:Metamorphosed Rock
Formation:Gabbro

Qz:Quartz
Pl:Plagioclase
Kf:Alkali Feldspar
Do:Dolomite
Bi:Biotite
Sr:Sericite
Sc:Scapolite

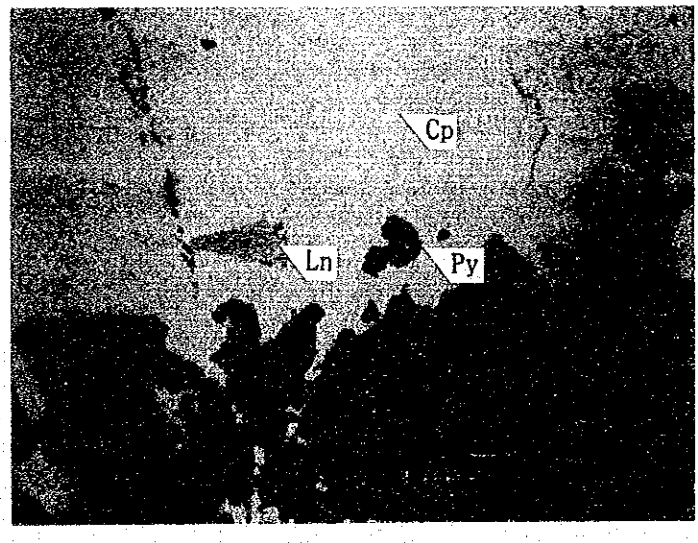
Photo 2 Microscopic Photograph of Thin Sections
(Open nicols)



Sample No.: P307
Locality: MJZC-3
Description:
Cp: Chalcopyrite
Py: Pyrite

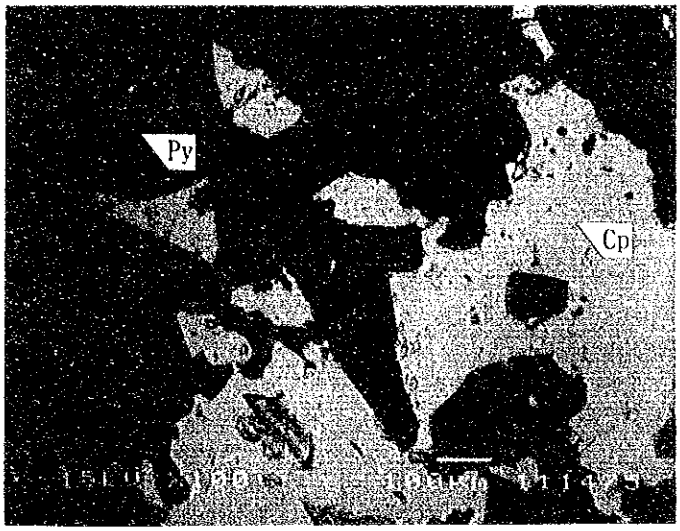


Sample No.: P309
Locality: MJZC-3
Description:
Cp: Chalcopyrite
Co: Cobaltite and Cobaltian Pyrite mixture

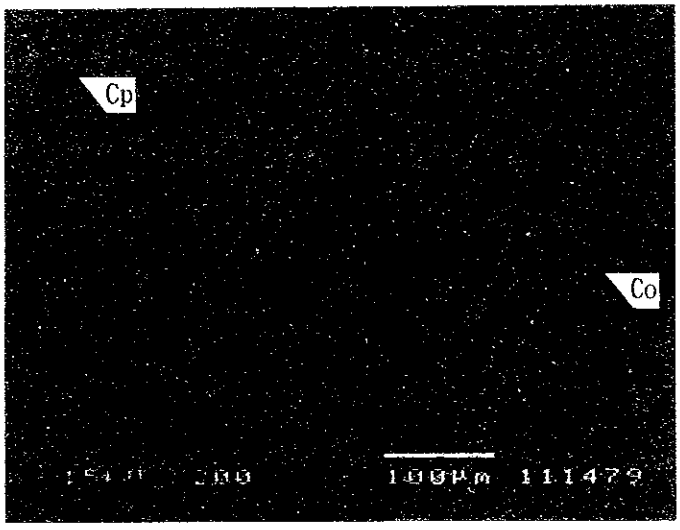


Sample No.: P309
Locality: MJZC-3
Description:
Ln: Linnaeite
Cp: Chalcopyrite
Py: Pyrite

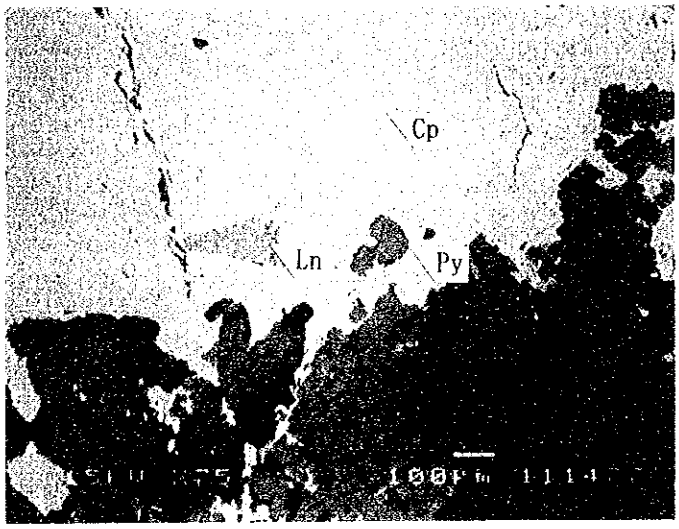
Photo 3 Microscopic Photograph of Polished Sections



Sample No. : P307
Locality: MJZC-3
Description:
Cp: Chalcopyrite
Py: Pyrite



Sample No. : P309
Locality: MJZC-3
Description:
Cp: Chalcopyrite
Co: Cobaltite and Cobaltian Pyrite mixture



Sample No. : P309
Locality: MJZC-3
Description:
Ln: Linnaeite
Cp: Chalcopyrite
Py: Pyrite

Photo 3 Microscopic Photograph of Polished Sections