1-6-6 Dong Noi area

1. Line setting

In this area, it sets the line which 1 × 1.0 km length with the direction of E-W.

Line location is shown in Fig.II-1-6-6.

2. Measurement result

Line DH (Fig.II-1-6-7)

The apparent resistivity shows from 80 to 1308Ω·m value. The low resistivity part of less than 100Ω·m is seen at the middle part (N=2) of station 400.

The chargeability of more than 20mV·sec/V is seen from the deep part of station 600 to the middle part of station 700, but for other part, the chargeability shows relatively low value.

3. Analysis result of 2-D

Line DH (Fig.II-1-6-8)

The resistivity shows relatively high value near the surface, but it shows lower value as the depth increase. The center of the low resistivity is seen around 800m above sea level under station 600.

The chargeability shows low value near the surface, but it shows high value in the deep part of the east side. The part of more than 20mV·sec/V is seen between station 700 and 1000 in the deep part.

4. Consideration

The apparent resistivity of this area shows from 80 to 1308 Ω·m value, and the chargeability shows a maximum of 24mV·sec/V.

As for the result of 2-D analysis, the resistivity shows high value in the shallow part and low value in the deep part. As for the geologic map, limestone, shale and sandstone (station 400 ~ 600,station 700~800) are distributed in this survey line, but the resistivity difference of lithologic character is not clear near the surface. The center of the low resistivity is seen at the station 600 about 800m above sea level.

The chargeability shows low value near the surface, but it shows higher value in the deep part of the east side. The part which shows more than 20mV·sec/V is seen from station 700 to station 1000 in the deep part. The measurement data shows low value in the shallow part of station 400 and shows high value in the deep part of station 600. In result, the chargeability showed high value in the deep part of the east side after 2-D analysis. But this part is the end of the survey line and out of measurement part, and it is supposed that the chargeability showed higher value as the result of 2-d analysis.

In Fig.II-1-6-9, it extracted the low resistivity part less than 150Ω·m and the high chargeability part more than 20mV·sec/V. The low resistivity and high chargeability part are seen between

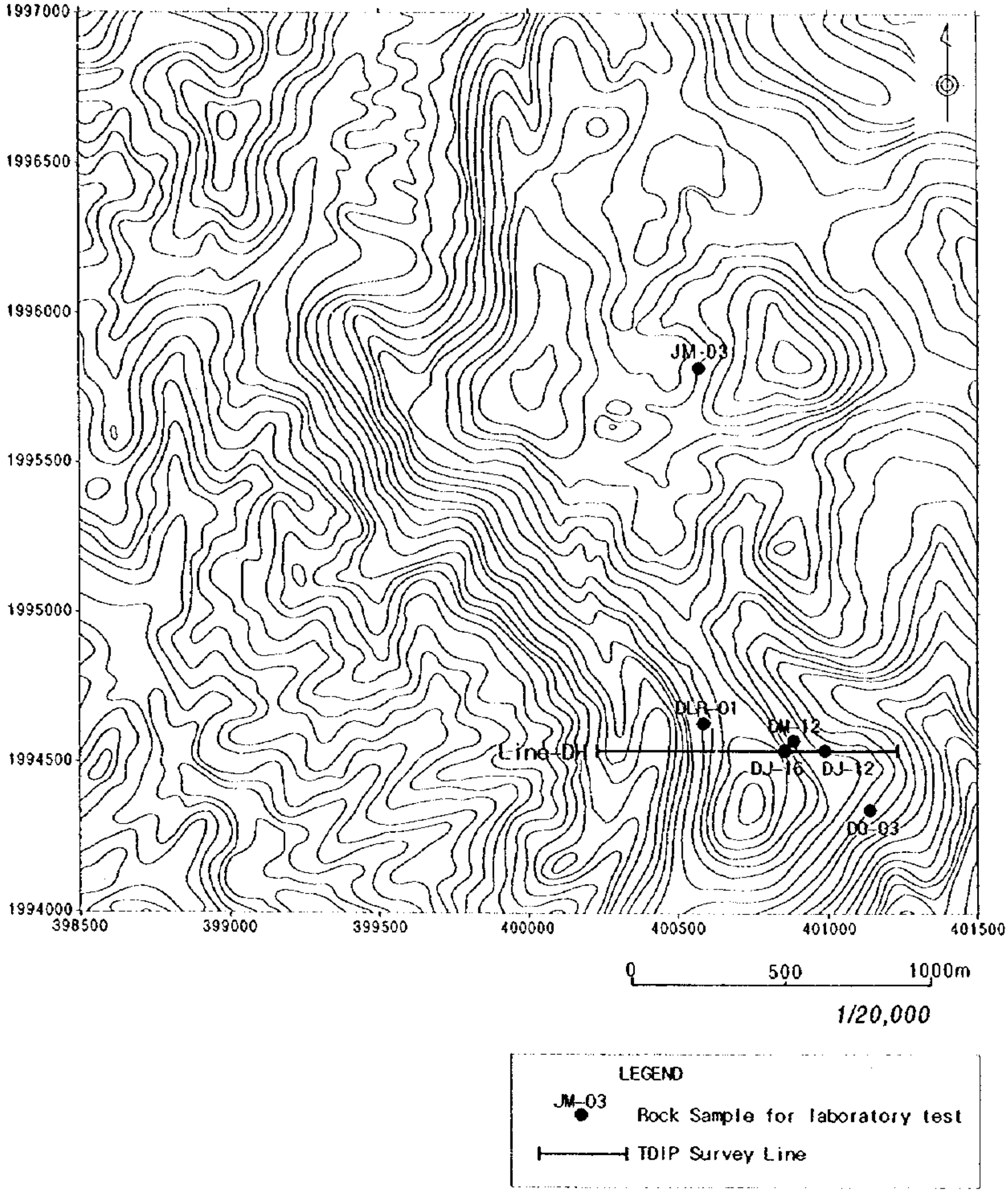


Fig.II-1-6-5 Locality of rock sample for laboratory test in the Dong Noi area

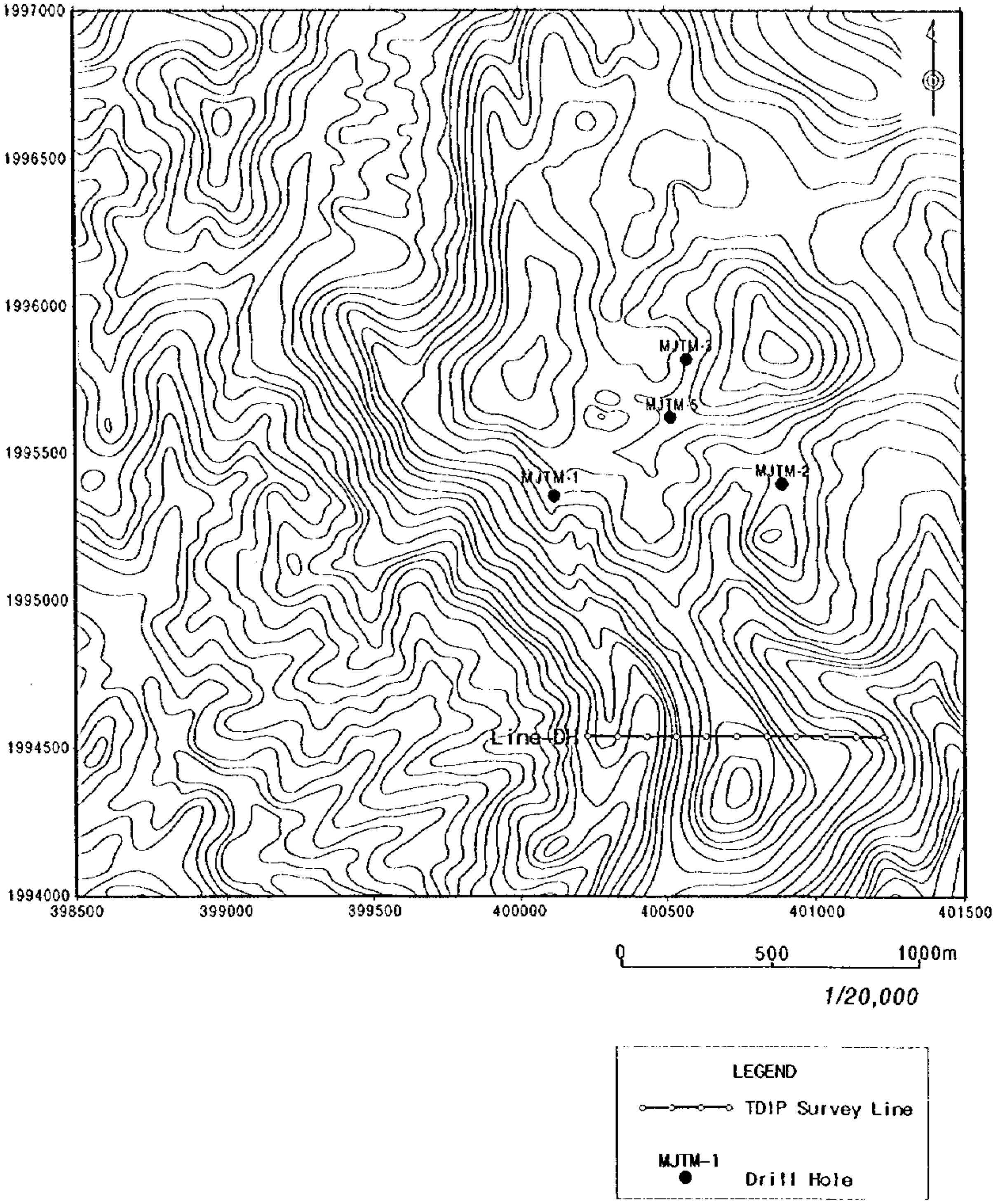


Fig.II-1-6-6 Location of survey line in the Dong Noi area

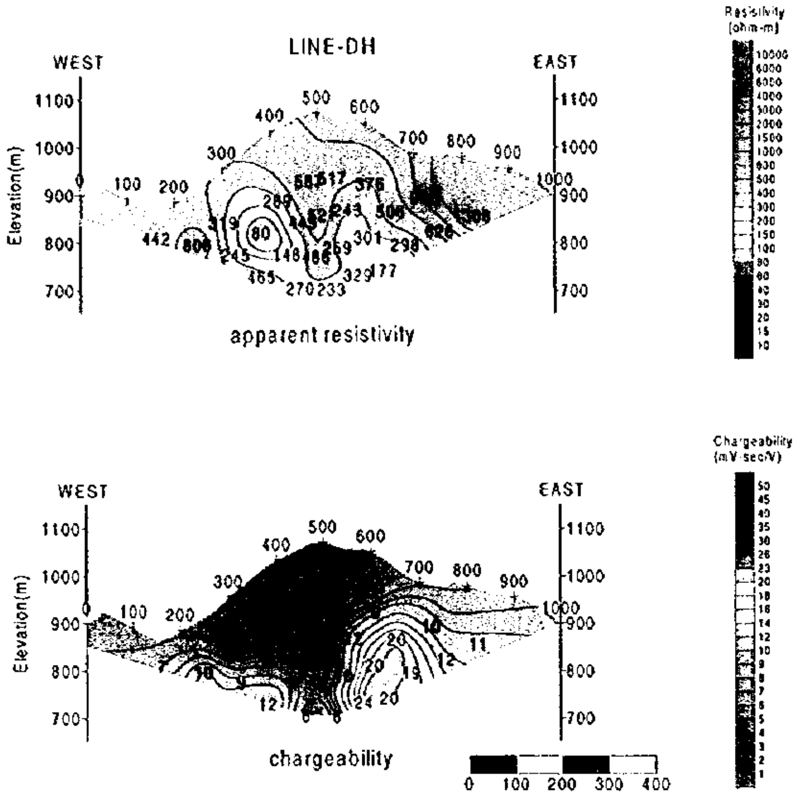


Fig.II-1-6-7 Pseudosection of apparent resistivity and chargeability of the Dong Noi area(DH)

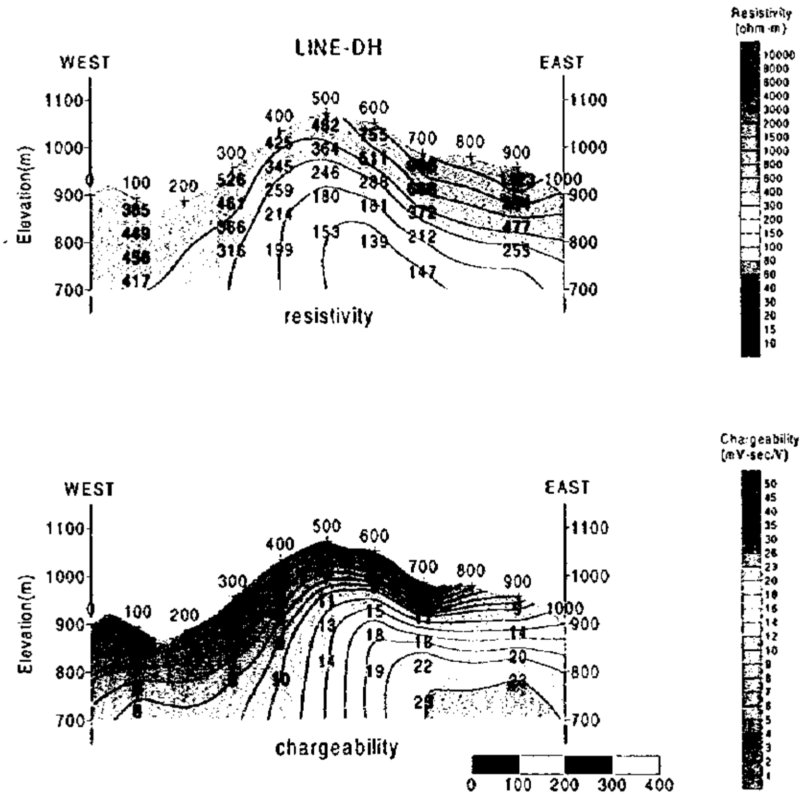


Fig.II-1-6-8 Results of model simulation of the Dong Noi area(DH)

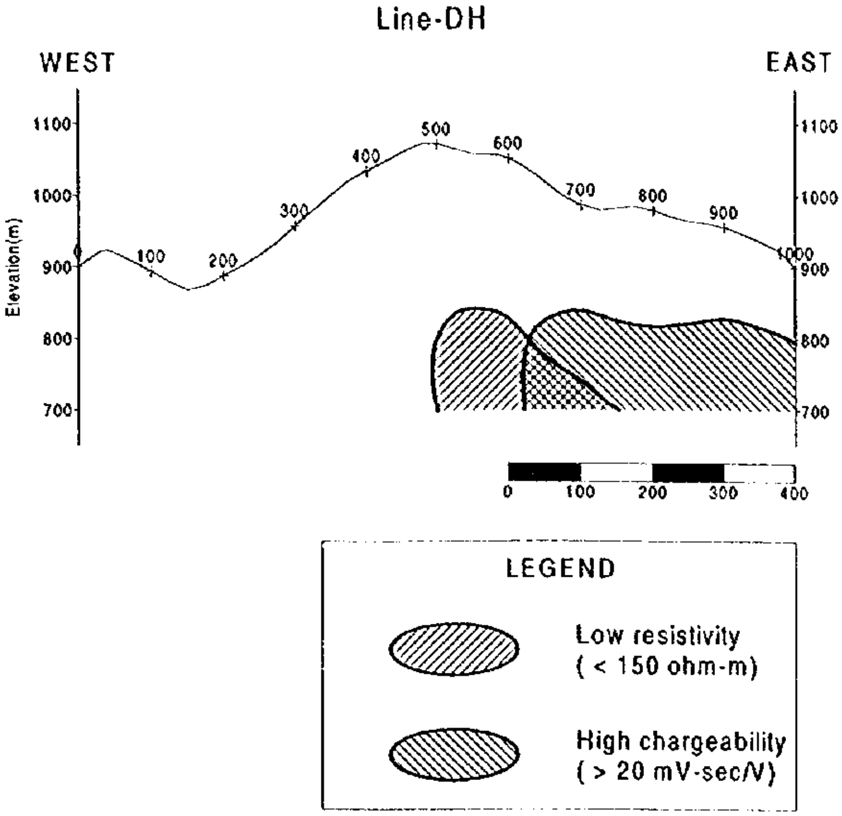


Fig.II-1-6-9 Integrated cross section of the Dong Noi area(DH) station 600 and 700 about 750m above sea level. But the anomaly part is limited in the deep part, and it is difficult to specify as the promising part. As for the mineral occurrence, the gossaneous float is seen near station 600 and the rock sample shows high chargeability (27mV·sec/V). As for the measurement data and 2-D analysis of IP survey, the chargeability did not show the high value near the surface. It supposed that if the gosssan exists, the measurement data shows anomaly, but the gossaneous float is not enough quantity to show anomaly in the IP survey.

1-7 Trench Survey

On the basis of the soil geochemistry in the Phase I survey, two trenches put into practice at the anomaly containing several thousands ppm of zinc in soil.

The horizontal length of Trench No.1 is 100 meters. All work of Trench No.1 was made by hand because the site is very steep.

The horizontal length of Trench No.2 is 102 meters. Trench No.2 was roughly made by a backhoe and then cleaned by hand.

The sketch of the each trench is shown in appendix 13.

1-7-1 Trench No.1

The dolomitized carbonate rock and weathered shale occur in Trench No.1. A boulder of 50 cm in diameter with galena-barite veinlets is discovered in the central part of the trench. A galena dissemination is also sporadically found at the bottom of the trench, but no sphalerite is observed in spite of the high zinc anomaly in soil. It is said that galena is stable whereas sphalerite is unstable in the weathering condition. The sphalerite may have decomposed or contain a very small amount and too minute grains to observe in the field.

Dark brown carbonate material is commonly observed as a replacement mineral and irregular veinlets of dolomite. This material is composed of dolomite crystals stained by a large amount of the secondary iron and manganese oxidized material under the microscope.

The result of the chemical analysis of 11 channel samples of dolomite and limestone is shown in Table II-1-7-1.

The Zn content of the rocks is rather lower than that of soil, and it generally ranges from 100 to 500 ppm, except for TR-16 (1,800 ppm).

The Pb content is generally near the background value, except two samples: 2,840 and 4,180 ppm. The irregular distribution of Pb content may indicate the irregularity of the density of galena-barite veinlets.

The channel samples contain much of Mn. All samples show over 1,000 ppm of Mn and one sample exceeds 1 %.

As only weak mineralization is found in Trench No.1, it appears that the high Zn anomaly of soil is not derived from the massive sulfide mineralization. There is a large possibility that the mineralization in Trench No.1 comes from a widespread low grade zone of veinlets or dissemination containing a small amount of sphalerite.

Table II-1-7-1 Result of the chemical analysis of rock samples in Trench No.1

Sample No.	Locality	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
TR-11	Trench No.1(50-54m)	<5	0.2	26	2860	360	2700
TR-12	Trench No.1(54-58m)	<5	0.2	15	314	140	1200
TR-13	Trench No.1(61-63m)	<5	0.2	18	184	260	5100
TR-14	Trench No.1(76-80m)	<5	<.2	12	23	110	2800
TR-15	Trench No.1(80-84m)	<5	<.2	15	15	90	3000
TR-16	Trench No.1(84-88m)	<5	<.2	21	76	1800	2500
TR-17	Trench No.1(88-92m)	<5	<.2	13	13	190	8100
TR-18	Trench No.1(92-96m)	<5	<.2	13	15	144	8900
TR-19	Trench No.1(96-100m)	<5	0.2	15	30	240	1450
TR1-53	Trench No.1(53m)	<5	0.2	24	4180	380	2850
TR1-93	Trench No.1(93m)	<5	<.2	13	26	520	>10000

1-7-2 Trench No.2

The area included Trench No.2 is overlapped with the high Zn anomaly of the soil above 1,000 ppm. The drill hole MJTM-2 is also carried out in this area.

The slightly recrystallized argillaceous limestone and phyllitic green shale occur in Trench No.2. The boundary between the argillaceous limestone and the shale is indistinct, because the argillaceous limestone contains a large amount of argillaceous lamina and grades into the phyllitic green shale. A boulder of 60 cm in diameter with galena-barite veinlets is discovered in the central part of this trench.

The result of the chemical analysis of 10 channel samples of argillaceous limestone is shown in Table II-1-7-2.

The Zn content of the rocks is rather lower than that of soil, and only two samples are obtained above 1,000 ppm, TR-24 (1,360 ppm) and TR-25 (1,020 ppm), though the Zn contents in the soil were wholly above 1,000 ppm.

The channel samples contain no anomalous Pb contents except two samples: 2,840 and 4,180 ppm.

As only weak mineralization is found in Trench No.2, it appears that the high Zn anomaly of soil is not derived from the massive sulfide mineralization, and it is also confirmed that the secondary Zn enrichment is not found in the site of Trench No.2. There is a large possibility that the mineralization in Trench No.2 came from the dissemination of sphalerite in the matrix of the brecciated or phyllitic portions of dolomite or the dissemination of the very fine-grained sphalerite in dolomite, observed as the mineralization in the drill hole MJTM-2, and zinc of decomposed sphalerite may have been highly concentrated to the soil in a weathering process.

Table II-1-7-2 Result of the chemical analysis of rock samples in Trench No.2

Sample No.	Locality	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
TR-20	Trench No.2(29-33m)	<5	5.8	100	786	70	1700
TR-21	Trench No.2(46-50m)	<5	1.2	15	382	50	1650
TR-22	Trench No.2(50-54m)	<5	1.2	14	399	110	1450
TR-23	Trench No.2(54-56m)	<5	1.2	25	67	62	1900
TR-24	Trench No.2(58-62m)	<5	5.2	24	2300	1360	2150
TR-25	Trench No.2(62-66m)	<5	0.8	17	214	1020	1300
TR-26	Trench No.2(88-92m)	<5	0.4	15	90	82	630
TR-27	Trench No.2(92-96m)	<5	0.2	13	150	60	545
TR-28	Trench No.2(96-100m)	<5	0.4	13	89	210	710
TR-29	Trench No.2(100-102m)	<5	1.2	15	264	420	800

1-8 Drilling Survey

1-8-1 Outline of the drilling survey

1. Outline of the work

The drilling survey is made in the Dong Noi and the I-4 area, which were selected as the promising regions based on the result of the Phase I exploration. The purpose is to check for the detail geology and to confirm and grasp an ore deposit and its mineralization type.

In the Dong Noi area, the existence of Zn-Pb ore deposits hosted by carbonate rock has expected by the north-south trending geochemical anomaly of Zn, Pb and Cd and the same trending IP anomaly in the area of the Ordovician carbonate rock.

Drilling work was planed to confirm underground geological information and mineral occurrence.

The sites of four drill holes are shown in Fig II-1-8-1. The length of each drill hole ranges from 100 to 345 meters, and total drilling length is 840.00 meters.

On 28 October 1998, we started the repair of the 20 kilometers rugged unpaved road branching off from Route 108 at Ban Mae Ho and leading to the Dong Noi. The work had been scheduled about one week. But it took 12 days because the work could be only carried out at night. The area was in a harvesting season and fully loaded trucks frequently passed in the day time. Further three days, from 22 November to 24 November, needed to make the new access road from the Dong Noi lead occurrence to the MJTM-3 and MJTM-2 drill sites and the site preparation. The new water reservoir near the MJTM-3 drilling site was also made at this time. The preparation of the access road and the MJTM-5 drilling site was carried out on 24 December to 26 December.

On this drying season, the Indochina including the northeastern and the northern part of the Thailand was affected the worst drought in this century. Since the reservoir dried up during the drilling of the MJTM-2 and MJTM-3, the water for drilling was transported by a truck attached 6 m^3 capacity of a water tank from the water-supply by the highway near the Ban Mae Ho. At the same time the new reservoir in a stream was prepared to the 3 km north of the Ban Dong Noi,

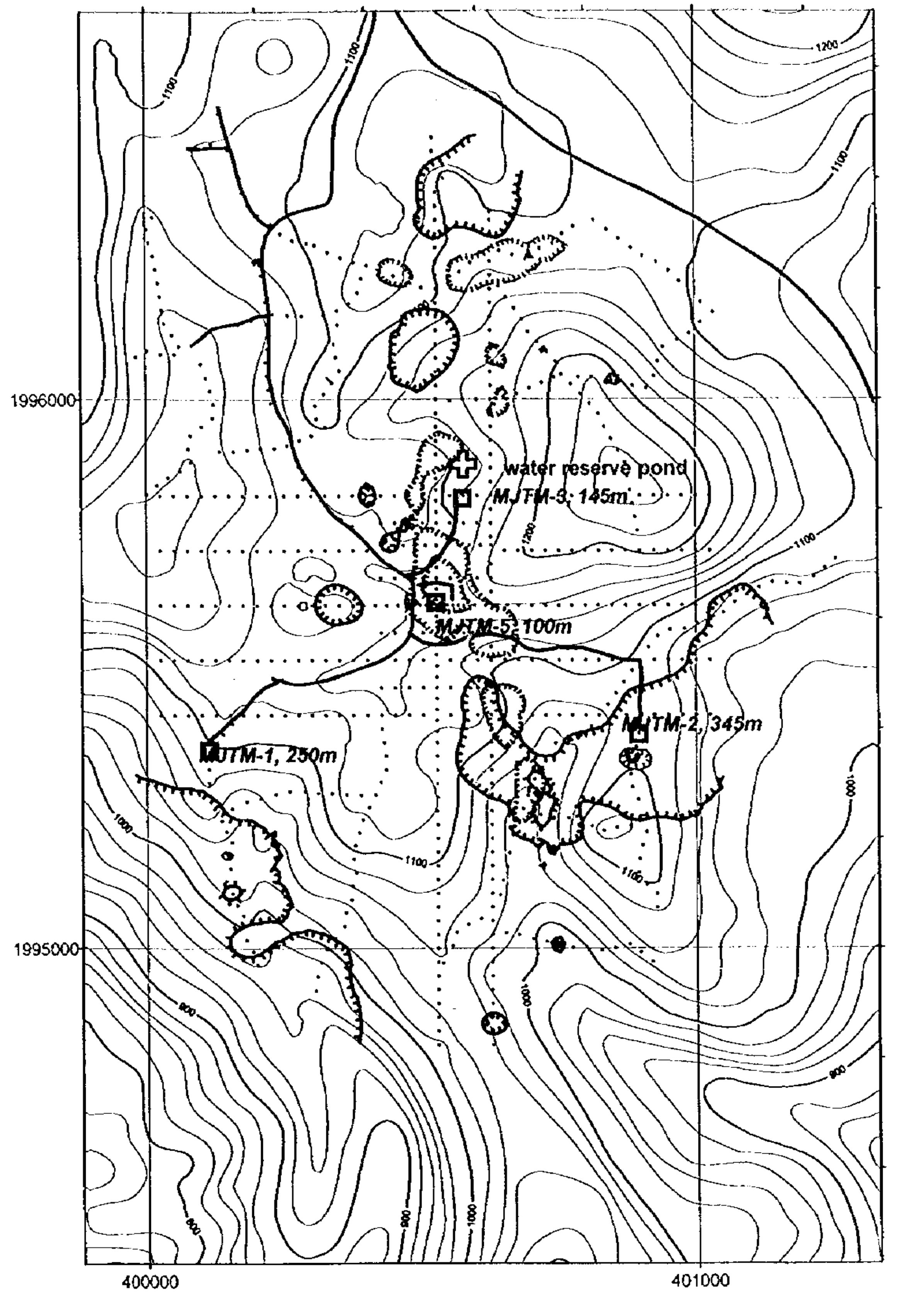


Fig. II-1-8-1 Location map of drilling point in the Dong Noi area

Table II-1-8-1 Program of drilling survey

Items	1998 October										1998 November																									
	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Road & Site Preparation				to MJTM-4																		to Dong Noi and Sites no.2,3													to site No.1	
Rig-1Mobilization, Set up, Break down																																				
Rig-1Drilling															MJTM-4					MJTM-2																
Rig-2 Mobilization, Set up, Break down																						bringing at MJTM-3												Setting up			
Rig-2 Drilling																															MJTM-3					
Demobilization																																				

Items					1998 December																															
	27	28	29	30	1	2	3	4	5	6	7	8	9	10	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Road & Site Preparation																														to site No.5						
Rig-1Mobilization, Set up, Break down																																				
Rig-1Drilling work																																				
Rig-2 Mobilization, Set up, Break down									move to MJTM-1					Setting																						
Rig-2 Drilling work												MJTM-1																								
Demobilization														No.1 Rig withdrow																						

Items					1999 January																															
	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1
Road & Site Preparation																																				
Rig-1Mobilization, Set up, Break down																																				
Rig-1Drilling work																																				
Rig-2 Mobilization, Set up, Break down																															MJTM-5					
Rig-2 Drilling work						MJTM-1																								MJTM-5							
Demobilization																																No.2 Rig withdrow				

from Dec 30 to Jan 3: new year's holiday

Table II-1-8-2 Summary of drilling activity

MJTM-1	Period	Total Turns	Working Turns	Day Off Turns	Turn Worker	Days
Mobilization	12/09	3	1	2	8	1
Drilling	12/10～01/24	129.5	108.5	21	526	43.5
Demobilization	01/24	1.5	1.5	0	10	0.5
total	12/09～01/24	134	111	23	544	45
Depth Planned	250.00	(m)	Drilling Speed	5.75	(m/ drilling day)	
Depth Drilled	250.00	(m)		5.56	(m / total working day)	
Core Length	245.50	(m)	Casing	39.00 (m)HW		
Core Recovery	98.20	(%)		213.00 (m) NW		
From 12/30 to 1/3 new years holiday			WaterCart	103.00 hours		

MJTM-2	Period	Total Turns	Working Turns	Day Off Turns	Turn Worker	Days
Mobilization	11/12	1	1	0	8	0.34
Drilling	11/13～12/08	75	56	19	176	25
Demobilization	12/09	3	3	0	12	1
total	11/02～12/09	79	60	19	196	26.34
Depth Planned	350.00	(m)	Drilling Speed	13.79	(m/ drilling day)	
Depth Drilled	344.70	(m)		13.09	(m / total working day)	
Core Length	342.25	(m)	Casing	12.00 (m) 125m/m		
Core Recovery	99.29	(%)		187.00 (m) NW		
12/05 National Holiday (King's Birthday)			WaterCart	64.00 hours		

MJTM-3	Period	Total Turns	Working Turns	Day Off Turns	Turn Worker	Days
Mobilization	11/20～11/22	9	3	6	12	3
Drilling	11/23～12/02	30	26	4	120	10
Demobilization	12/03	1	1	0	8	0.34
total	11/20～12/03	40	30	10	140	13.34
Depth Planned	200.00	(m)	Drilling Speed	14.50	(m/ drilling day)	
Depth Drilled	145.00	(m)		10.87	(m / total working day)	
Core Length	145.00	(m)	Casing	45.00 (m) HW		
Core Recovery	100.00	(%)				
			WaterCart	18.00 hours		

MJTM-4	Period	Total Turns	Working Turns	Day Off Turns	Turn Worker	Days
Mobilization	10/23～10/26	12	8	4	12	4
Drilling	10/27～11/01	27	24	3	109	9
Demobilization	11/05	2	2	0	10	0.67
total	10/23～ 11/05	41	34	7	131	13.67
Depth Planned	200.00	(m)	Drilling Speed	23.36	(m/ drilling day)	
Depth Drilled	210.20	(m)		15.38	(m / total working day)	
Core Length	210.00	(m)	Casing	9.20 (m) PVC		
Core Recovery	99.90	(%)				
			WaterCart	nothing		

MJTM-5	Period	Total Turns	Working Turns	Day Off Turns	Turn Worker	Days
Mobilization	01/25～01/26	6	3	3	34	2
Drilling	01/27～0/31	15	15	0	80	5
Demobilization	02/01～	1	1	0	12	0.33
total	01/25～02/01	22	19	3	126	7.33
Depth Planned	100.00	(m)	Drilling Speed	20.00	(m/ drilling day)	
Depth Drilled	100.00	(m)		13.64	(m / total working day)	
Core Length	100.00	(m)	Casing	5.00 (m) HW CP		
Core Recovery	100.00	(%)				
			WaterCart	3.00 hours 3trips		

and a water was pumped up by 1,000 meters water-pipe, 150 meters difference in elevation, to the water tank by the side of the road. On the end of December, the amount of flow to the new reservoir decreased only less than 10 m^3 per day. The amount was too little to supply one time a day. The drilling was carried out in loss water condition with loss water, because the drilling sites are in the limestone with a large amount of fissure. The drilling was often suspended by a shortage of water supply. Especially the completion of the MJTM-1 heavily delayed than expected.

All drilling work was completed on 31 January. The breaking down of machine and withdrawal work including the recovery of the sites were finished on 2 February. The cores were stored in the core warehouse of the Chiang Mai Branch of the Department of Mineral Resources.

The program and the summary of the drilling survey were shown in Table II-1-8-1 and Table II-1-8-2.

2. Drilling method and used drilling machines

The drilling is carried out by a wire-line method using three size bits of PQ, HQ, NQ.

For protection of loss circulation and wall sloughing, we prepared sufficient casing pipes and cased off it to drilling hole. Also we used cementing for stopping loss circulation.

The types of drilling machines were the MPR-3 which was the caterpillar mounted type of the Drillcorp South East Asia, and the LY-38 of the Longyear Corp.

The drilling machines and wear parts used in the drilling work including those in the MJTM-4 hole of the I-4 area are shown in Appendix 10.

3. Drilling work

(1) Setup works

[Road Preparation]

The lifeline road connecting between Ban Mae Ho and Bang Dong Noi was necessary to repair and to expand, because its road condition was bad for damage during rainy season and was too narrow to transport the drilling equipment. Construction term was prolonged for a week for compelling to work only night time, since traffic was so heavy in daytime by shipping vegetables of hill tribes. From center of Dong Noi area, access roads to each drilling site were cleared. Before starting drilling work, access road to MJTM-2, MJTM-3 and Water reserve pond was constructed. Access roads to MJTM-1 and MJTM-5 were cleared simultaneously with drilling works at earlier site.

[Bringing and Setup of Equipment]

Drilling machine MPR-3 was driven from Ban Mae Ho to MJTM-2 site by itself after finishing work of MJTM-4. LY-38 was caried in site of MJTM-3 by ten-ton truck.

(2) Shifting of Equipment

In shifting from MJTM-3 to MJTM-1 and MJTM-1 to MJTM-5, Drilling machine mounted on iron skid was pulling by dump truck and moved by itself using winch. Other equipment as Drilling rods were carried by manpower.

(3) Drilling Water

At the start water reserve pond was settled in small stream nearby MJTM-3 expanding water supplying pond of Ban Dong Noi. From this pond, drilling water was supplied to MJTM-2 and MJTM-3 through one inch iron pipe by pump. Nevertheless, catchment volume was reducing not enough to drilling at the last of November owing to a abnormal water famine. For this counterplan 4 m^3 reserved tank was used to store water besides drilling sites, water carting began using $6m^3$ water tank mounted on ten-ton dump truck from Ban Mae Ho and a new reservoir pond finding at abut 4km north of Ban Dong Noi. One round trip to new reservoir takes one to one and half hours, and trip to Ban Mae Ho takes four to five hours.

Drilling sites were situated in the limestone area and at the ridge of mountain, complete loss was often occurred by crushing zone and we cloud not supply sufficient water to two driiling sites. For this reason, we decided to withdraw MPR-3 after drilling at MJTM-2.

From the middle of December, spring water had been more decreasing, new reservoir was hard to recover in a day after pumping water.

(4) Drilling Operation

Summary of drilling activity including MJTM-4 in I-4 area is shown in Table II-1-8-2. Drilling works of four holes in Dong Noi area are described below.

MJTM-1: Drilling was performed using a PQ diamond bite from surface to 39.00m, HQ size bit from 39.00m to 93.30m, from 101.20 to 163.30m and from 209.00m to 213.00m. NQ size drilling was bored from 93.30m to 101.20, from 163.30m to 209.00m and 213.00 to 250.00m. Almost operation was blind drilling without a section from 163m to 209m and from 213m to bottom.

A HW casing pipes were going down to 39m, and NW pipe cased off 213m.

Drilling work from 101m to 105m and from 209m to 211.40m was so difficult as to two sheared zone in limestone and black shale.

During Casing off from 163 to 209m, drilling work stopped about eight days because of some accidents such as rod broken and oil leaking of hydraulic chuck.

MJTM-2: Drilling was performed using by HQ bit from surface to 186.60m and by NQ size bit from 186.60m to bottom.

Five inches casing pipe was insert to 12m and NW pipe was case off at 186.60m.

All drilling work except of topsoil was blind. Complete loss happened at 160.40m and 255.40m. It was difficult to stop leaking at 255.40m using by LCM and dense mud. For this reason, a section between 250m to 255.40m was grouted by cement.

Drilling tools stuck at 345m, and core tube assemble could not be retrieved unfortunately.

MJTM-3: Drilling was performed using by a PQ bit from surface to 32.10m and by HQ size bit from 32.10m to 145.00m. HW casing pipe was inserted to 32.10m.

Drilling work al most proceeded smoothly, but a complete loss occurred at the depth of 122.20m.

Unexpectedly a granite body was developing below 122.70m. Because of no mineralization observed in granite, drilling work was canceled at 145m

MJTM-5: This Hole was drilled by HQ size bits to bottom. HW casing pipe was inserted to 5m. Drilling work proceeded smoothly.

(5) Withdraw of equipment

MPR-3 ran to Ban Mae Ho by itself on December 9, and it was carried to Bangkok by a trailer truck.

LY-38 was broken down immediately after drilling, and it and its equipment were carried by two ten-ton trucks to Chiang Mai.

Each drilling sites was cleaned up after withdraw of equipment rapidly.

The cores were observed and taken samples for analysis in Mae Sariang town and were stored in the core warehouse of the Chiang Mai Branch of the Department of Mineral Resources.

1-8-2 Geology of Drill hole

MJTM-1 and MJTM-2 were planed to determine the feature of mineralization occurring in the ground and geological feature beneath the geochemical anomaly zones of Zn, Pb, Zn developed in southeast and southwest end of the Dong Noi area. MJTM-3 and MJTM-5 were planed to clear the feature of mineralization corresponding with Cu, Pb, Ag, Sb geochemical anomaly and IP anomaly in the central Dong Noi area.

For geology, mineralized zone and ore assay grade, there are described below. Drilling log of scale 1: 200 were prepared and are shown in Appendix 12.

MJTM-1: to 250.00 m

0.00～ 9.40 m Topsoil

9.40～ 20.90 m Limestone. The upper part contains a large amount of argillaceous parts with some bands of the pink to yellow dolomitic limestone. The lower part is massive but partly brecciated, with frequent intercalations of reddish-brown clay material of dolines.

20.90～ 24.50m dark brown calcareous clayey soil. It is strongly weathered brown carbonate mineral with fragment of limestone.

24.50～ 53.75m Black shale is dominant in this section. It intercalates pale green limestone with weak skarnization. Inclination of bed is about 20 degrees. High-angled calcite-brown carbonate mineral vein is abundant. Oxidation of rocks are frequent along cracks.

53.75～ 62.00m Alternation of limestone, shale, sandstone. In a section from 53.75 to 60.00m it is composed of pebbly and / or clayey core mixed with fine breccia of shale, limestone and brown carbonate. It is judged fault zone.

62.00～ 98.35m Alternate distribution of brown carbonate minerals and dolomite. Brown carbonate mineral veins often cut in dolomite with high angle. Quartz-calcite stringers well develop in brown carbonate band.. Also this carbonate band often contains brecciated continuous quartz vein. This fact suggests them to be the product of hydrothermal activity. We supposed these mineral were the origin of high Zinc geochemical anomaly. Nevertheless, ore assay result does not show high zinc content, only 46 to 420ppm, but Fe and Mn are high. By X-ray diffraction calcite, quartz sericite and chlorite are detected. Under Microscopic observation This carbonate is composed of brecciated calcite containing with goethite and hematite.

98.35～158.70m Coarse grained re-crystalline dolomite. Massive part and banded part with muddy seams are alternate. Generally this section show high angle inclination. Muddy part slightly subjected to hornfels metamorphism. Calcite-brown carbonate veinlets are observed in parallel to laminar.

158.70～174.90m Alternation of shale and dolomite. Partly weak silicification occurs in shale and dolomite with pyrite dissemination.

174.90～208.65m Re-crystalline dolomite with a little chert and chlorite seams.

208.65～211.15m Black shale. The greater part are effected shearing and turn to clayey core. In remained hard part silicification is strong with dense pyrite dissemination.

211.15～220.20m Re-crystalline dolomite. Pyrite and brown carbonate occur in the matrix of brecciated part and in veinlet. Ore assay in pyrite rich part shows Zn=268ppm

220.20～227.40m Alternation of dolomite, chert and black shale. Chlorite-calcite veins are commonly developed in this section. Pyrite dissemination is remarkable around these veins. Ore assay data do not show high content of Zn, Pb, Cu.

227.40～238.00m Pelitic hornfels. In upper section fine porphyroblastic texture by cordierite and garnet is remarkable. Sphalerite and galena are found in 236.30 to 238.00m. Ore assay in this part shows 5,050ppm Zn, 510ppm Pb, 1.2ppm Ag.

238.00～240.10m Chert. This intercalates thin bed of limestone, dolomite and shale. Pyrite dissemination occurs along lamination.

240.10～242.05m Coarse grained re-crystalline dolomite with a small amount of chert and shale.

242.05～243.25m Black shale with dolomite thin bed.

243.25～250.00m Banded dolomite. Fine and coarse grained band by re-crystallization is remarkable. Coarse band is accompanied with fine pyrite.

MJTM-2 : to 345.00m

0.00～ 9.00m Topsoil: brown soil with pebble of limestone.

9.00～ 66.70m Massive impure limestone. Many sulfide such as pyrite, pyrrhotite, galena and sphalerite disseminates in the matrix of remarkable brecciated part of limestone. Skarnization occurs in limestone around brecciated part. Interbedded mud laminas turned into biotite hornfels. Ore assay result of sulfide disseminated brecciated part is 1.6 to 11.6g/t Ag, 37 to 243ppm Cu, 89 to 1,680ppm Pb, 40 to 1,920ppm Zn.

66.70～ 69.20m Thin alternation of dolomite and chert. From 68.70 to70.70m pyrrhotite and sphalerite disseminate abundantly.

69.20～ 74.60m Massive impure dolomite with thin interbedded shale and sandstone. Thermal metamorphism affected in sandstone. In the upper of this section, dissemination of sulfide occurs in matrix of brecciated part. This assay shows 4.6g/t Ag, 728ppm Pb, 4,500ppm Zn.

74.60～ 76.50m Dark gray dolomitic shale.

76.50～ 98.65m Banded dolomite intercalating with thin bed of shale, sandstone and chert. Brecciated texture is remarkable from 77.00 to 80.20m with much of fine sulfide and chlorite.

98.65～107.60m Pale green re-crystalline dolomite. Garnet and epidote commonly occur with a small amount of pyrite. Assay of a section from 97.60 to 99.50m shows 4.0g/t Ag, 1,260ppm Pb, 980ppm Zn.

107.60～119.00m Alternation of chert, shale and tuff. Tuff turned into skarn and shale turned into hornfels. Small amount of pyrite and pyrrhotite disseminate all over. Chalcopyrite and galena are observed in skarnized calcite vein.

119.00～121.30m Massive limestone, partly weakly dolomitized. It get weak skarnization.

121.30～171.30m Amphibole-garnet-epidote green skarn dominates in this section. Original sedimentary texture well remains in weaker skarnized part. Magnetite bands are abundantly developed with sulfide. Magnetite-garnet skarn occurs from 148.10 to 150.60m and from 163.40 to 165.30m. Chalcopyrite and bornite are scattering in Quartz vein from 165.30 to 166.10m. Magnetite skarn has no high content of Cu, Pb, Zn.

171.30～175.35m Massive silicified sandstone with pale green color.

175.35～237.20m Alternate banding of (garnet-) green skarn and magnetite skarn. Sulfide dissemination are well developed as a whole, but it is rare from 175.35 to 196.60m. Between 216.30 to 218.40m siliceous sandstone is intercalated.

237.20～271.30m Pale green siliceous sandstone, massive. Fine pyrite disseminates all over. Partly coarse idiomorphic pyrite occurs with nebulitic texture. Barren quartz veins are developed at 250.30～252.20m and 263.20～269.50m.

271.30～285.40m Amphibole andesite dyke with intersertal texture. Penocryst of plagioclase and amphibole is remarkable. Chlorite-smectite-carbonate alteration is strong. Dense dissemination of pyrite is developed at 281.70～289.30m. Ore assay of this part is 0.2g/t Ag, 69ppmCu, 13ppmPb, 24ppm Zn.

285.40～296.80m Strong altered aphanitic andesite. Chlorite-smectite-carbonate alteration is strong. Calcite and dolomite veinlets are common.

296.80～297.10m Chlorite-calcite-quartz vein with small amount of pyrite.

297.10～309.60m Alternation of amphibole green skarn and garnet skarn with small quantity of pyrite and chalcopyrite. Chlorite-smectite-mica clay mineral alteration is developed and silicification is partly observed.

309.60～322.60m Silicified amphibole green skarn. Silicification and sericitization is remarkable. Silicification is unhomogeneous, then green skarn is observed in places. Ore assay at 320.20～321.80m shows <0.2g/t Ag, 13ppm Cu, 101ppm Pb, 92ppm Zn.

322.60～322.80m Quartz vein with small amount of chlcopyrite.

322.80～329.00m Thin alternation of chert and tuff. It dips 25 to 30 degree. Tuff part is altered by chlorite and epidote.

329.00～344.70m Epidote skarn originated from tuff or tuffceous sandstone. Nebulitic pyrite dissemination occur abundantly from 335.50 to 337.00m.

MJTM-3: to 145.00m

0.00～ 10.00m Clayey topsoil with orange to brown color.

10.00～ 10.50m Pale green foliated weathered rock originated from shale.

10.50～ 49.30m Dolomite and calcareous alternation with thin bed of shale and tuff in part. Shale part completely turned into biotite hornfels. Some parts of dolomite and tuff are replaced by diopside skarn. Cu, Pb, Zn contents is less than 20ppm.

49.30～ 69.15m Strong silicified rock. Fine pyrite disseminates as a whole. Abundant idiomorphic pyrite occurs between 63.10 and 64.20m. At 54.50～55.20m dolomite with pyrite dissemination is interbedded. Chalcopyrite and galena dissemination is remarkable from 59m to 69m. Particularly at 68.90～69.05m Chalcopyrite is abundant and copper content is up to 1.64%.

69.15～ 74.65m Green skarn and magnetite skarn alternation. It is cut by aplite vein which dips 50 degree at 69.30～69.40m. Abundant pyrite disseminates all over partly accompanied with chalcopyrite and galena. In a section between 73.00m and 74.00m assay shows 551ppm Cu, 3ppm Pb, 38ppm Zn.

74.65～ 92.30m Greenish white silicified rock replacing green skarn. As to silicification is uneven, green skarn is observed in place. Magnetite bands with galena distribute scatteringly. Entirely pyrite dissemination is abundant.

92.30～122.70m It is composed of magnetite-arnet skarn and green skarn with small amount of meta-sandstone and pelitic hornfels. Pyrite dissemination is observed in whole section and chalcopyrite is scattering. Ore assay from 93.00 to 94.00m is

611ppm Cu, 8ppmPb, 52ppm Zn, at 98.10～99.30m 1,420 ppm Cu, 52ppm Pb, 240ppm Zn, at 104.50～105.70m 5,320 ppm Cu, 15ppm Pb, 500ppm Zn, at 113.60～115.50m 889ppm Cu, 33ppm Pb, 280ppm Zn, at 121.50～122.70m 912ppm Cu, 11ppm Pb, 270ppm Zn

122.70～122.95m Quartz vein cut and bounded between skarn and granite. It has much pyrite but no other sulfide.

122.95～125.20m Fine grained muscovite-biotite aplite. It is marginal facies of porphyritic granite. Chloritization is remarkable.

125.20～145.00m Potash feldspar porphyritic biotite granite. It is altered by chlorite, kaolinite, sericite. It has no endmorphic skarn mineralization except pyrite.

MJTM-5: to 100m

0.00～ 0.30m brecciated boulder of galena ore.

0.30～ 3.85m Reddish brown clayey weathered soil. It contains skarnized boulder with much of galena. Assay of boulder shows 224g/t Ag, 2,660ppmCu, 24.9%Pb, 242ppm Zn.

3.85～ 8.40m Strong silicified rock with white color. It is massive but brittle. Pyrite and galena rarely disseminate.

8.40～ 11.10m Orange or brown weathered soil. It almost turned into clay but some of foliated rock fragment remained. It seems originated from foliated shale.

11.10～ 17.45m Greenish gray foliated limestone. Foliated texture and brecciated texture is extremely remarkable. Large quantity of chlorite, pyrite, chalcopyrite, galena and magnetite occur along foliation and in matrix of brecciated texture. At 12.00～12.50m malachite is observed on the surface of blocky core. Assay results in this section is 46.4g/t Ag, 1.30% Cu, 4,440ppmPb, 958ppm Zn, and 19.8g/t Ag, 2,480ppm Cu, 874ppm Pb, 560ppm Zn.

17.45～ 36.30m Dark gray impure dolomite with abundant pelitic laminas. Foliated texture and brecciated texture are decreasing toward lower. In proportion as this, amount of sulfide also decreases. Pelitic laminas is almost replaced by magnetite. In a foliated part from 20.00m to 21.00m assay is 1.40g/tAg, 708ppm Cu, 194ppm Pb, 378ppm Zn. It is 0.4g/t Ag, 703ppm Cu, 26ppm Pb, 80ppm Zn at 31.00～32.00m where developing calcite-quartz veinlet.

36.30～ 80.50m Magnetite skarn and dolomite alternation. Dolomite is very rich in impurities and well observed sedimentary structure of sole mark and load cast. Magnetite skarn is calcareous and is made over replacing muddy beds and stringers. Magnetite skarn dominates in 48.80～80.50m intercalating many thin dolomite. Four analysis data in this section show <0.2 to 0.6g/t Ag, 237 to 767ppm Cu, 21 to 55ppm Pb, 27 to 129ppm Zn.

80.50～ 96.20m Pale green to greenish gray skarnized dolomite. Skarnization occurs all over but the center of brecciated texture is fresh escaping skarnization. Mud seams replaced by magnetite is abundant. It is remarkable brecciated texture from 85.50 to 86.60m. Chlorite and chalcopyrite is rich in this matrix. Assay result is <0.2g/t Ag, 254ppm Cu, 10ppm Pb, 62ppm Zn.

96.20～100.00m Alternation of magnetite skarn and epidote skarn. Chalcopyrite abundantly disseminates in 97.00～98.50m. Ore assay of chalcopyrite rich part is 2.2g/t Ag, 1,685ppm Cu, 16ppm Pb, 22ppm Zn.

1-8-3 Consideration

Drill hole MJTM-1 was planed to confirm mineralization under the ground beneath Zn and Cd geochemical anomaly distributed in carbonate rock of southwestern Dong Noi area (Fig. II-1-8-2). The uppermost part of MJTM-1 is composed of alternation of shale and sandstone. In the deeper part there is dominated by dolomite. Granitic rock distributes about 400m from MJTM-1 in western side. Because of this, we supposed distribution of skarn rocks at the deeper part of this hole. Nevertheless, only pelitic hornfels is observed at 227～238m. Dark brown carbonate vein developing in 60～100m of MJTM-1 might deposit from hydrothermal solution which caused geochemical anomaly in this zone, because those carbonate veins often contains fragmentary quartz vein. The highest value of this assay is only 420ppm Zn. It was not nearly so geochemical anomaly of last phase, which was up to several thousand ppm. X-ray diffraction analysis and microscopic observation revealed that that carbonate is a calcite containing very fine-grained goethite and oxidized manganese. Salinity of fluid inclusion of quartz veins closely relating with brown carbonate vein is very low. It suggests that the nature of hydrothermal solution forming these brown carbonate vein is much different from the chemical nature of solution forming stratiform type or massive type mineralization replacing carbonate rocks.

MJTM-2 was planed to grasp mineralization and to reveal geologic structure beneath Zn, Cd, Pb geochemical anomaly spreading at the southeastern end of Dong Noi area (Fig. II-1-8-3). The upper part of this hole is impure muddy dolomite intercalating many shale and chert seams. In this dolomite high-angled foliated shear zone and brecciated zone is well developed. Pyrrhotite, pyrite, sphalerite, galena and chalcopyrite occur in the matrix of these textures. Biotite hornfels is also developed in muddy part around mineralization. Assay results from these mineralized section with 1 to 3m in length show high content of Pb, Zn that is 1.2 to 11.6g/t Ag, 22 to 1,690ppm Pb, 42 to 4,500ppm Zn. Anomaly zone on the surface might be reflective of the distribution of these network-type mineralized zone. Nevertheless the volume of mineralized zone is little.

The lower part of MJTM-2 deeper than 120m is composed of magnetite skarn and garnet-magnetite skarn. Original sedimentary texture is often remained in skarnized rock in place. Sandstone bed and silicification zone are observed. Ore assay result is very low in skarn zone.

Salinity and homogenized temperature of quartz vein are high. It might show the presence of high salinity hydrothermal solution.

MJTM-3 was planed to confirm the mineralization corresponding to IP anomaly beneath Pb and Cu geochemical anomaly [Fig. II-1-8-4]. It is composed of alternation for dolomite, sandstone and tuff from surface to 49.30m. It is partly turned into skarn or hornfels without sulfide. At the deeper part more than 49.30m, there is magnetite skarn and silicified green skarn. At 122.70m it is cut by biotite granite. The uppermost part is low content of Cu, Pb and Zn. On the side assay of skarn corresponding to the highest IP anomaly shows high content of copper. There are 551～5,320ppm Cu of 1 to 2m in length, maximum 1.64% Cu in 30cm.

MJTM-5 was planed to certify the occurrence of mineralization under lead mineralized outcrop [Fig.II-1-8-4]. Lead mineralized zone is only 30cm in core after leveling of ground for preparation of drilling site. Clayey weathered rock containing boulder of galena disseminated green skarn distributes under this zone about 3.5m in thick. This assay shows 224g/t Ag, 2,660ppm Cu, 24.9% Pb. At a depth of 3.85 to 11.00m barren silicified rock and weathered rock overlie dolomite at 11.00 to 36.30m. Dolomite shows remarkably sheared texture with high angle. Sheared texture is decreasing toward lower. Abundant sulfide of pyrite, galena and chalcopyrite disseminate along shear plane with chlorite. Assay in the strongest sheared zone with 6 m length are 19.8～46.4g/t Ag, 2480ppm～1.30% Cu, 874～4,440ppm Pb, 560 and 958ppm Zn.

Below at a depth of 36.30m there is alternation of magnetite skarn and dolomite. Skarn rock is not mature and calcareous. In the skarn rock Pb and Zn content are low but Cu is 250～750ppm. Drilling survey reveals the contrast of geologic setting under the ground at western half and eastern half of Dong Noi area. In the western half there is composed of dolomitized limestone intercalating shale and sandstone and is close to granite mass. But in this half it is not distinct mineralization and thermal effect such as skarnization and hornfelsization. On the other hand, in the central and eastern side of the Dong Noi area skarn and its related mineralization of abundant magnetite and sulfide are well developed from surface to deeper part. Also IP anomaly zone in skarn has high contents of copper that is 0. 1～1. n%.

Mineral occurrence found in the upper part of MJTM-2 and MJTM-5 suggests the genesis as follows. Hydrothermal solution with high salinity and middle to high temperature was departed from skarnized zone and went up to upper dolomite. Simultaneously brecciated zone and foliated shear zone were formed in dolomite and mineralization of galena, sphalerite and chalcopyrite occurred in those textures. Nevertheless, stockwork type mineralization zone around MJTM-2 is not so wide and is a small quantities of volume. If there exists high porosity part and/or easy to replacing part by high salinity hydrothermal solution in the carbonate rock of the Dong Noi area, big ore body may be existing in the Dong Noi area.

A lead occurrence at MJTM-5 is confirmed to the depth about 20m. Those assays show 19.8～224g/t Ag, 30ppm～1.30% Cu, 874ppm～24.9% Pb, 242～3,000ppm Zn. This mineralization is formed in shear or fractures zone that is 70 to 80 degrees. This fact suggests the hydrothermal

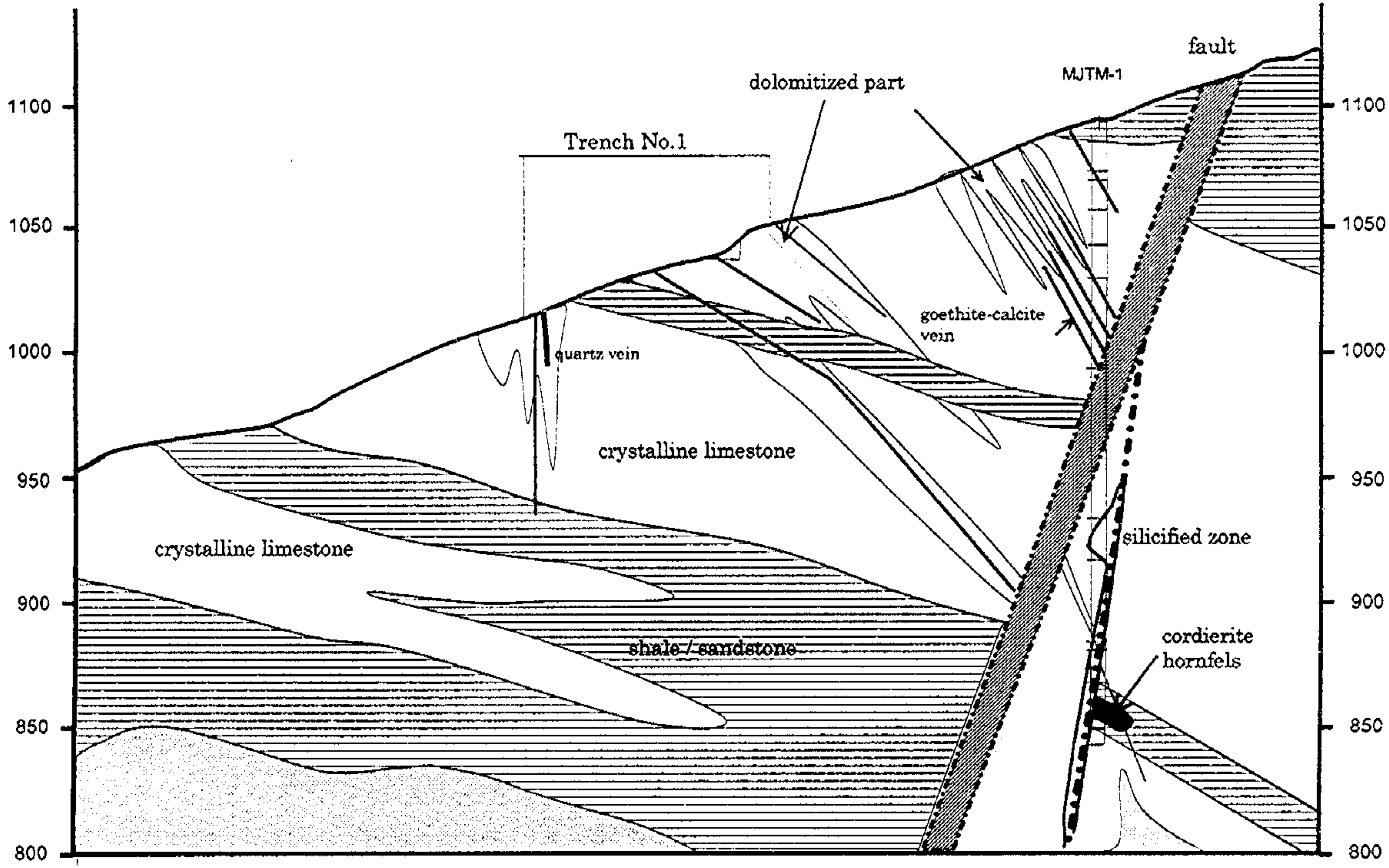


Fig. II-1-8-2 Interpretation section around MJTM-1 and Trench No.1 in the Dong Noi area

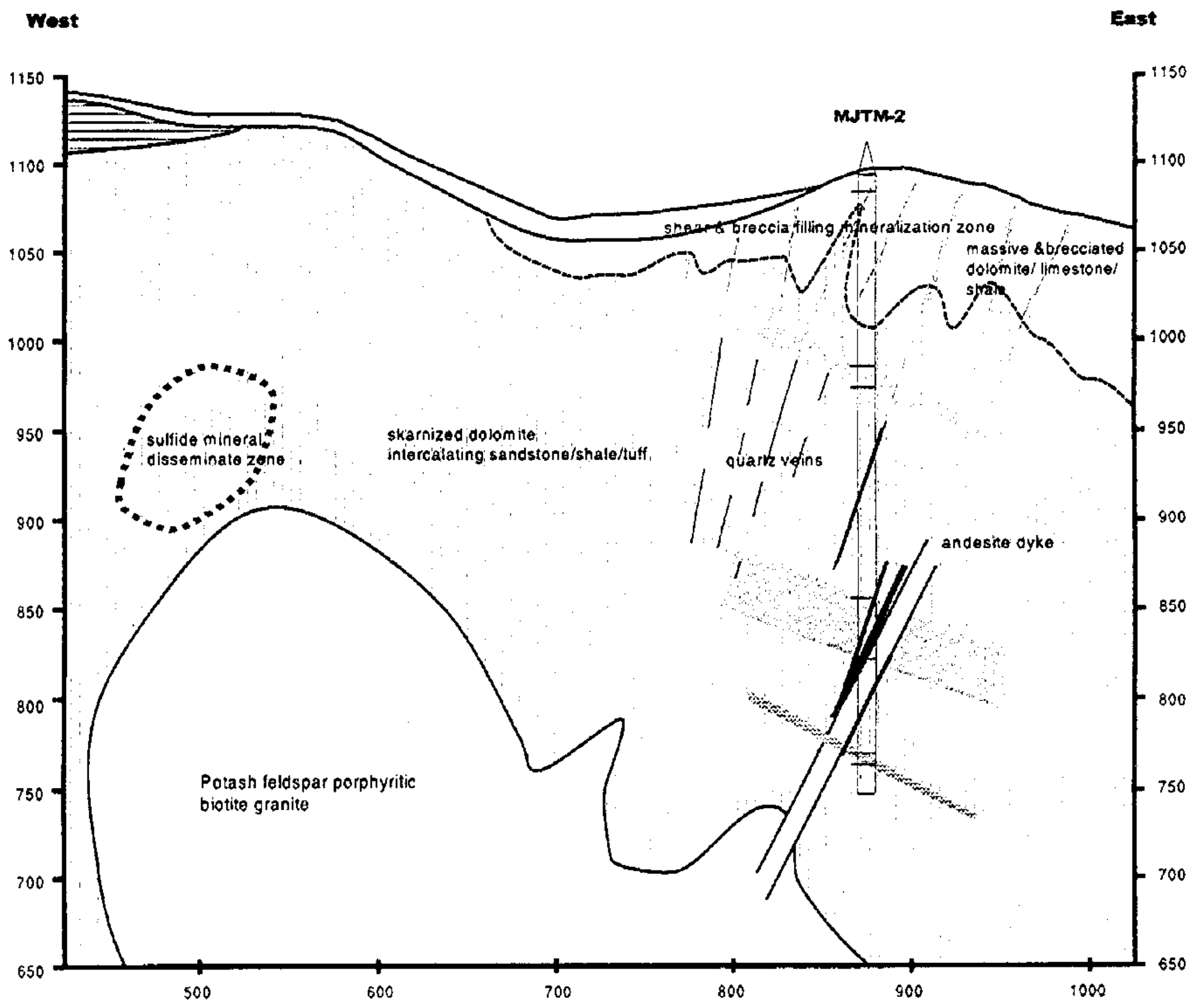
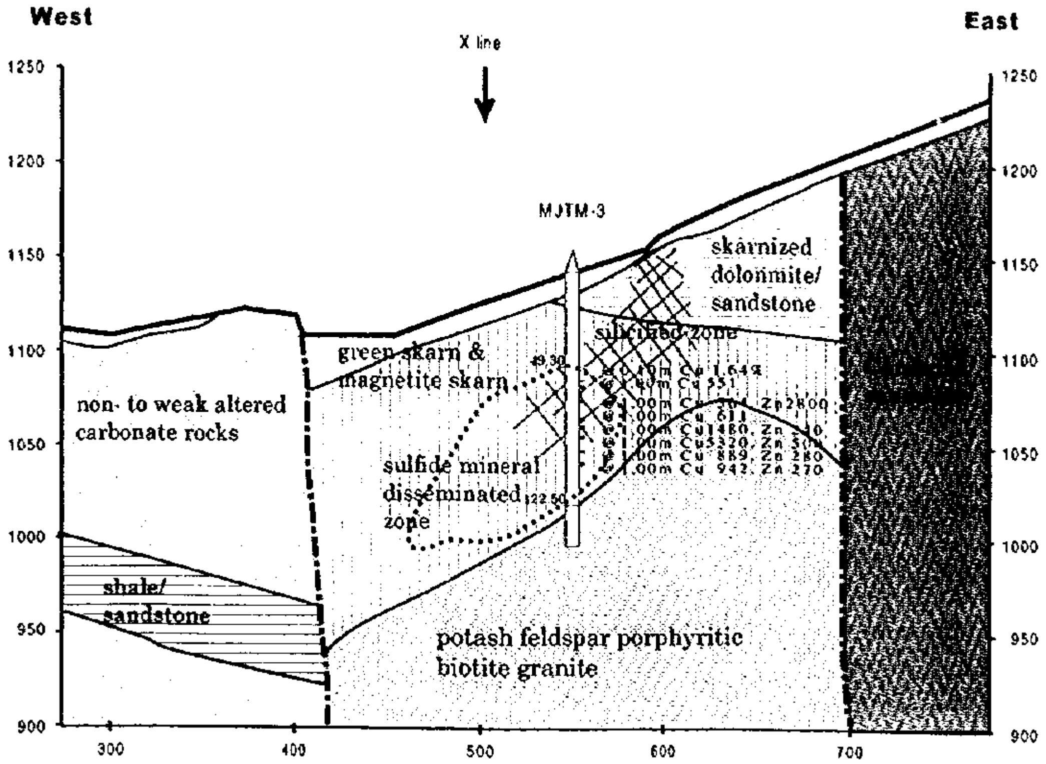


Fig. II-1-8-3 Interpretation section arund MJTM-2 in the Dong Noi area



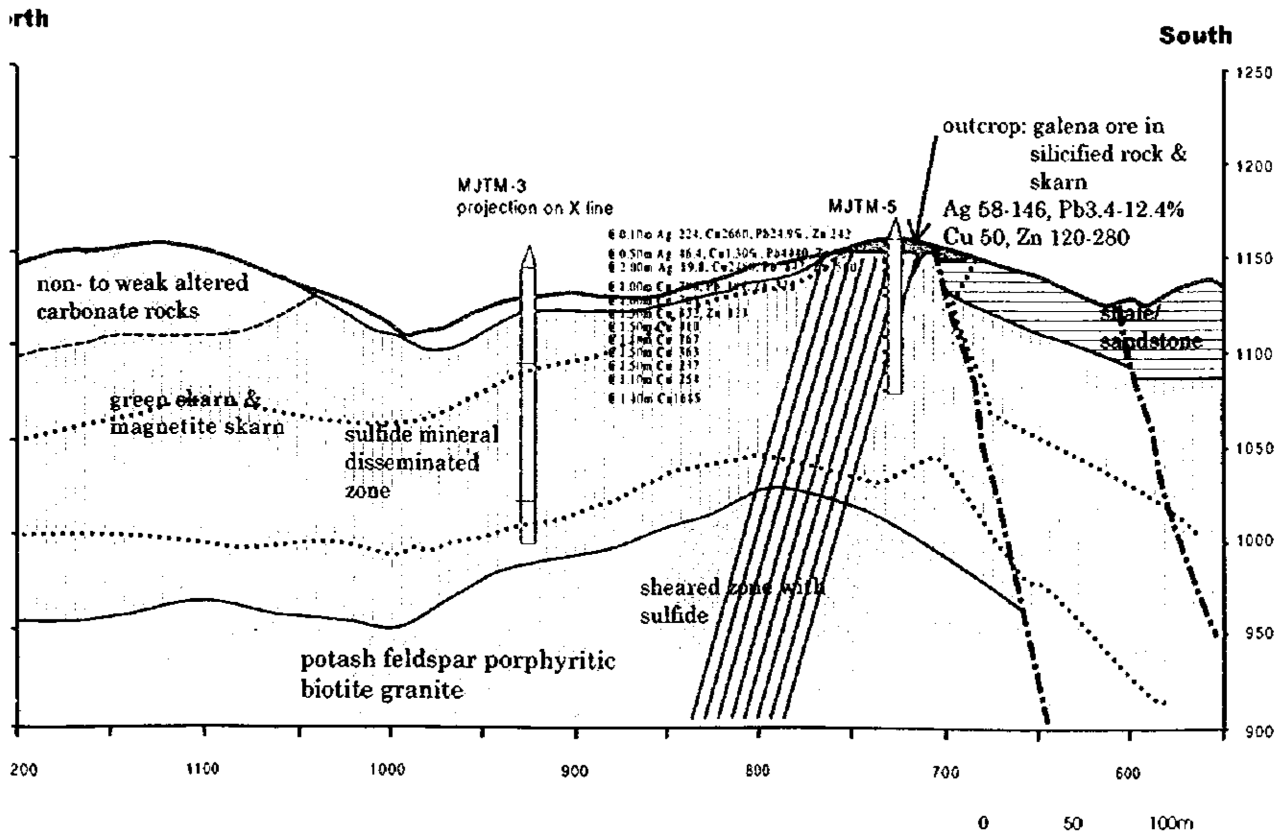


Fig. II-1-8-4 Interpretation section between MJTM-3 and MJTM-5 in the Dong Noi area solution rising area may not be directly under MJTM-5.

1-9 General Discussion

The detailed geological and geochemical survey, and the drilling survey was programed for the Phase II exploration in the Dong Noi area.

The geochemical survey was confined zinc and lead anomaly zones extending to the outside of the Phase I area. Four drill holes made clear the mineralized zones and the geologic structure underneath of the Dong Noi area.

Two main zinc geochemical anomaly zones are delineated in the Dong Noi area. The one is in the western part in the Dong Noi area that overlaps with a strong dolomitized limestone area. The other is in a southeastern limestone body where the drill hole MJTM-2 and Trench No. 2 were carried out.

In the former west zinc anomaly zone, limestone is recrystallized, and intercalated shale beds have been subjected to pelitic hornfels metamorphism. But skarnization is not observed.

In the southern part of the west anomaly, the drill hole MJTM-1 and Trench No.1 were carried out. A small amount of galena dissemination in dolomitic limestone and a float with galena-barite veinlets are found in Trench No. 1. Sphalerite is not observed in the trench, nor in the drill hole MJTM-1, even in the trench samples containing 1,800 ppm Zn. Though the high zinc content in soil, that is generally more than 1,000 ppm Zn, has not been clear yet, it can be stated that the existence of a massive zinc ore deposit is questionable in the southern part of the west anomaly based on the result of drilling and trenching survey. The northern part of the west anomaly also shows a high geochemical zinc anomaly and limestone has been affected dolomitization, but no further work has been carried out. Therefore this northern part still remains the potential for an ore deposit.

In the latter southeastern zinc anomaly, it can be interpreted that the high concentration of zinc in soil is derived from disseminations of sphalerite in the matrix of some brecciated and shear parts of dolomite layers, that are observed at the upper portion of drill hole MJTM-2. This sphalerite dissemination is also associated with galena, chalcopyrite and pyrrhotite. The dolomite in MJTM-2 is generally compact and hard, though it contains a large amount of argillaceous laminas. Perhaps porous or fractured rocks may need to trap ore solution and then to form a massive ore deposit, but brecciated and shear parts in dolomite are commonly very small-scale and porous carbonate rocks do not occur in MJTM-2. It appears that a massive zinc ore deposit may not exist in the southeastern part of the Dong Noi area.

The Pb moderate anomaly overlaps with the west zinc anomaly. This Pb anomaly can be explained by above-mentioned occurrence of galena-barite veinlets in the dolomitized limestone.

Other two Pb geochemical anomalies are detected; the area in the periphery of the drill hole MJTM-2 and Trench No. 2, and the area extending northward from the Dong Noi lead occurrence along a north-south striking fault and southeastward of the Dong Noi occurrence.

The Pb anomaly of the periphery of MJTM-2 is interpreted the same as the southeastern Zn anomaly that derived from dissemination in the brecciated and shear parts of dolomite layers.

The Pb anomaly centering the Dong Noi lead occurrence overlaps with the high Cu geochemical anomaly. It can be interpreted that the high concentration of lead and copper in soil is derived from the skarn-type Pb-Cu-Ag mineralization, that are observed at MJTM-5 and MJTM-3 drill holes.

The depth of skarn-type mineralization intersected by drill holes are quite consistent with the distribution of IP anomaly by Phase 1 geophysical survey. The intensity of IP has a close relation to the copper grade of the drill core. This IP anomaly is a columnar shape plunging gently north with 100 m in diameter and more than 800 m in length, and the roughly estimated potential is 20 million tons of mineralized rocks. In this year, only two holes have been drilled in the IP anomaly. Further drilling work needs to confirm ore reserve and grade in the whole IP anomaly.

Though the similar argillaceous limestone crops out in the western, central and southwestern parts of the Dong Noi area, the facies of limestone under the ground are very different with each other according to the drilling survey. The drill core of the western limestone shows only weakly skarnization though the limestone adjoins a granite batholith, whereas the drill core of the central and eastern limestone has been strongly skarnized from a shallow part to the bottom. It is inferred that a granite body intruded to the shallow depth along the north-south striking fault and this intrusion has caused the skarnization related to magnetite, chalcopyrite and galena mineralization in the central and western part of the Dong Noi area. Actually the drill hole MJTM-3 encountered a granite body at 123 meters depth to the bottom. The high salinity ore fluid may have been further brought and/or passed from the skarnized rocks to out side haloes, where sulfide minerals such as galena-sphalerite deposited in the brecciated or schistosed texture of dolomite. While the western dolomitized limestone may have also been suffered by sphalerite-galena mineralization, but the grade of the mineralization may have been weak and only have formed a high Zn-Pb geochemical anomaly zone.

The northwestern limestone has undergone by the strong dolomitization but no skarnization, and overlaps with a high geochemical anomaly. Therefore the possibility of the existence of a massive ore deposit depends on the occurrence of porous and fractured host rocks. Further survey needs to make clear the characteristic of the limestone and fracture pattern in the northwestern limestone area.

Another mineralization as a gossan zone was confirmed on the ridge in the southern part of the Dong Noi area for the first time by this phase detailed geologic survey, and the geochemical soil sampling and the IP geophysical survey was carried out on this gossan zone. The gossan channel samples contain ranging from 600 to 800 ppm Cu. The result of the geochemical survey shows a rather high copper content more than 100 ppm, and a weak gold anomaly ranging from 30 to 40 ppb on the gossan zone, and that anomaly does not have a halo. Other elements anomalies are not detected in the area. The IP geophysical survey is detected a low resistivity and high

chargeability anomaly deeper than 800 meters above sea level. It is inferred that a mineralized zone might continue to the zone underneath the gossan zone, because gossan zone is commonly formed at the extremity of ore solution pass from an ore deposit. The result of the geochemical survey and the IP survey may lead the occurrence of the vein-type or stockwork-type ore deposit under the gossan zone, that is a unique mineralization in the Dong Noi area.

Chapter 2 Mae Kanai Area

2-1 Outline of Geology

The Mae Kanai area is widely underlain by the Pareozoic rocks. Triassic granite is distributed in the western part of the area as a large-scale batholith.

The Pareozoic rocks are mainly the Ordovician shale and sandstone, and limestone. The Silurian-Devonian sandstone occurs in the northern part and southern part of the area. It is in east-west trending fault contact with the Ordovician formation.

Shale and sandstone are predominant in the Ordovician sedimentary rocks at the surface, but in the central part of the area there is a large basin typically formed in the large limestone body. It is inferred that the central part mainly consists of the Ordovician limestone, though at the surface the distribution of outcrops and floats are very confined.

The basin is elongated to the north-south direction. It seems that the basin was formed by the dissolution of the limestone body influenced by a shear zone of the north striking fault.

Many large gossan zones with several hundreds meters in diameter occur in places in the Ordovician sedimentary rocks.

Fig.II-2-1-1 and Fig. II-2-1-2 show a geologic map and profiles of the Mae Kanai area.

2-2 Detail Description of Geology

2-2-1 Sedimentary rocks

1. Ordovician sedimentary rocks (Ol, Os)

The Ordovician sedimentary rocks are composed of two limestone units and interbedded shale and sandstone unit.

The upper limestone unit generally contains a large amount of argillaceous thin layers and schlierens. The limestone in the western and southern parts of the area is crystalline and irregularly replaced by white massive dolomite. The dolomite rarely contains a disseminated galena. The lower limestone unit has been widely metamorphosed to calc-silicate rocks composed of amphibole, hedenburgite and garnet. They are locally accompanied by a dissemination of magnetite or galena.

The shale and sandstone unit is widespread in the survey area centering the basin. Phyllitic black shale is dominant around Ban Sam Luang, whereas gray to white psammitic hornfels is

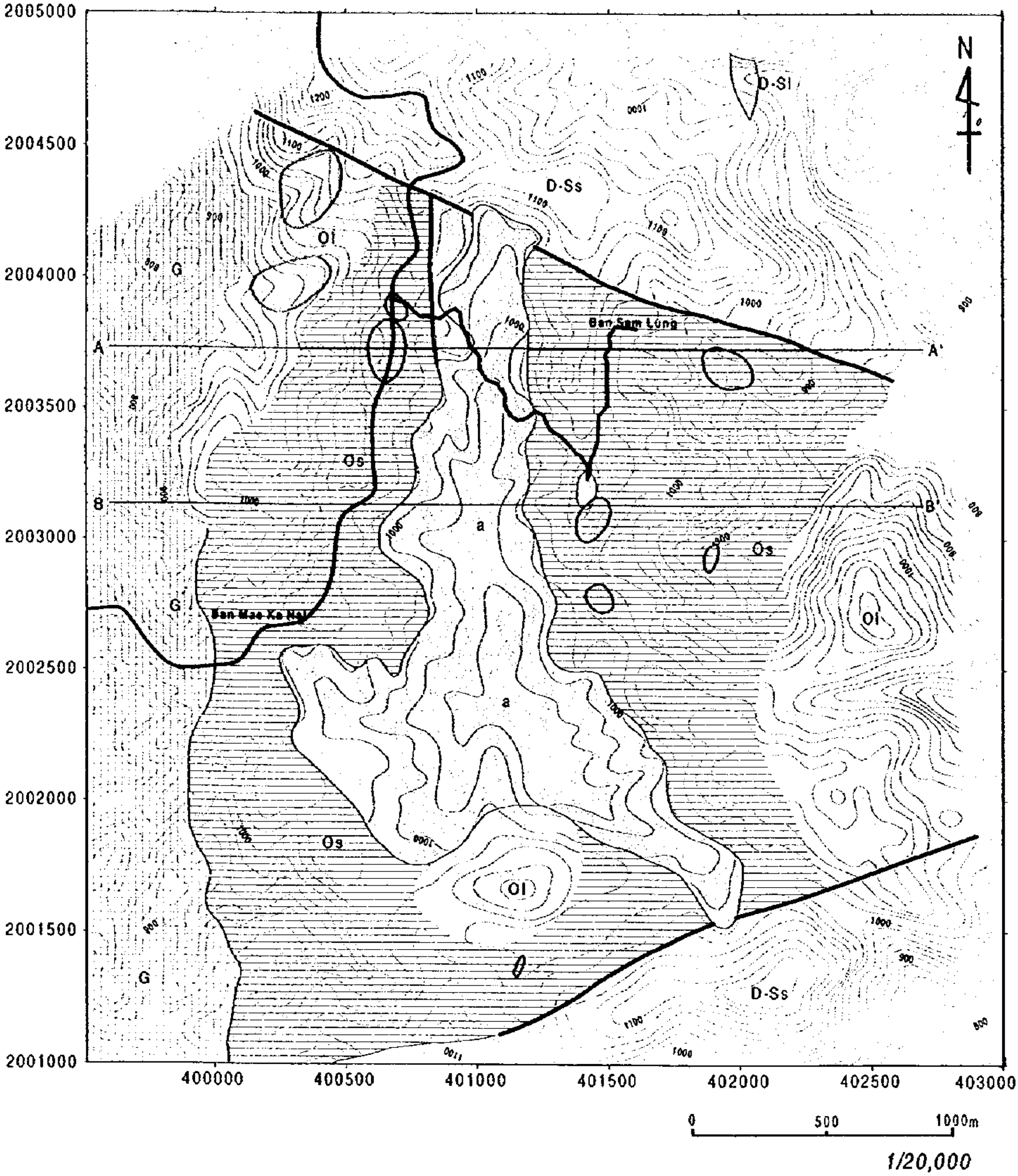


Fig. II-2-1-1 Geologic map of the Mae Kanai Area

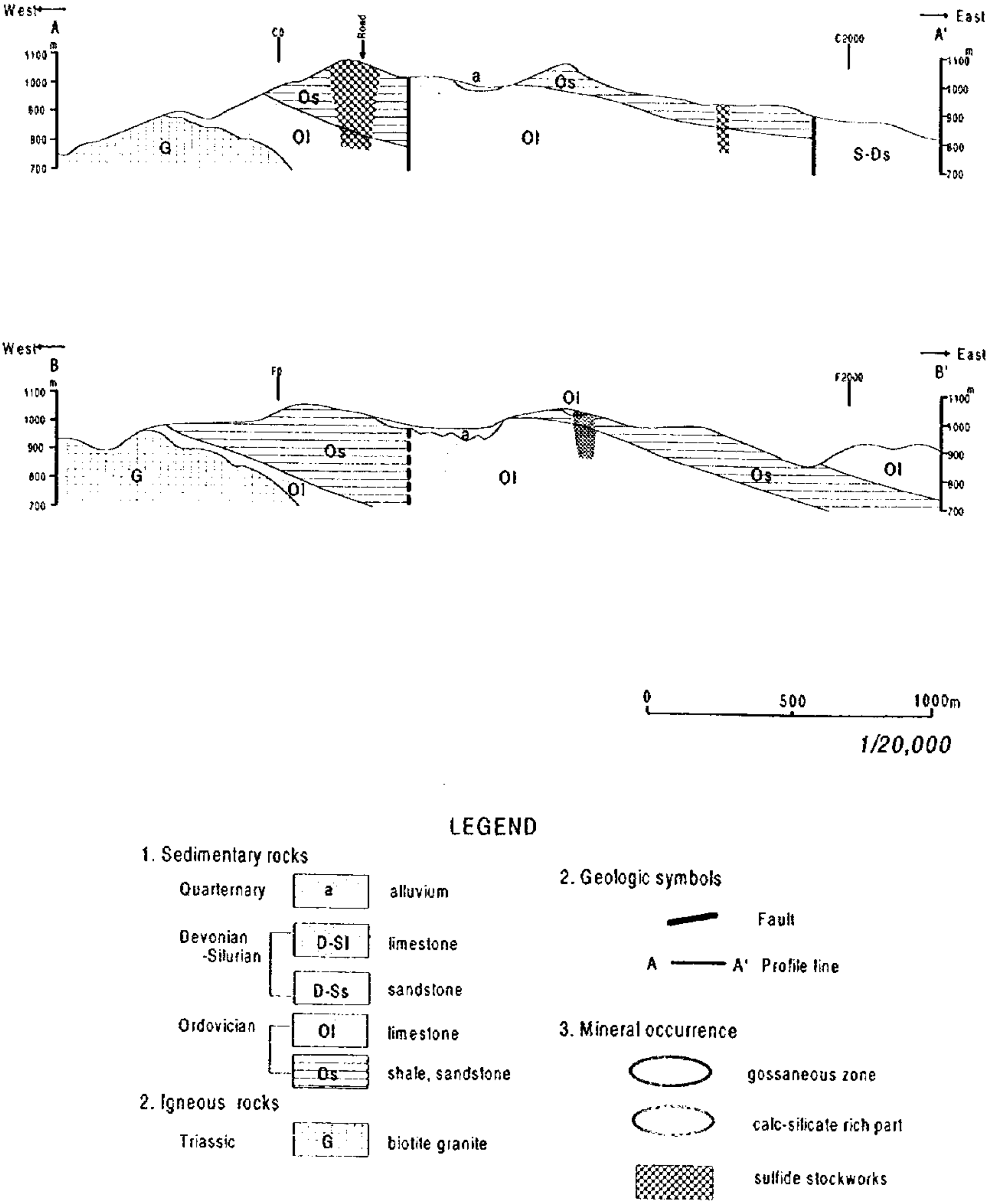


Fig. II-2-1-2 Geologic profile of the Mae Kanai Area

dominant near Ban Mae Kanai.

Gossan zones occur in the shale and sandstone unit in many places. They are surrounded by white strongly silicified shale and sandstone. The silicified rocks are generally brecciated, and the matrix of the breccia is filled by secondary oxidized iron and manganese minerals.

2. Silurian-Devonian sedimentary rocks (D-Ss, D-Sl)

The Silurian-Devonian sedimentary rocks are distributed in the northern part and southern part of the area. It is in east striking fault contact with the Ordovician rock.

The rocks consist of sliliceous sandstone, with small-scale limestone lenses. Black shale is dominant at the lower part of the rocks as observed on the bank of the Huai Mae Ho.

2-2-2 Granitic rocks (G)

Triassic porphyritic biotite granite widely exposes in the western part of the area. The granite is characterized by a large amount of euhedral phenocrysts of potassium feldspar, and contains biotite and a small amount of hornblende. Though the granite facies normally uniform, an aplitic fine-grained biotite granite inferred as marginal facies of the porphyritic granite is distributed near the boundary between the biotite granite and sedimentary rocks.

2-3 Geological Structure

The Pareozoic is cut by two east-west striking faults at the southern part and northern part of the area. The Ordovician sedimentary rocks are separated from the Silurian-Devonian rocks by these faults.

The result of this year's geophysical program is assumed that several north-south striking faults are consistent with the direction of the basin in the central part of the area. But the details of its structure have not been clear at the surface because unconsolidated material widely covers on the basin.

It is inferred that the Ordovician formation gently dips east as a whole, judging from the relation of the limestone units and the shale and sandstone unit.

2-4 Mineral Occurrences

Fig. II-2-4-1 shows the location of mineral occurrences in the Mae Kanai area.

2-4-1 Gossan zone

More than seven gossan zones with usually several hundreds meters in diameter occur on the Ordovician shale and sandstone unit. These zones are composed of a large amount of boulder and sub-crop of massive limonite and hematite. Generally only oxide and hydroxide iron minerals are identified by X-ray diffraction examination and under the microscope. They are generally surrounded by silicified and brecciated shale and sandstone, and the matrix of breccia is filled by limonite and hematite.

The gossan zone in the southeast of Ban Sam Lung shows a rather high concentration of zinc. There is an outcrop as a waterfall in a small stream, and the dimension is about 7 meters wide

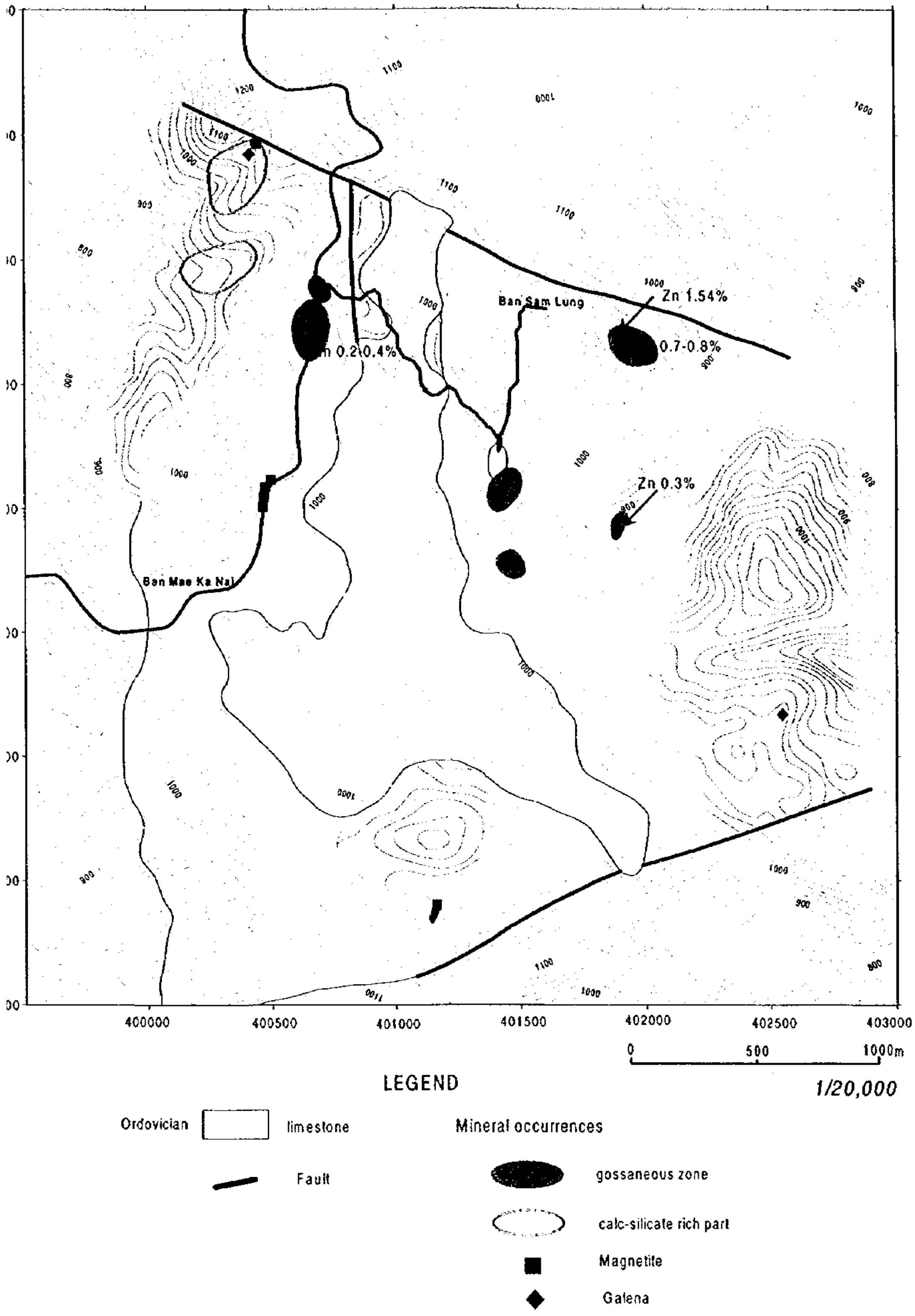


Fig. II-2-4-1 Mineral occurrences of the Mae Kanai Area and 7 meters high. It is composed of massive limonite and hematite. Two channel samples on this outcrop (MMR-27, MMR-28) contain 0.7 to 0.8 % Zn. Also MMR-26 of 5 meters channel interval on the boulder near Ban Sam Lung contains 1.54 % Zn.

The samples collected in another zone 1.5 km south of Ban Sam Lung contains 0.3% Zn (MMR-30, MMR-31).

MMR-19 obtained from the southern most gossan zone is identified Woodruffite $[(Zn,Mn)_2Mn^{4+}{}_5O_{12}\cdot 4H_2O]$ by X-ray diffraction examination. It means that some portion of zinc in gossan is contained into the secondary manganese mineral.

2-4-2 Magnetite-quartz vein

Many floats of magnetite-quartz veins are scattered on the road near the Ban Mac Kanai, extending north-south direction about 200 meters. These veins are only composed of quartz, magnetite and secondary iron minerals under the microscope (MKR-15).

2-4-3 Other occurrences

A small amount of galena dissemination rarely occurs in the dolomite (NR-19).

Calc-silicate rocks of the lower limestone unit are locally accompanied with a dissemination of magnetite or galena near the boundary between granite and sedimentary rocks in the northwestern part of the area.

2-5 Geochemical Survey

2-5-1 Ordinary soil geochemistry

1. Sampling

Samples are taken at spacing of 50 m by using geophysical survey traverse lines. The intervals between traverse lines are 200 m or 250 m. At the central area and the area near Ban Sam Lung, the density of sampling was increased to 50 × 50 m because of the occurrences of the silicified breccia or gossan zone. The number of the soil samples is 510.

2. Statistical analysis

The common logarithm of each analysis is used for analysis. As for an analysis value lower than a detection limit value in the statistical processing, a half of that value was adopted. Also, as for an analysis value higher than a maximum detection limit value, a limit value was adopted.

Table II-2-5-1 shows statistic quantities of each element.

The histogram and the probability plot of each element show in Fig. II 2-5-2(1)-(4). The class interval of the histogram is 1/2 σ .

Table II-2-5-2 shows correlation coefficients matrix of element. The principal component analysis is made on this matrix. Table II-2-5-3 shows the eigenvalues and main three factor loadings. On the basis of the principal component analysis, the elements are divided into two groups. One is Ag-As-Ba-Fe-(Hg)-Mn-Pb-Sb-Zn, and there is a strong correlation each other. The other is Ba-Cd-Mg. It means that the variations of most pathfinder elements are integrated to the Z-01 factor of the principal component analysis.

Table II-2-5-1 Geochemical basic statistic quantities of soil samples in the Mae Kanai Area

Element	Unit	Lower Detection Limit	Maximum Value	Minimum Value	Average	Standard Deviation (Log)
Au	ppb	5	30	<5	3.10	0.2195
Ag	ppm	0.2	2	<0.2	0.12	0.1956
As	ppm	2	840	6	68.44	0.3102
Ba	ppm	10	4,940	30	218.01	0.4332
Cd	ppm	0.5	3	<0.5	0.28	0.1610
Cu	ppm	1	2,390	7	51.69	0.3719
Fe	%	0.01	15	0.66	4.84	0.2362
Hg	ppb	10	8,130	<10	44.79	0.3630
Mg	%	0.01	4	0.02	0.09	0.2842
Mn	ppm	5	>10,000	15	1,427.96	0.5025
Pb	ppm	2	2,250	18	122.66	0.4888
Sb	ppm	2	730	<2	3.61	0.6276
Zn	ppm	2	1,350	6	84.24	0.4312

Table II-2-5-2 Correlation Coefficient of soil samples in the Mae Kanai Area

	Au	Ag	As	Ba	Cd	Cu	Fe	Hg	Mg	Mn	Pb	Sb	Zn
Au	1.0000												
Ag	0.0530	1.0000											
As	-0.0130	0.3030	1.0000										
Ba	0.0800	0.2910	-0.0280	1.0000									
Cd	-0.0250	0.4060	0.1200	0.3410	1.0000								
Cu	0.1750	0.4860	0.4570	0.1160	0.1700	1.0000							
Fe	0.1240	0.3040	**0.5680**	-0.1800	0.1490	**0.6270**	1.0000						
Hg	-0.1340	0.2990	0.3540	0.0110	0.1460	0.2940	0.2850	1.0000					
Mg	-0.0890	0.3560	0.0000	0.3780	**0.5670**	0.0960	0.0500	0.0990	1.0000				
Mn	-0.0180	0.3420	0.4090	0.0700	0.2830	**0.5030**	**0.6730**	0.3200	0.2840	1.0000			
Pb	-0.0650	**0.5110**	**0.6100**	0.0890	0.1830	**0.5810**	**0.5370**	0.4830	0.2060	**0.6050**	1.0000		
Sb	-0.1370	0.4170	0.4980	-0.0510	0.1010	0.4270	0.4350	**0.5280**	0.1260	0.4510	**0.7520**	1.0000	
Zn	-0.0870	0.3800	**0.5190**	0.1370	0.3930	0.4510	**0.6100**	0.3110	0.3920	0.7100	**0.6470**	0.4310	1.0000

Table II-2-5-3 Result of the principal component analysis of soil samples in the Mae Kanai Area

Component	Eigenvalue	Percent	Cumulative
Z-01	5.10	39.24	39.24
Z-02	1.95	14.99	54.23
Z-03	1.27	9.75	63.98
Z-04	1.01	7.75	71.73
Z-05	0.67	5.14	76.86
Z-06	0.60	4.62	81.48
Z-07	0.57	4.39	85.87
Z-08	0.51	3.94	89.81
Z-09	0.37	2.82	92.62
Z-10	0.35	2.72	95.34
Z-11	0.24	1.85	97.19
Z-12	0.22	1.68	98.87
Z-13	0.15	1.13	100.00

Factor Loading	Z-01	Z-02	Z-03
Au	-0.0248	-0.0165	-0.8555
Ag	0.6340	0.3243	-0.0769
As	0.6904	-0.3098	-0.0131
Ba	0.1460	0.7067	-0.1287
Cd	0.4095	0.6829	0.0081
Cu	0.7162	-0.1232	-0.3654
Fe	0.7463	-0.3324	-0.2905
Hg	0.5503	-0.1385	0.3975
Mg	0.3617	0.7407	0.1306
Mn	0.7779	-0.0182	-0.0859
Pb	0.8609	-0.1380	0.1218
Sb	0.7220	-0.2134	0.3119
Zn	0.8137	0.0963	0.0016

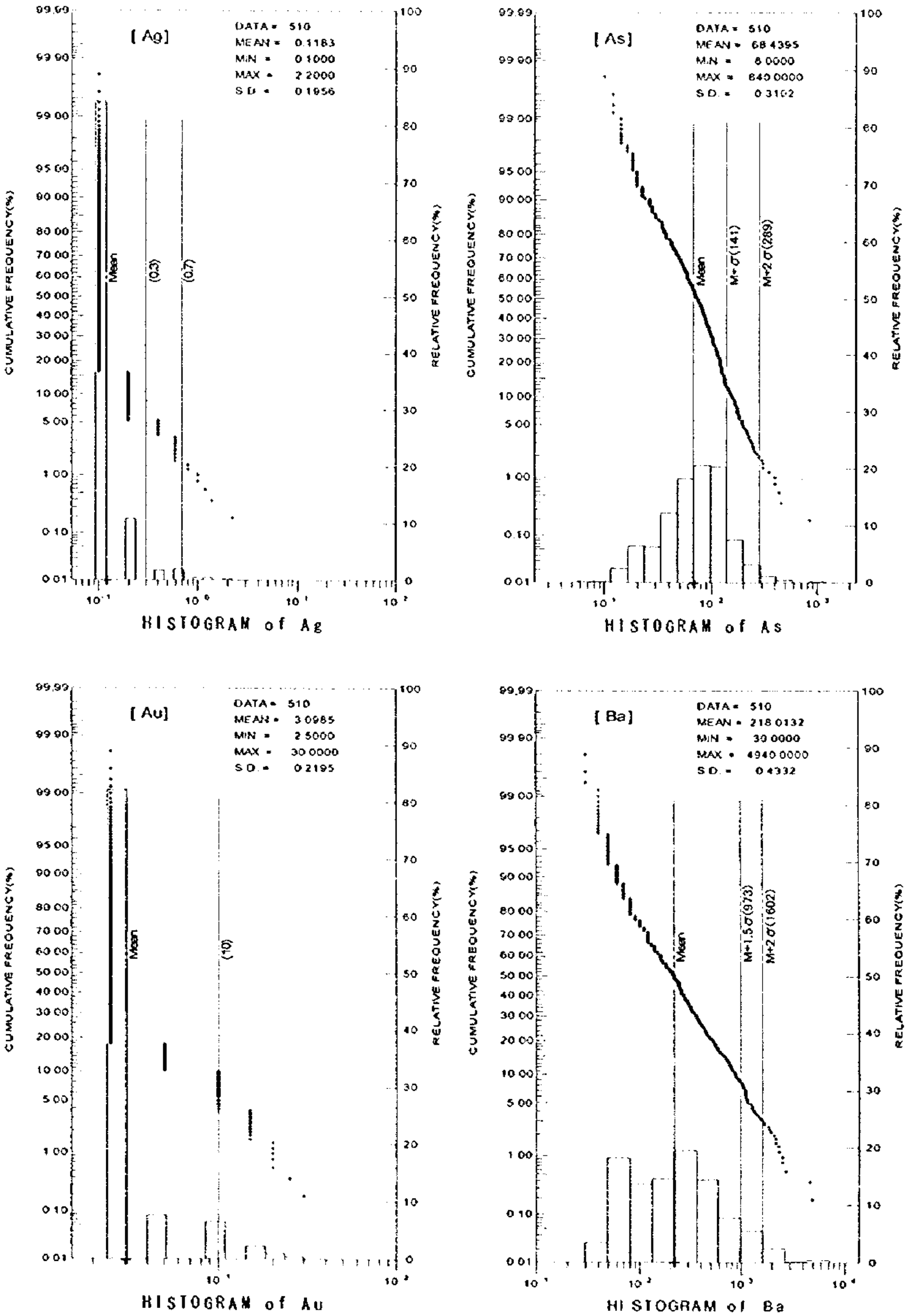


Fig. II-2-5-1 Probability plot of the soil samples in the Mae Kanai Area (1)

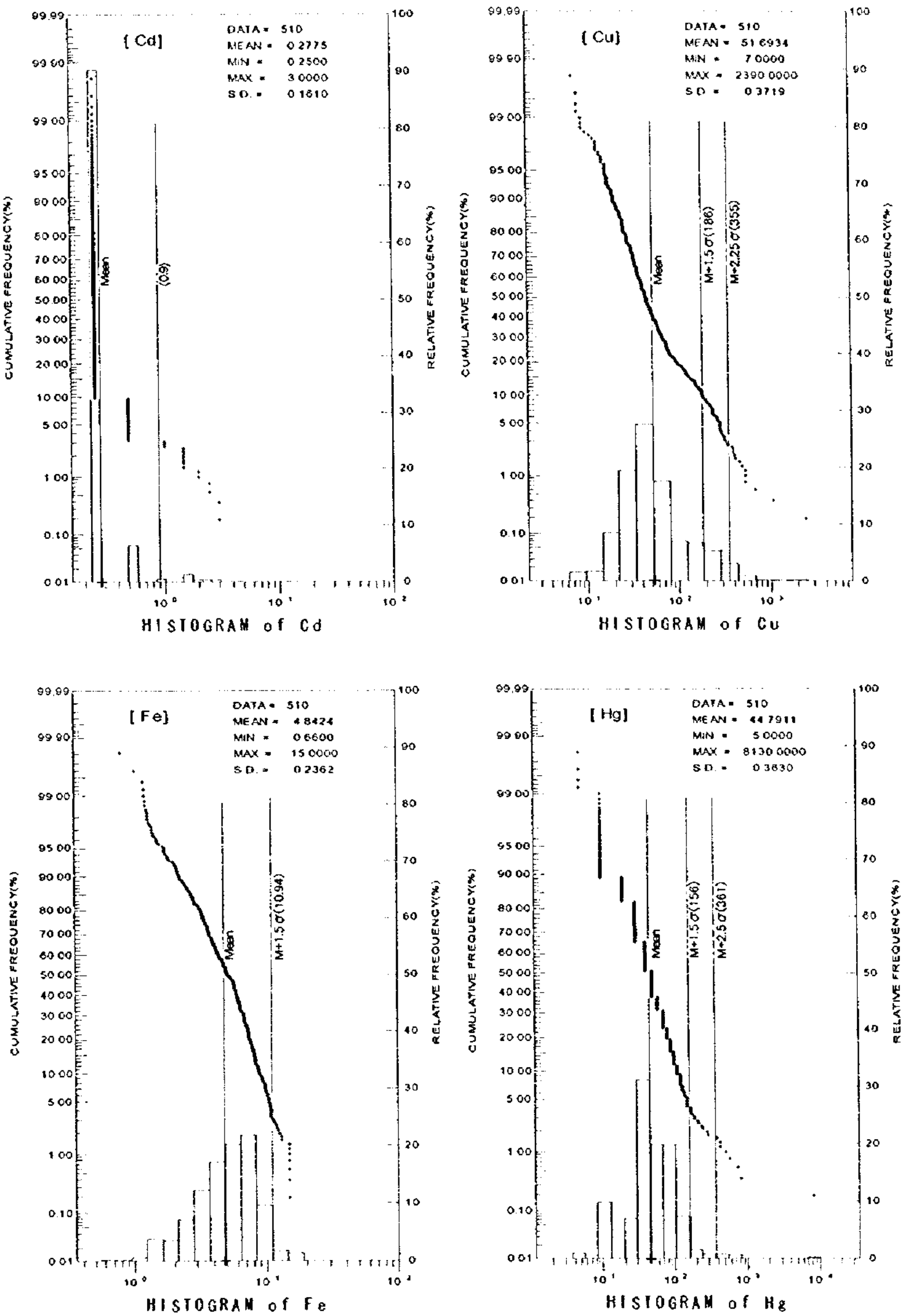


Fig. II-2-5-1 Probability plot of the soil samples in the Mae Kanai Area (2)

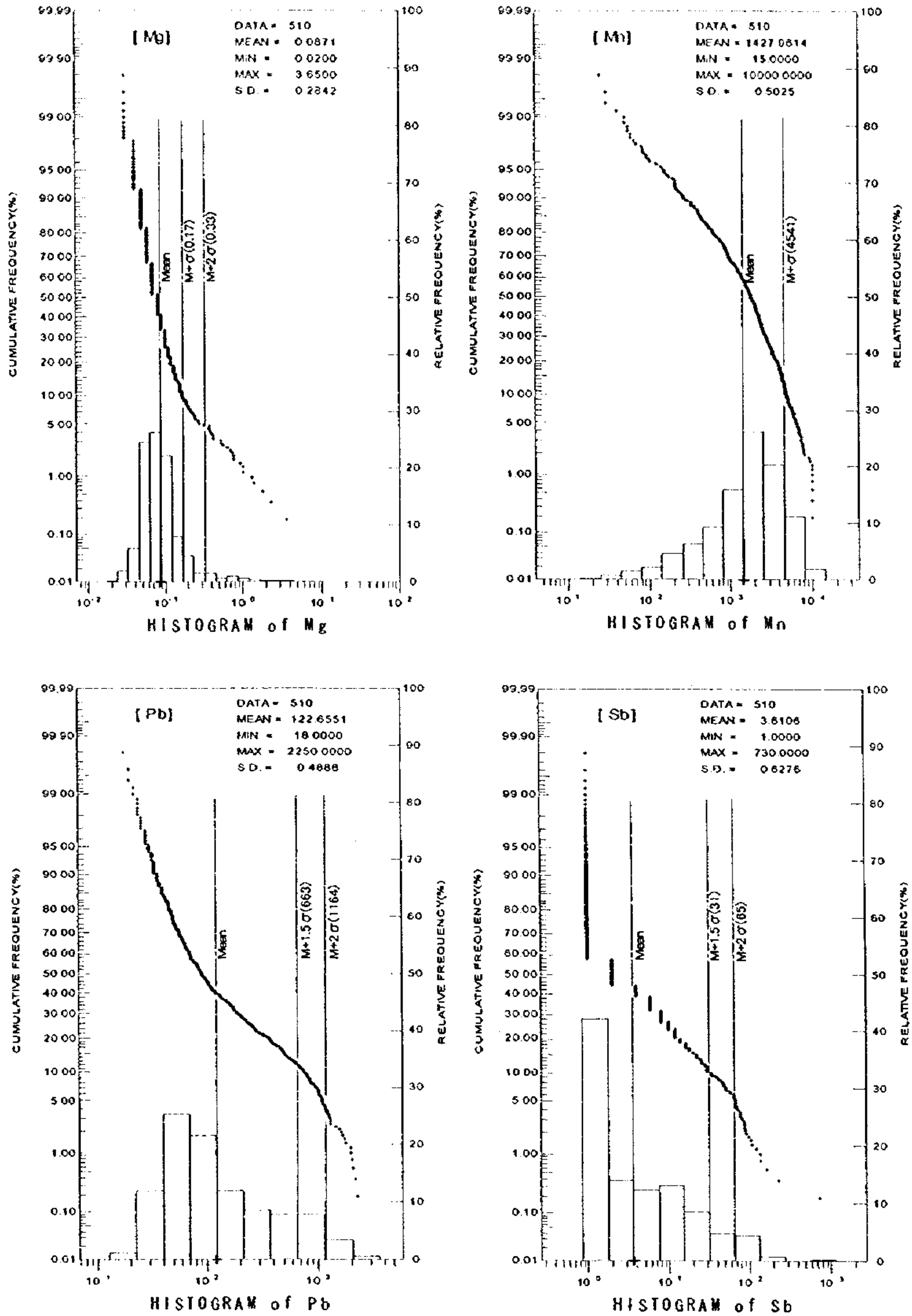


Fig. II-2-5-1 Probability plot of the soil samples in the Mae Kanai Area (3)

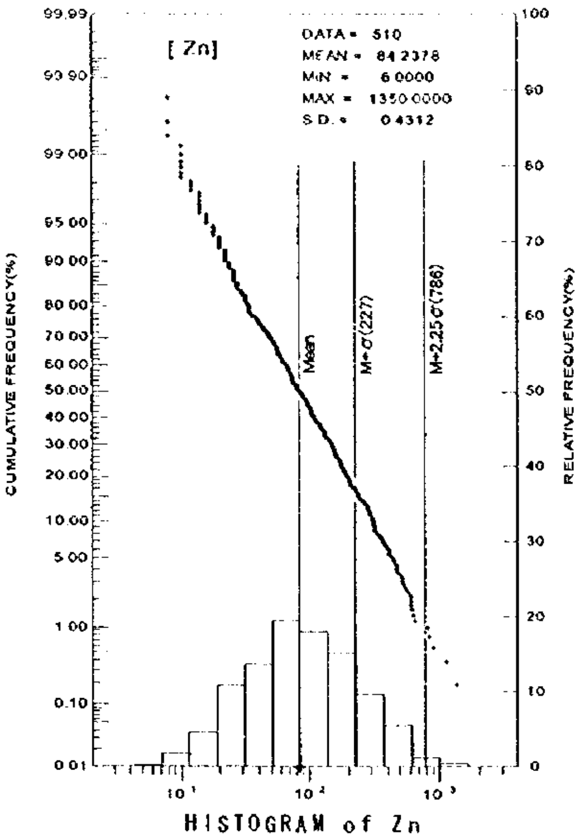


Fig. II-2-5-1 Probability plot of the soil samples in the Mae Kanai Area (4)