1-7 Drilling Survey

1-7-1 Outline of the Diamond Drilling

(1) Purpose of the Diamond Drilling

As a result of geological and geochemical surveys carried out in the initial phase of the project, a porphyry copper type ore deposit was found to be expected as a promising target for future exploration in the Hasandere area. In the second phase, a drilling survey consisting of three holes (total hole length 900m) was planned and successivly carried out in order to explore underground emplacement of the porphyry-copper type ore deposit, and to investigate and unravel the relationship between the emplacement conditions of the ore deposit and the results of geological and geochemical surveys.

The Purpose of these cores are as follows ;

MJT-1 : exploration of copper and molybdenum mineralized area discovered on the surface

MJT-2 : exploration of copper and molybdenum mineralized area and copper anomalous area as found by soil geochemical survey on the surface.

MJT-3 : exploration on molybdenum anomalous area found by soil geoch emical survey

(2) Outline of Drilling Operation

① Location of drill holes

	Y	X	Z [m sea level]
MJT-1	42705.50	01097.63	1,518.1
MJT-2	42762.04	01708.32	1,437.6
MJT-3	43444.09	01825.46	1,635.1

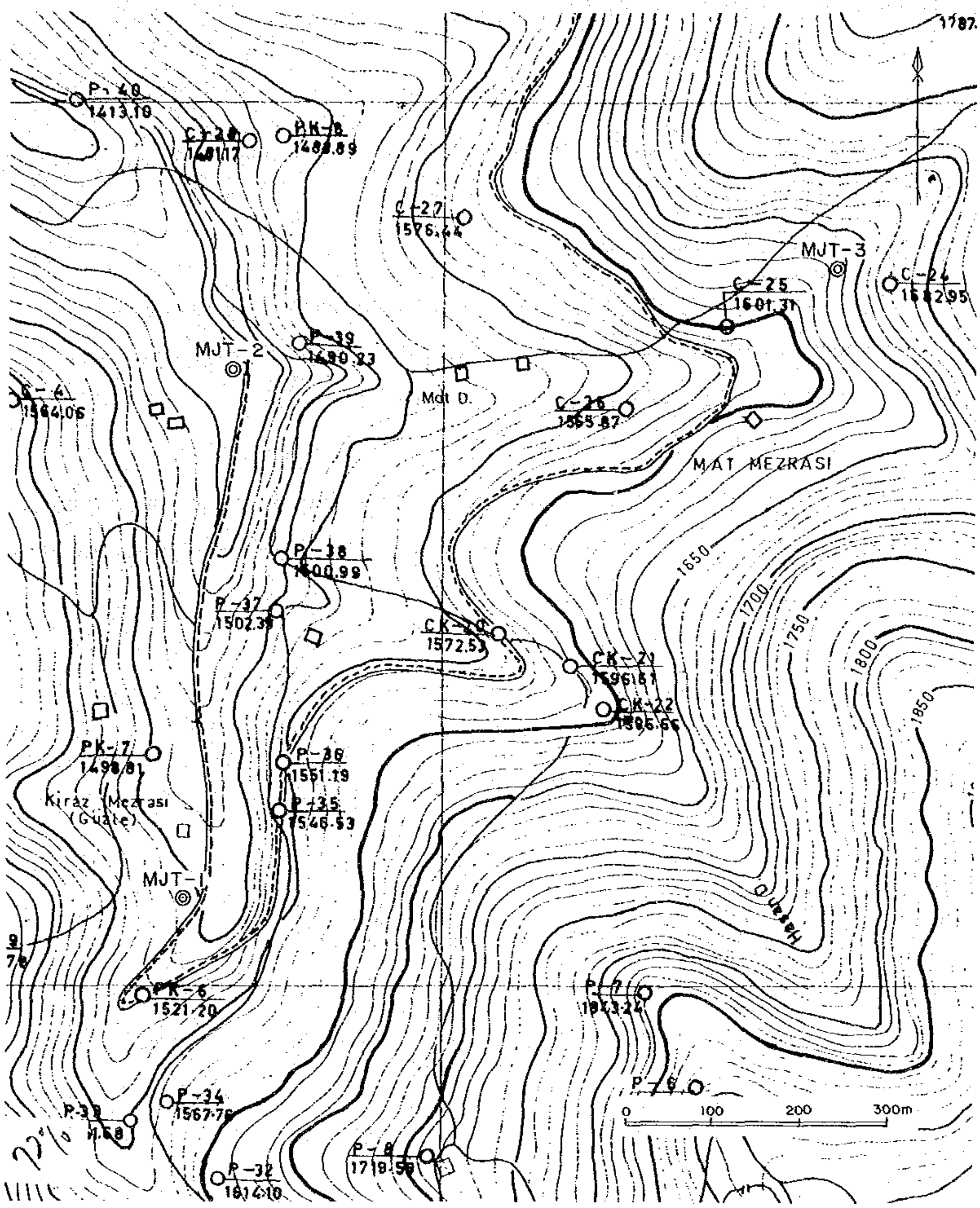


Fig.48 Location Map of Drilling Holes in the Hasandere Area

② Drilling operation method

Wire line drilling method using NQ type diamond bit as far as possible was applied. Drill inclination is vertical.

③ Core survey

A geological columnar section 1/200 in scale was complied, and colour photographs of all drilling cores collected was taken.

④ Chemical assay of drilling cores

Whole cores collected were split along the core extention, and half pieces of the split core were chemically assayed to detect molybdenum and copper content for the enter section, while selected samples were analysed for gold, tungsten, and tin content.

⑤ Laboratory works of the core

Microscope observations of rock thin sections and ore polished specimens,measurement of homogenization temperature and salinity of fluid inclusions, and detection of altered minerals by X-ray diffraction meter were performed.

(3) Drilling holes performed

Drilling Holes Performed

Drilling No.	Drill length planned	Drill length performed	Dip	Surface soil	Core length	Core recovery	Period
MJT-1	300m	301.00m	-90°	9.90m	290.40m	96%	Sep.12 - Oct 1
MJI-2	300m	301.00m	-90°	9.50m	276.40m	91%	Sep.12 - Oct. 8
MJT-3	300m	401.00m	-90°	0.00m	398.85m	99%	Oct.8 - Oct.30
Total	900m	1,003.00m		19.40m	965.65m	96%	

1-7-2 Drilling Operation

(1) Drilling Method

The drilling operation was performed by means of wire line method using a diamond drilling bit of NQ size [75m/m diameter] not only at MJT-1 and MJT-2 sitescovered by surface soil but also at the MJT-3 site which had exposed bed rock atthe surface.

Bentonite mud water was circulated during the drilling operation, and cutting oil [lubricant] was suitably added in the circulating mud water in order to reduce torque resistance caused by collapse in the hole.

Geology of the Hasandere area consists of andesite,porphyritic granite and quartz porphyry. At the predominantly alterated sections of rocks in the hole, the rocks are soft and brittle and have many well-developed cracks and fissuresoften cause loss of circulating mud water and much flash water through fissures meanwhile, strong silicified rock is very hard to drill.

(2) Drilling Machine, Equipment and Consumables

Longyear L-38 was used for the drilling operation. Types and specifications of the machine, engine, pump and equipments, and amount of comsumables are shown in Table 13 and 14.

(3) Operation Members and Shifts

The operation of move-in and move-out from site to site, and preparation work in the site were performed by a shift per day system, while the actual drilling operation was carried out by three shifts per day with eight working hours per shift. One drilling shift consists of six members, a Japanese drilling engineer, a Turkish assistant driller [MTA] and four Turkish workers.

(4) Transportation

The drilling machines, equipment and consumables were transported from the East Black Sea Regional Office of MTA located in Trabzon, to a place near these drilling sites by a large truck, and then to the drilling sites by a small truck. As there was no access road to MJT-3, a new of 3 km road was constructed by bulldozer.

(5) Water Supply

The water necessary for the drilling operation was run through a polyethirene pipe line from neighbouring river.

(6) Withdrawal

After completion of the second phase drilling survey, the drilling machines and equipment were stored in the storehouse of the MTA Office in Trabzon.

1-7-3 Results of the Diamond Drilling

(1) MJT-1

The hole reached bed rock [andesite] at 9.90m after cutting through surface soil by NQ size diamond bit,circulating dense bentonite mud water. After reaming by the NX casing shoe bit, NX casing pipes were inserted at 11.00m

Below 11m, NQ wire line method, bentonite mud water and cutting oil were used for the operation. The major rock was andesite,accompanied by several narrow intrusions, namely dikes of quartz porphyry and porphyritic granite. The rocks have undergone strong sericitization from surface to 200 m, and collapse of the wall causing loss of water circulation, partly occurred. However, below 200m, the rock was silicified andesite, gradually become more strongly silicified and

Table13 List of Specification and Drilling Meterage of Diamond Bits (1)

Drilling Machine Model "L - 38 "	2 set
Specifications :	
Capacity	700 m (BQ - WL)
Dimensions L × W × H	2,150mm × 1,170mm × 1,450mm
Hoisting capacity	4,500 kg
Spindle speed	Forward 236,490,900,1,510 rpm
Engine Model "F4L912 "	18 ps / 1,800 rpm
Drilling Pump Model "535RQ "	2 set
Specifications :	
Piston diameter	70 mm
Stroke	70 mm
Capacity	Discharge capacity 132 ℓ/min
	Max pressure 56 kg/cm²
Dimensions L × W × H	1,905mm × 788mm × 940mm
Engine Model "WISCON "	18ps / 2,000 rpm
Wire line hoist	Attached to drilling machine
Derick	Attached to drilling machine
Drilling tools	
Drilling rod	NQ - WL 3 m 234 pcs.
Casing pipe	HX 1.5 m 4 pcs.
	NX 1.5 m 1 pc.
	NX 3 m 21 pcs.

Table13 List of Specification and Drilling Meterage of Diamond Bits (2)

Item	Size	Bit No.	Drilling Meterage by Unit			Total (m)
			MJT-1	MJT-2	MJT-3	
Diamond bit	NQ	A-6973		11.95		11.95
		A-6978		14.20		14.20
		A-6979			15.70	15.70
		A-6985			21.45	21.45
		A-6991			29.10	29.10
		A-6996			33.15	33.15
		A-6999	14.20			14.20
		NN- 1	57.30		57.30	
		NN- 2	38.35		38.35	
		NN- 3	44.80		44.80	
		NN- 4		34.55		34.55
		NN- 5			47.25	47.25
		NN- 6			38.05	38.05
		NN- 7	49.55			49.55
		NN- 8		46.10		46.10
		NN- 9	58.55			58.55
		NN-10			42.65	42.65
		NN-11		17.60		17.60
		NN-12		36.15		36.15
		NN-13	76.00			76.00
		NN-14	56.40			56.40
		NN-15	46.30			46.30
		S-6208			24.40	24.40
		S-6218			48.80	48.80
		S-6243			27.35	27.35
		S-6290			18.25	18.25
		S-6293			33.00	33.00
		S-6322			21.85	21.85
		Total	301.00	301.00	401.00	1,003.00
Grand Total		Drilling length/bit (1,003.00/28)				35.82

Table14 List of Consumables Used

Discription	Specifications	Unit	Quantity			
			MJT-1	MJT-2	MJT-3	Total
Light oil		ℓ	2,810	3,860	4,510	11,180
Petrol		ℓ	750	900	900	2,550
Engine oil		ℓ	60	80	160	300
Hydraulic oil		ℓ	40	60	80	180
Grease		Kg	30	30	40	100
Cement		Kg	1,750	1,750	1,750	5,250
Bentonite		Kg	6,850	5,750	6,825	19,425
C.M.C		Kg	70	60	80	210
Cutting oil		ℓ	50	80	240	370
Diamond bit	NQ	pcs	6	9	13	28
Diamond reamer	BQ	pcs	3	5	7	15
Casing diamond shoe	NX	pcs	1	4		5
Casing metal shoe	HX	pcs		2		2
Core barrel Ass'y	NQ-WL	set	1	1	1	3
Inner tube	NQ-WL	pcs	1	1	1	3
Core lifter case	NQ-WL	pcs	8	12	12	32
Core lifter	NQ-WL	pcs	16	22	24	62
Thrust ball bearing	NQ-WL	pcs	4	6	6	16
Chack piece	NQ-WL	set	1		1	2
Cylinder liner	535-RQ	pcs	3		3	6
Valve seat	535-RQ	pcs	6	6	6	18
Steel ball	535-RQ	pcs	12	12	12	36
Piston rubber	535-RQ	pcs	6	6	9	21
Core box	NQ	pcs	55	53	78	186

Table15 Working Time Table of the Drilling Operation

Hole-No	Drilling			Shift		Working man		Working Time							
	Bit size	Drilling	Core length	Drilling	Total	Engineer	Worker	Drilling working	Other ring	Recove	Total	Removing	Water trasportation	Road construction and others	G.Total
		m	m	shift	shift	man	man	h	h	h	h	h	h	h	
MJT-1	NQ	301.00	290.40	50	60	90	372	246° 00	148° 00	-	394° 00	80° 00	-	8° 00	482° 00
MJT-2	NQ	301.00	276.40	52	73	108	422	280° 00	190° 00	64° 00	534° 00	80° 00	-	8° 00	622° 00
MJT-3	NQ	401.00	398.85	73	90	115	560	415° 00	165° 00	-	580° 00	80° 00	-	56° 00	716° 00
Total		1,003.00	965.65	175	223	313	1,354	941° 00	503° 00	64° 00	1,508° 00	240° 00	-	72° 00	1,820° 00

Table16 Record of the Drilling Operation of MJT-1

	Drilling length			Total		Shift		Working man	
	Shift.1	Shift.2	Shift.3	Drilling	Core lngth	Drilling	Total	Engineer	Worker
	m	m	m	m	m	shift	shift	man	man
September									
4	Road-con								
5	Pds								
6	Pds								
7	Tra-Ress						4	12	25
8-11	Tra-Ress								
12	2.00			2.00	-				
13	2.90	3.00		5.9	3.40				
14	6.30	3.90		10.20	4.10	5	9	21	62
15	6.45	6.55		13.00	13.00				
16	6.60	5.60		12.20	12.20				
17	6.55	5.80		12.35	12.35				
18	4.95	6.55		11.50	11.50				
19	5.15	6.65	6.05	17.85	17.85				
20	5.70	5.40	6.65	17.75	17.75				
21	5.60	5.85	5.90	17.30	17.35	17	17	21	105
22	6.55	7.15	7.20	20.90	20.90				
23	4.65	5.35	8.70	18.70	18.70				
24	6.60	7.25	7.40	21.25	21.25				
25	6.70	6.05	4.55	17.30	17.30				
26	5.65	5.05	6.10	16.80	16.80				
27	6.10	6.10	6.10	18.30	18.30				
28	5.50	6.20	6.10	17.80	17.80	21	21	21	105
29	6.60	7.20	8.05	21.85	21.85				
30	6.10	6.10	9.15	21.35	21.35				
October									
1	6.65			6.65	6.65				
2	Dismant								
3	Dismant					7	9	15	75
Total	113.30	105.75	81.95	301.00	290.40	50	60	90	372

Abbreviation

Road-con ; Road construction
Pds ; Preparation for drilling site
Transpor ; Transportation
Tra-Ress ; Transportation and Reassemblage
Dismant ; Dismantlement
Recoveri ; Recovering work
Ins-C.P ; Inserting casing pipe
Out-C.P ; Taking out casing pipe

Table17 Record of the Drilling Operation of MJT-2

	Drilling length			Total		Shift		Working man	
	Shift.1	Shift.2	Shift.3	Drilling	Core length	Drilling	Total	Engineer	Worker
September	m	m	m	m	m	shift	shift	man	man
4	Road-con								
5	Pds.								
6	Pds.								
7	Tra-Ress						4	12	24
8-11	Tra-Ress								
12	6.00			6.00	-				
13	3.35	2.60		5.95	2.25				
14	6.10	8.10		14.20	11.10	5	9	21	60
15	1.75	4.35		6.10	6.10				
16	9.15	15.25		24.40	22.10				
17	7.85	Out-C.P		7.85	7.85				
18	Reaming								
19	Reaming								
20	Ins-C.P	10.45	13.25	23.70	22.15				
21	6.85	5.70	7.05	19.60	17.25	10	14	21	84
22	1.50	8.35	2.15	12.00	9.40				
23	Day off	0.90	1.80	2.70	1.30				
24	Reacoveri	Reacoveri	Reacoveri						
25	0.65	0.30		0.95	0.95				
26	1.05			1.05	1.05				
27	Recoveri	Recoveri	Recoveri						
28	2.40			2.40	0.80	9	15	18	84
29	6.40	6.85	8.00	21.25	21.25				
30	7.85	7.40	6.10	21.35	21.35				
Othober									
1	6.10	6.10	5.65	17.85	17.85				
2	6.10	6.55	6.10	18.75	18.75				
3	6.10	6.10	6.10	18.30	18.30				
4	6.10	6.10	6.10	18.30	18.30				
5	6.65	5.55	6.10	18.30	18.30	21	21	21	105
6	6.10	6.10	6.10	18.30	18.30				
7	6.10	6.10	5.70	17.90	17.90				
8	3.80	Out-C.P		3.80	3.80				
9	Dismant								
10	Dismant					7	10	15	65
Total	107.95	112.85	80.20	301.00	276.40	52	73	108	422

Table18 Record of the Drilling Operation of MJT-3

	Drilling length			Total		Shift		Working man	
	Shift.1	Shift.2	Shift.3	Drilling	Core length	Drilling	Total	Engineer	Worker
	m	m	m	m	m	shift	shift	man	man
September									
22-27	Road-con								
28	Pds						7	10	63
29	Pds								
30	Tra-Ress								
October									
1-5	Tra-Ress						7	21	77
6	1.25			1.25	1.00				
7	3.40	6.10	5.50	15.00	14.30				
8	6.50	5.60	4.70	16.80	15.60				
9	4.10	5.15	5.35	14.60	14.60				
10	5.80	4.80	5.75	16.35	16.35				
11	5.10	5.50	5.20	15.80	15.80				
12	4.70	4.35	5.80	14.85	14.85	19	19	21	105
13	6.95	5.65	5.90	18.50	18.50				
14	8.55	8.00	6.10	22.65	22.65				
15	6.10	6.10	6.10	18.30	18.30				
16	6.10	5.50	6.10	17.70	17.70				
17	6.10	6.70	4.70	17.50	17.50				
18	4.45	6.10	5.30	15.85	15.85				
19	5.50	4.45	6.10	16.05	16.05	21	21	21	105
20	6.10	6.10	6.10	18.30	18.30				
21	6.10	6.10	6.10	18.30	18.30				
22	6.10	6.10	6.10	18.30	18.30				
23	6.10	6.10	6.10	18.30	18.30				
24	6.10	6.10	6.10	18.30	18.30				
25	6.10	6.10	6.10	18.30	18.30				
26	3.05	3.05	3.05	9.15	9.15	21	21	21	105
27	6.10	3.05	6.10	15.25	15.25				
28	6.10	6.10	6.10	18.30	18.30				
29	3.05	6.00	6.10	15.15	15.15				
30	3.05	6.10	3.00	12.15	12.15				
31	Dismant								
November									
1	Transpor								
2	Transpor					12	15	21	105
Total	132.55	134.90	133.55	401.00	398.85	73	90	115	560

Table19 Summary of the Drilling Operation of MJT-1

		Survey Period				Total man day	
		Period	Days	Work day	Off day	Engineer	Worker
Operation				days	days	man	man
	Preparation	4.9.1985 ~ 11.9.1985	8	8	0	24	50
	Drilling	12.9.1985 ~ 1.10.1985	20	Drilling 20	0	60	292
				Recovering 0	0	-	-
	Removing	2.10.1985 ~ 3.10.1985	2	2	0	6	30
	Total	4.9.1985 ~ 3.10.1985	30	30	0	90	372

Drilling length				
Length planed	300.00 m	Overburden	9.90 m
Increase or Decrease in length	m		m
Length drilled	301.00	Core recovery	96.4 %

Core recovery of 100 m hole

Core Depth of hole recovery (m) Core length 290.40	Core cumulated (%)	recovery (%)
0 ~ 100	89.4	
100 ~ 200	100	94.7
200 ~ 301	100	96.4

Working hours	h	%	%
Drilling	246° 00	62.4	51.0
Other working	148° 00	37.6	30.7
Recovering	-	-	-
Total	394° 00	100	81.7
Reassemblage	64° 00		13.3
Dismantlement	16° 00		3.3
Water transportation	-	-	
Road construction and others	8° 00		1.7
G.Total	482° 00		100

Efficiency of Drilling

Total m/work Period (m/day)	301.00 m/20days (15.05 m/day)
Total m/total Shift (m/shift)	301.00 m/50 shifts (6.02 m/shift)

Drilling length/bit (each sized bit)

Bit size	NQ		
Drilled length	301.00		
Core length	290.40		

Casing pipe inserted

Size	Meterage (m)	Meterage drilling length × 100 (%)	Recovery (%)
NX	11.00	3.7	100

Table20　Summary of the Drilling Operation of MJT-2

	Survey Period				Total man day	
	Period	Days	Work day	Off day	Engineer	Worker
Operation			days	days	man	man
Preparation	4.9.1985 ~11.9.1985	8	8	0	24	48
Drilling	12.9.1985 ~8.10.1985	27	Drilling 23	0	66	294
			Recovering 4	0	12	60
Removing	9.10.1985 ~10.10.1985	2	2	0	6	20
Total	4.9.1985 ~10.10.1985	37	37	0	108	422

Drilling length			
Length planed	300.00 m	Overburden	9.50 m
Increase or Decrease in length	– m	Core length	276.40 m
Length drilled	301.00	Core recovery	91.8 %

Core recovery of 100 m hole		
Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0 ~ 100	81.7	
100 ~ 200	93.7	87.7
200 ~ 301	100	91.8

Working hours	h	%	%
Drilling	280° 00	52.4	45.0
Other working	190° 00	35.6	30.5
Recovering	64° 00	12.0	10.3
Total	534° 00	100	85.8
Reassemblage	64° 00		10.3
Dismantlement	16° 00		2.6
Water transportation	-		-
Road construction and others	8° 00		1.3
G.Total	622° 00		100

Efficiency of Drilling	
Total m/work period(m/day)	301.00 m/ 23 days (13.09 m/day)
Total m/total shift (m/shift)	301.00 m/ 58 shifts (5.19 m/shift)

Drilling length/bit(each sized bit)			
Bit size	NQ		
Drilled length	301.00		
Core length	276.40		

Casing pipe inserted			
Size	Meterage (m)	Meterage / drilling length × 100 (%)	Recovery (%)
NX	64.50	21.4	100

Table21 Summary of the Drilling Operation of MJT-3

	Survey Period				Total man day	
	Period	Days	Work day	Off day	Engineer	Worker
Operation			days	day	man	man
Preparation	22.9.1985 ~ 5.10.1985	14	14	0	31	140
Drilling	6.10.1985 ~30.10.1985	25	Drilling 25	0	75	375
		0	Recovering 0	0	0	0
Removing	31.10.1985~2.11.1985	3	3	0	9	45
Total	22.9.1985 ~2.11.1985	42	42	0	115	560

Drilling length				Core recovery of 100 m hole		
Length planed	300.00 m	Overburden	- m	Core Depth of hole recovery (m)	Core cumulated (%)	recovery (%)
Increase or Decrease in length	+ 100.00 m	Core length	398.85 m	0 ~ 100	97.8	
				100 ~ 200	100	98.9
Length drilled	401.00	Core recovery	% 99.4	200 ~ 300	100	99.2
				300 ~ 401	100	99.4

Working hours	h	%	%	Efficiency of Drilling			
Drilling	415° 00	71.6	58.0				
Other working	165° 00	28.4	23.0	Total m/work period(m/day)	401.00 m/ 25 days (16.04 m/day)		
Recovering	-						
Total	580° 00	100	81.00	Total m/total shift (m/shift)	401.00 m/ 73 shifts (5.49 m/shift)		
Reassemblage	56° 00		7.8				
Dismantlement	24° 00		3.4	Drilling length/bit(each sized bit)			
Water transportation				Bit size	NQ		
Road construction and others	56° 00		7.8	Drilled length	401.00		
G.Total	716° 00		100	Core length	398.85		

Casing pipe inserted			
Size	Meterage (m)	Meterage / drilling length × 100 (%)	Recovery (%)
NX	2.00	0.5%	100

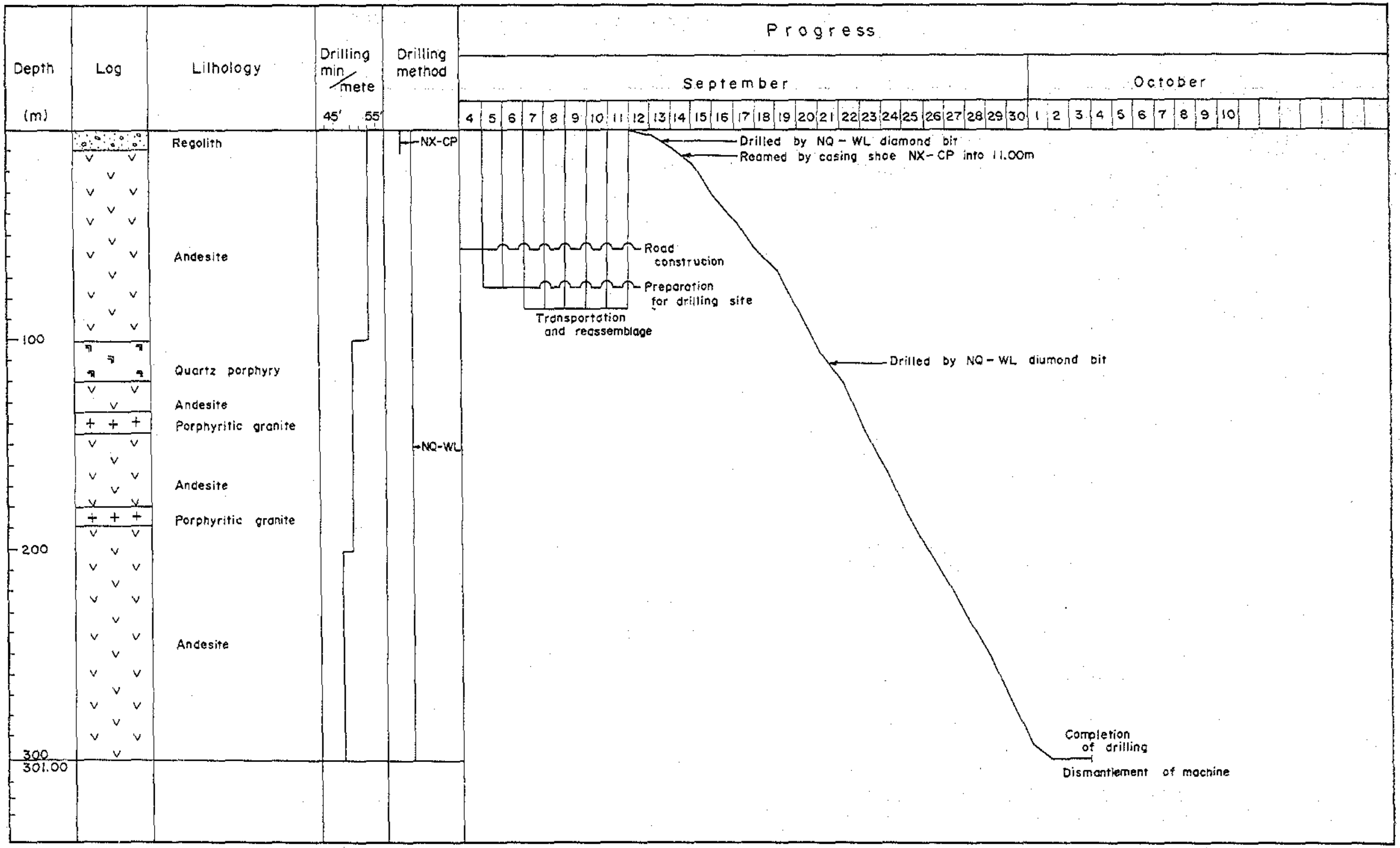


Fig.49 Drilling Progress of MJT-1

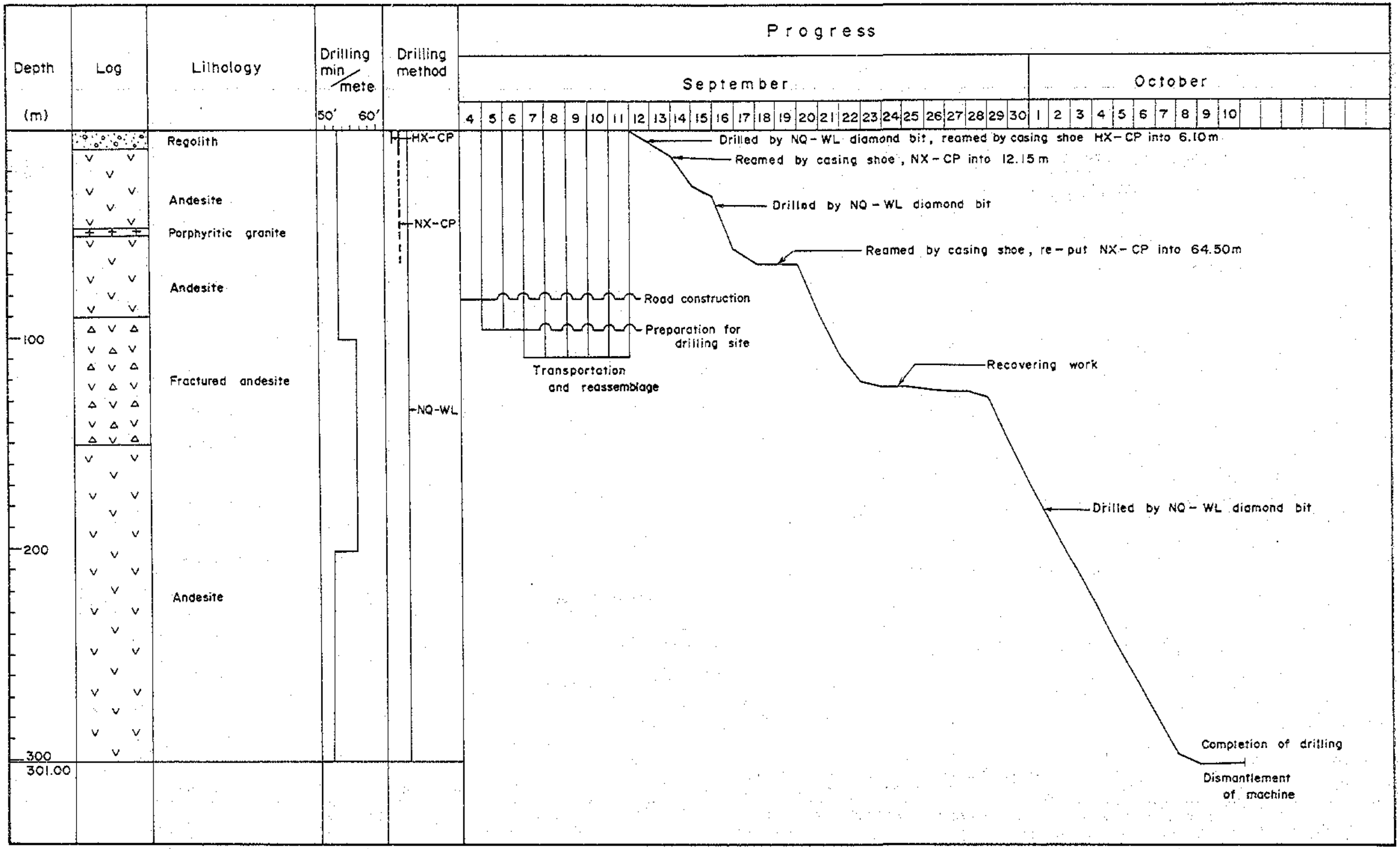


Fig.50 Drilling Progress of MJT-2

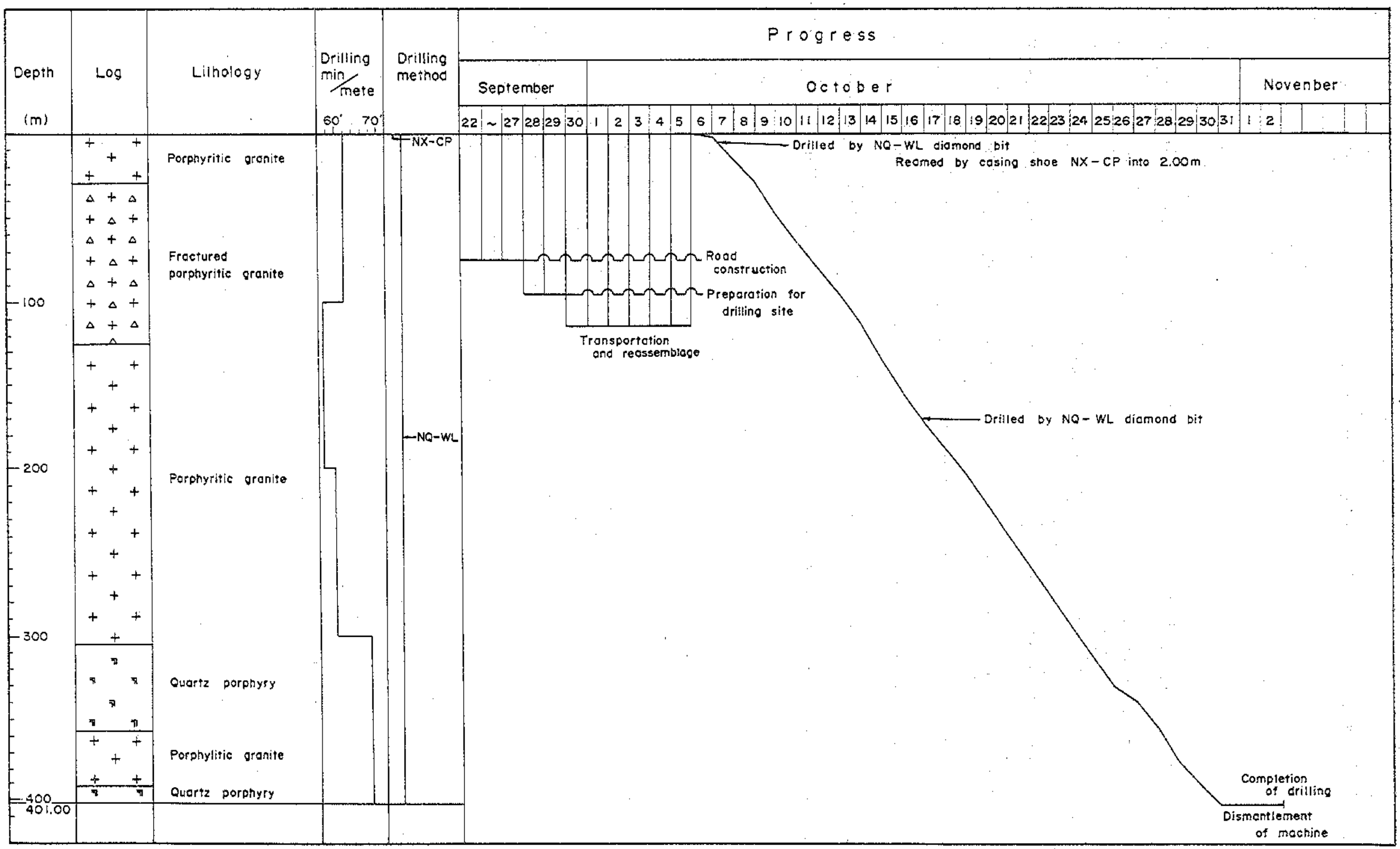


Fig.51 Drilling Progress of MJT-3

mineralization became poores toward the deeper part. The drilling was completed at 301.00 m.

(2) MJT-2

The hole reached bed rock [andesite] at 9.90 m, after cutting through surface soil by NQ size diamond bit, circulating dense bentonite mud water. Drilling was continued to 12.15 m where NX casing pipe was inserted after reaming by the NX casing shoe bit.

Below 12.15m, the drilling operation was carried out by wire line method, circulating mud water mixed with bentonite and cutting oil. The rock between 35 m to 65 m in depth was silicified and fractured andesite. It was very difficult to drill further without extention of the casing because of the severe collapse of the drill hole and much flash water through fissures NX casing pipes were thus inserted to 64.5m after reaming to 64.1 m by the NX metal casing bit and to 64.5 m by the NX diamond casing shoe bit. Severely fractured andesite continued to 125 m, but below 125 m the andesite gradually underwent stronger silicification toward the deeper part. The hole was completed at 301.00 m.

(3) MJT-3

As porphyritic granite was exposed at the surface of the site, the hole was drilled using on NQ diamond bit, circulating bentonite mud water,and was reamed by an NX casing shoe bit. An NX casing bit was also inserted through porphyritic granite to 2.00 m.

Below 2.00 m, NQ wire line method, mixed mud water of bentonite and cutting oil were used for the drilling operation. The major rock was porphyritic granite with well-developed fissures to 125 m, but below 125 m, silicified rock accompanied by copper and molybdenum mineralization occurred.

The drill hole was extended to 401.00 m because the mineralization was still apparent at 301.00 m.

1-7-4 Geology and Mineralization of Drilling Hole

(1) MIT-1

【Geology】

0.00 ～ 9.90 m ： Surface soil and weathered andesite

9.90 ～101.60 m ： Mainly silicified andesite. Colour changes gradually from dark green to pale green at depth. There are well-developed fissures in the andesite, and pyrite-molybdenite-chalcopyrite bearing quartz veins within 10 mm width are embedded along with these fissures.

101.60 ～ 119.90 m ： White silicified and sericitized quartz porphyry accompanied by molybdenite and chalcopyrite along with fractures in the rock.

119.90 ～ 113.80 m ： Dark green chloritized andesite containing magnetite and very thin pyrite-molybdenite bearing quartz veins having mm- sized width.

133.80 ～ 144.80 m ： Pale green sericitized porphyritic granite. Molybdenites and chalcopyrites are embedded in fissures or accompanis quartz veins.

144.80 ～ 180.20 m ： Pale green andesite having well-developed fissures. There is a little chalcopyrite and molybdenite contained in the quarts veins.180.25 ～ 189.40 m ： White silicified porphyritic granite. Fissures and quartz veins are slightly well-developed.

189.40 ～ 274.50 m ： Dark green andesite. Chlorites are mainly seen as altered minerals. Pyrites and molybdenites predominantly accompany fissures and quartz veins.

274.50 ～ 275.40 m ： White porphyritic granite. Pyrites and molibdenites are not recognizable in the rock.

275.40 ～ 301.00 m ： Predominantly chloritized and epidotized dark green andesite. Quartz veins in the rock contain some chalcopyrite and molybdenite.

【Alteration】

Under general observation, the shallow sections of andesite and quartz porphyry, and porphyritic granite near the surface have predominantly undergone sericitization, but chlorite increases towards the deep section, and epidote is also recognizable with the apperrance of chlorite. Thus the alteration is classified into two zones as follows ：

9.90 ～ 195.00 m ： Phyllic zone consisting mainly of sericite with accessories of chlorite and [epidote].

195.00 ~ 301.00 m : propylitic zone consisting of chlorite with epidote and calcite.

【Mineralization】

Mineralization accompanying pyrite,chalcopyrite and molybdenite is observed throughout from surface to hole bottom, but generally is weak mineralizarion. Chalcopyrites and molybdenites are embedded in quartz veins and fissures, while pyrites are disseminated in the rock and also in the quart veins and fissures. Comparatively strong mineralization occurs from 200 m to 250.00 m

(2) MJT-2

【Geology】

0.00 ~ 9.50 m : Surface soil and weathered andesite

9.50 ~ 41.80 m : Green andesite. The andesite has slightly undergone sericitization, but chlorite is the main altered mineral. Some chalcopyrite and molybdenite accompany quartz veins and fissures. Magnetites are predominantly disseminated in the rock.

41.80 ~ 50.40 m : Three dykes of white porphyritic granite have intruded into the andesite. The andesite has been subjected to chloritization, and predominant amounts of chalcopyrites occur in quartz veins and fissures.

50.40 ~ 277.20 m : Green andesite distributed to around 50 m has undergone chloritization accompanyed by small amounts of sericite. Chalcopyrite and molybdenite occur in quartz veins and fissures. The rock was so severely fractured that the cores were mostly broken and recovery was poor from 90 m to 150 m. Below 150 m, chloritized andesite had additionally suffered silicification, and the drilling operation was able to get good core recovery. Fissures and quartz veins accomped by chalcopyrite and molybdenite were well-developed below 150 m.

277.20 ~ 278.20 m : White and pale green porphyritic granite. Chalcopyrite and molybdenite accompany fissures and quartz veins, similar to the surround andesite.

278.20 ~ 301.00 m : Dark green chloritized andesite. The ratio of distribution frequency per meter of quartz veins decreases slightly at depth, but emplacement of chalcopyrite and molybdenite along with fissures is seen more predominantly.

【Alteration】

Andesite has mostly undergone chloritization and weak epidotization contrarily, small intrusions of porphyry granite have undergone sericitization. Thus the alteration zone is classified into the propylitic zone.

【Mineralization】

Mineralization with chalcopyrite and molybdenite is emplaced in quartz veins and fissures. A strong part of the mineralization of chalcopyrite and molybdenite is located especially in quartz veins and fissures within chloritized andesite accompanied by magnetite around 10 ～ 80 m and 180 ～ 300 m. Results of the chemical assay of ores at the strongly mineralized sections indicate (199～222m Wd:3m) 0.92 % copper and 0.043 % molybdenum. Mineralization of MJT-2 is better and strongers than mineralization in MJT-1 because a greater number of finer, irregularly directioned fractures are developed and chalcopyrite and molybdenite are emplaced along these fine fissures, in comparison with the case of MJT-1.

(3) MJT-3

【Geology】

0.00 ～ 2.30 m : Limonite-stained porphyritic granite

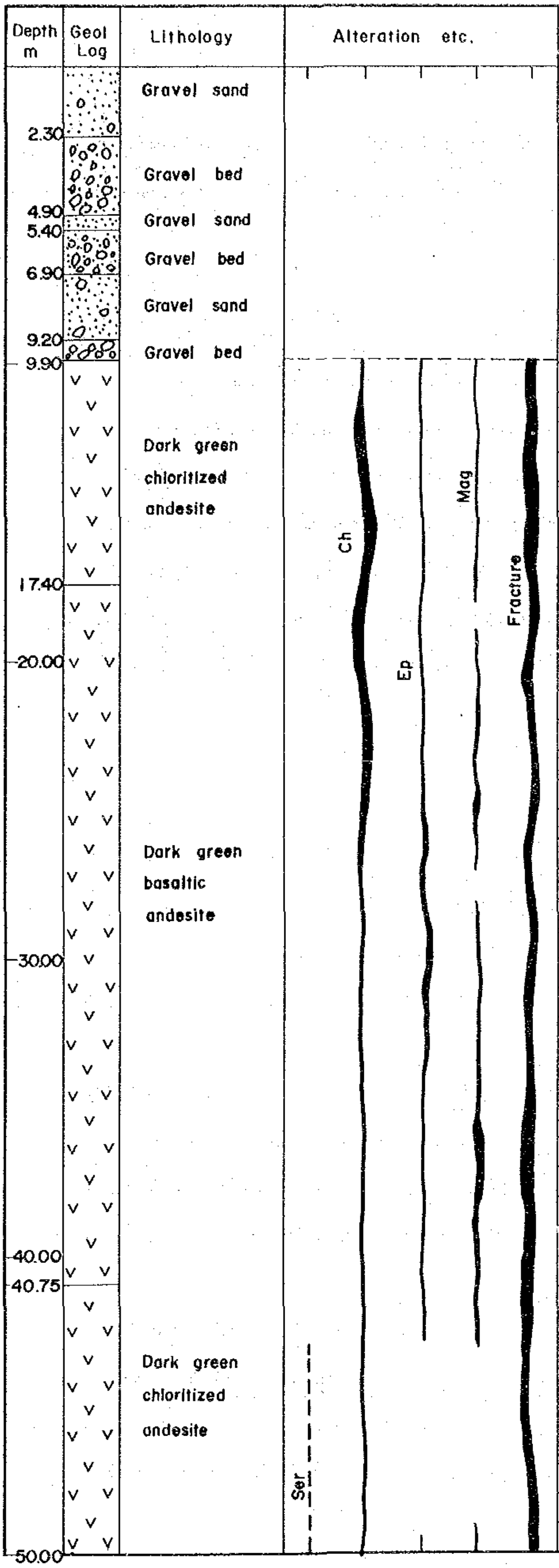
2.30 ～ 30.00 m : White and pale green sericitized porphyritic granite.

Chalcopyrite and molybdenite occur not only in fissures and quartz veins but also as disseminationd in the rock.

30.00 ～ 125.00 m : White and pale green porphyritic granite. The rock texture is clearly ribbon structure. Therefore cores collected used to be plate shape. Disseminated chalcopyrites are usually observed on the plates of the core, and it forms a high grade mineralized section. Molybdenites are also associated in this section, but it is of comparatively low grade.

125.00 ～ 304.90 m : Below 125 m, the rock suffered strong silicification and was collected as massive cores by the drilling operation. Very thin fssures with irregular direction occur in white and pale green sreicitized, porphyritic granite,in section with a high fissures,chalcopyrites can be found as disseminations or embeded along the fissures.

MJT－1　　　　0 m ～ 50 m

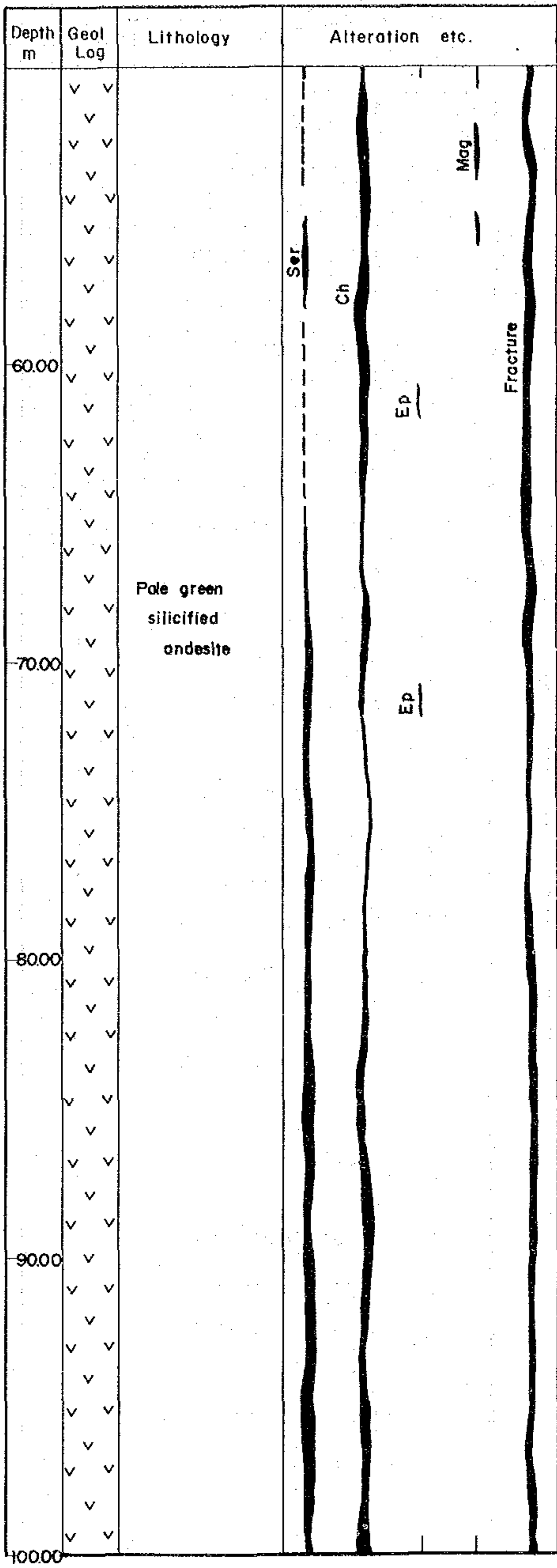


Qz vein No	Qz vein Wd (mm)
4	4
3	6
4	5
6	3
2	4
1	3
7	10
7	8
1	7
4	4
3	4
1	3
6	4
5	3
3	6
3	3
7	5
7	4
7	8
9	8
8	3
4	1
4	2
6	9
4	2
11	4
1	2
6	6
7	10
2	2
6	5
6	2
4	2
7	6
9	6
6	6
8	6
4	5

Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
001	0.05	0.001			
002	0.10	<0.001			
003	0.10	0.001			
004	0.09	<0.001			
005	0.07	0.004			
006	0.05	0.005			
007	0.05	0.003			
008	0.08	<0.001			
009	0.19	0.001	<5	1	1
010	0.02	0.001			
011	0.06	0.003			
012	0.05	0.002			
013	0.06	0.001			
014	0.06	0.005			

Fig.52　Geological Log of MJT-1(1)

MJT - I 50 m ~ 100 m

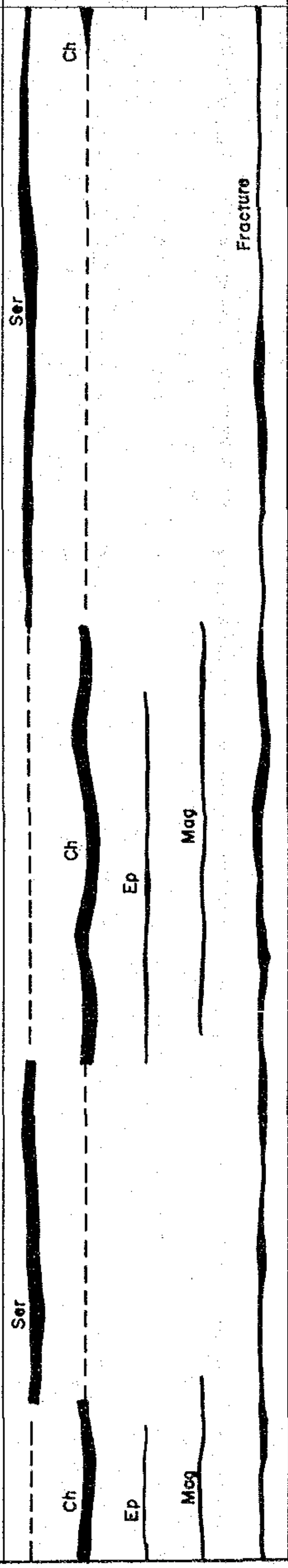


Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
7	8						
1	2						
4	10	015	0.06	0.001	<5	4	1
3	7						
2	6						
4	10	016	0.08	0.010			
7	50						
4	20						
8	2	017	0.06	0.001			
3	10						
1	2						
3	4	018	0.06	0.001			
4	8						
5	10						
7	10	019	0.05	<0.001			
5	5						
3	3						
4	9	020	0.03	0.002			
2	4						
2	2						
		021	0.05	0.001			
		022	0.02	<0.001			
		023	0.03	0.001			
2	6						
3	2	024	0.12	<0.001			
3	2						
4	6						
3	6	025	0.04	0.001			
1	2						
2	4						
		026	0.11	0.001	<5	3	1
2	4						
3	4						
3	1	027	0.01	<0.001			
5	2						
3	1						
		028	0.01	<0.001			
4	3						
3	2						
3	2	029	0.02	<0.001			
4	1						
1	3						
5	4	030	0.03	<0.001			
3	3						
6	3						

Fig.52 Geological Log of MJT-1(2)

MJT-1　　100 m ~ 150 m

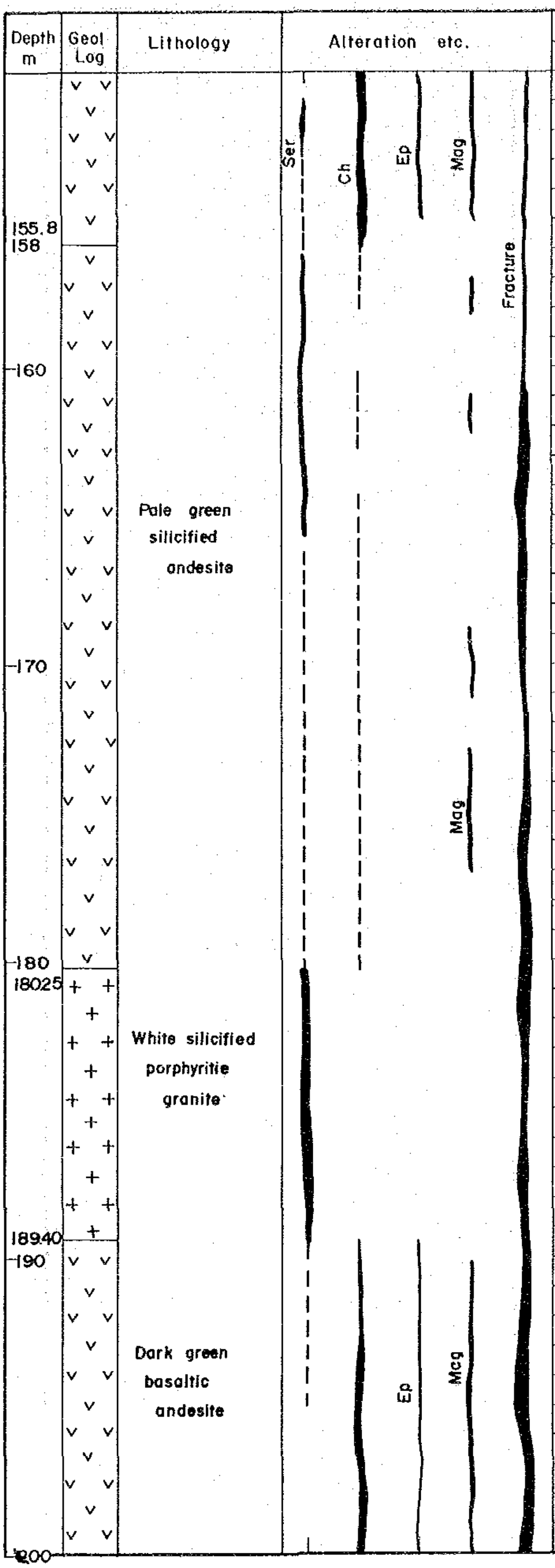
Depth (m)	Lithology
100.00 – 101.60	(andesite)
101.60 – 119.90	White silicified quartz-porphyry
119.90 – 133.80	Dark green chloritized andesite
133.80 – 144.80	Light grey porphyritic granite
144.80 – 150.00	Pale green ~ grey chloritized andesite



Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
4	2	031	0.09	0.009			
3	3						
12	5	032	0.07	0.002			
8	5						
5	8						
12	3	033	0.02	<0.001			
10	6						
10	4						
6	5	034	0.02	0.001			
9	4						
10	8						
11	4	035	0.05	0.002			
17	3						
16	5						
9	4	036	0.03	0.002	<5	2	1
14	5						
14	4						
12	2	037	0.15	0.004			
20	1						
11	2						
10	3	038	0.09	0.005			
8	3						
14	4						
6	2	039	0.06	<0.001			
4	8						
12	3						
3	10	040	0.08	0.001			
5	2						
10	2						
14	2	041	0.07	0.001			
6	3						
3	2						
8	4	042	0.16	0.002			
6	3						
11	4						
8	10	043	0.12	0.004			
5	8						
5	10						
7	7	044	0.08	0.004			
9	2						
9	8						
6	7	045	0.03	0.003			
8	8						
7	6						
4	10	046	0.08	0.002	<5	2	1
2	11						
4	5						
5	3	047	0.06	<0.001			
7	3						
8	3						

Fig.52　Geological Log of MJT-1(3)

MJT－1 150 m ～ 200 m



Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
8	5	048	0.10	0.001			
7	3						
3	2						
4	3	049	0.06	0.001			
5	3						
3	3						
7	5	050	0.03	0.003			
7	4						
3	3						
3	4	051	0.05	0.001			
1	3						
		052	0.11	0.006	<5	4	1
1	3						
5	3						
4	3	053	0.06	0.002			
		054	0.03	0.002			
3	4						
1	1						
2	6	055	0.05	0.001			
1	3						
2	6	056	0.07	0.002			
1	4						
		057	0.03	0.004			
3	3						
		058	0.08	0.004			
		059	0.09	0.019	<5	1	1
1	4						
4	6						
9	15	060	0.23	0.013			
3	2						
		061	0.15	0.004			
1	4						
2	5						
3	3	062	0.11	0.001			
2	3	063	0.05	0.006			
7	5						
6	4						
4	4	064	0.06	0.001			
10	10						

Fig.52 Geological Log of MJT-1(4)

MJT－1 200 m ～ 250m

Depth m	Lithology	Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
		4	5						
		4	4						
		7	4	065	0.06	0.004			
		5	4						
		4	3						
		7	6	066	0.10	0.002			
		3	6						
		1	2						
		2	2	067	0.06	0.001			
210		5	3						
		6	10						
		6	4	068	0.10	0.002			
		5	4						
		2	3						
		3	2	069	0.07	0.002			
		6	4						
		4	4						
		3	6	070	0.08	0.002			
	Dark green basaltic andesite	5	4						
220									
		7	4	071	0.16	0.005	<5	1	1
		4	5						
		5	14						
		5	4	072	0.15	0.008			
		2	8						
		3	4						
		3	4	073	0.11	0.008			
		3	10						
		3	4						
230		3	3	074	0.10	0.003			
		3	4						
		3	4						
		3	3	075	0.07	0.001			
		3	4						
		–	–						
		5	8	076	0.10	0.001			
		7	10						
		2	6						
		9	5	077	0.15	0.003			
		5	4						
240		14	3						
		15	2	078	0.05	0.002			
		3	4						
		4	7						
244		5	4	079	0.08	0.006	<5	1	1
	Dark green chloritized andesite	8	6						
		5	6	080	0.06	0.004			
		8	8						
250		3	3						

Alteration etc.

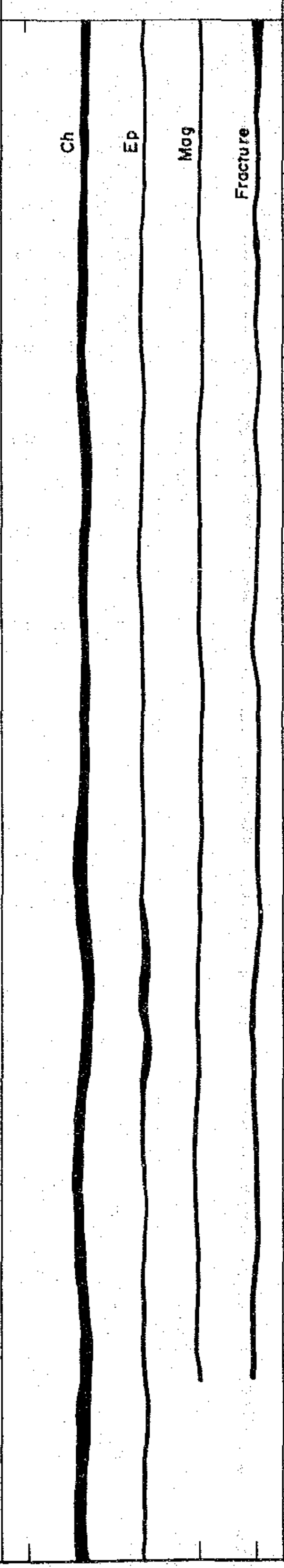


Fig.52 Geological Log of MJT-1(5)

170

MJT－I　　250 m ～ 301 m

Lithology (Depth m):
- 250 – ~259: Dark green chloritized andesite
- ~259: Green clay (fault?)
- ~259 – 274.50: Dark green basaltic andesite
- 274.50 – 275.40: White porphyritic granite
- 275.40 – 285.00: Dark green basaltic andesite
- 285.00 – 301: Pale green auto brecciated andesite

Alteration etc.: Ch, Ep, Mag, Fracture, Ser

Depth m	Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
250			081	0.03	0.002			
251	2	4						
252	1	4	082	0.02	0.001			
253	2	4						
254								
255			083	0.02	0.008			
256								
257								
258	1	4	084	0.03	0.001			
259	4	3						
260	5	5						
261	8	3	085	0.03	0.001			
262	3	8						
263	7	4						
264	3	4	086	0.04	0.001			
265	4	3						
266	2	2						
267	3	3	087	0.06	0.001			
268	2	4						
269								
270	3	3	088	0.07	0.002			
271								
272	2	6						
273	2	6	089	0.04	<0.001			
274	2	4						
275	3	4						
276	3	6	090	0.02	<0.001			
277	1	20						
278	4	3						
279	3	8	091	0.02	0.002			
280								
281	6	8						
282	3	6	092	0.04	0.001			
283	4	6						
284	1	3						
285	5	8	093	0.03	0.002			
286	3	12						
287	3	8						
288	1	8	094	0.04	0.011			
289	3	8						
290	3	15						
291	2	8	095	0.02	0.002			
292	3	10						
293	2	8						
294	4	10	096	0.02	<0.001			
295								
296								
297	1	12	097	0.01	<0.001			
298	1	10						
299	1	4						
300	5	20	098	0.06	0.001	< 5	3	1

Fig.52　　Geological Log of MJT-1(6)

MJT-2 0 m ~ 50 m

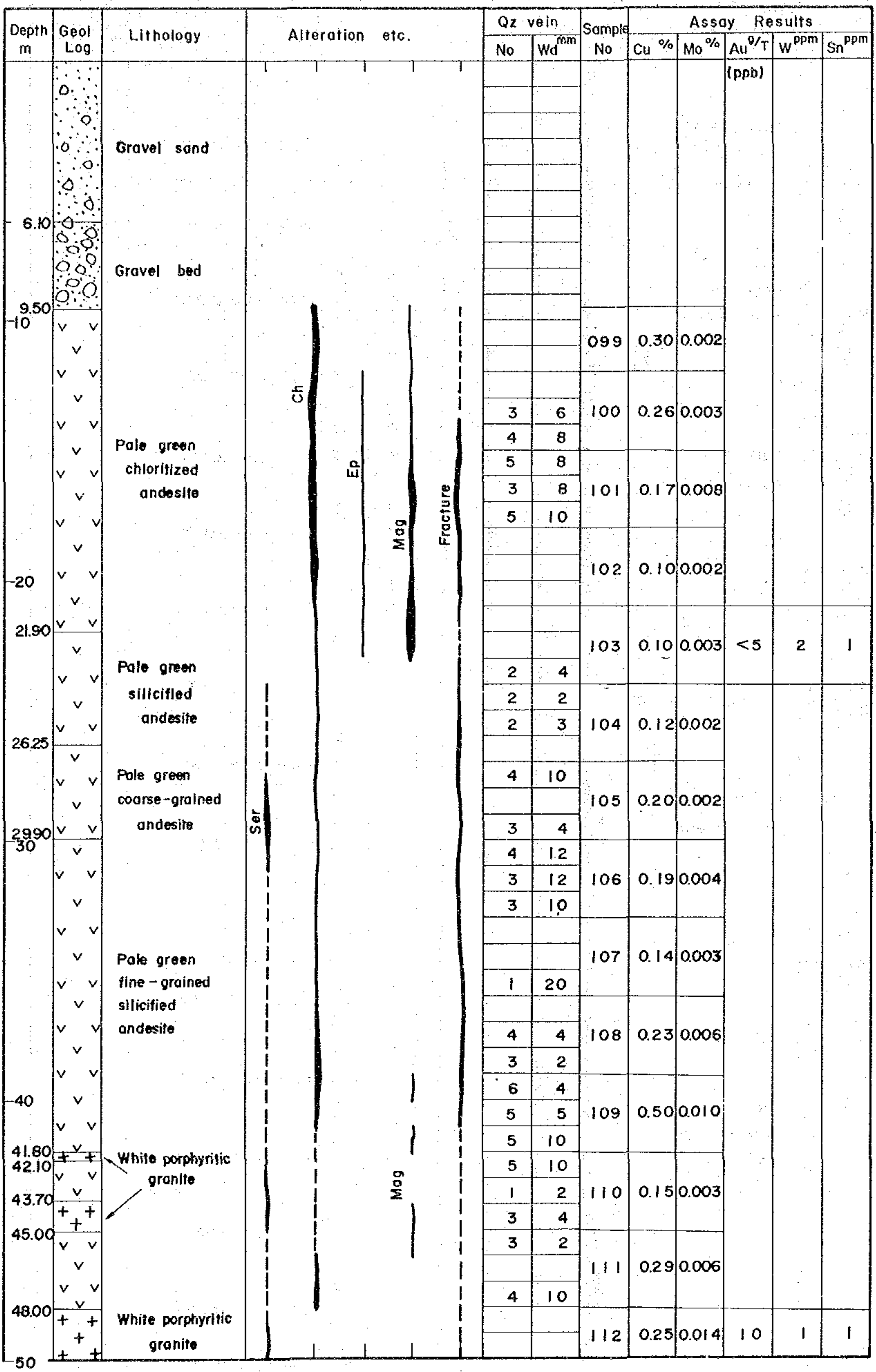
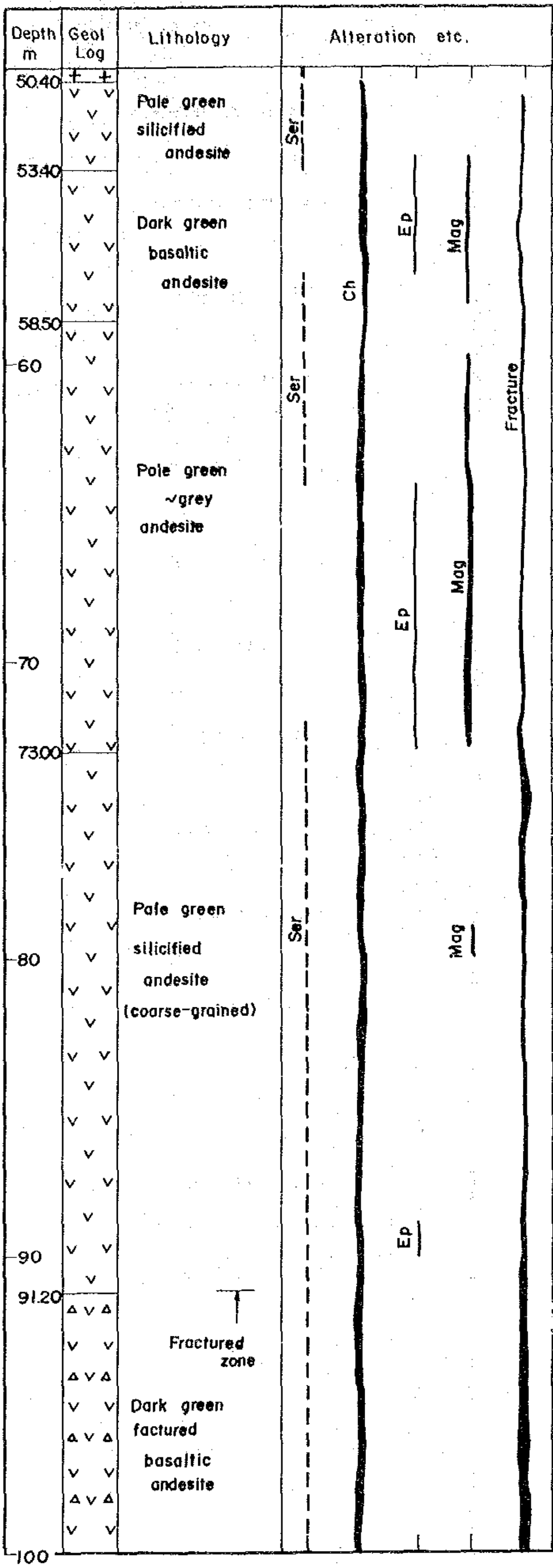


Fig.53 Geological Log of MJT-2(1)

MJT－2　　　　50 m ～ 100 m



Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
3	2						
4	3						
7	12	113	0.40	0.010			
3	15						
5	14						
4	15	114	0.21	0.006			
4	4						
4	6						
4	8	115	0.29	0.012			
4	6						
3	10						
3	4	116	0.32	0.013			
3	15						
3	3	117	0.42	0.004			
2	6						
4	10						
2	4	118	0.38	0.012			
6	12						
3	5						
3	2	119	0.28	0.009			
7	6						
6	5						
5	5	120	0.21	0.009	15	1	1
4	3						
6	4						
6	5	121	0.16	0.006			
5	5						
4	4						
7	5	122	0.16	0.002			
6	8						
1	3						
3	3	123	0.11	0.004			
6	12						
6	6						
4	10	124	0.17	0.011			
10	4						
—	—						
1	4	125	0.12	0.001			
1	3						
2	4	126	0.12	0.010			
3	5						
3+α	4	127	0.12	0.002			
		128	0.07	0.002			
		129	0.06	0.014			

Fig.53　Geological Log of MJT-2(2)

MJT－2　　　　　　　　　　　　100m ～ 150m

Depth (m): 110, 120, 130, 140, 150

Geol Log: Δ V Δ (100 m – 150 m)

Lithology: Dark green fractured basaltic andesite

Alteration etc.: Ser, Ch, Fracture

Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
		130	0.07	0.003	<5	1	1
		131	0.11	0.004			
		132	0.08	0.002			
		133	0.08	0.003			
		134	0.11	0.004			
		135	0.05	0.002			
		136	0.08	0.002			
		137	0.06	0.001			
3+α, 3+α, 2+α	2, 3, 3	138	0.08	0.003			
4+α, 4, 2	3, 3, 4	139	0.08	0.003			
4, 2, 3	4, 2, 2	140	0.10	0.002	<5	3	1
4, 3, 3	4, 3, 4	141	0.10	0.003			
4, 2, 5	4, 2, 4	142	0.13	0.002			
1, 6, 7	2, 4, 4	143	0.11	0.001			
3, 4, 3	3, 3, 2	144	0.10	0.002			
1, 4, 3	2, 2, 3	145	0.12	0.009			
2, 3	4, 5	146	0.08	0.005			

Fig.53　Geological Log of MJT-2(3)

MJT－2 150 m ～ 200 m

Depth m	Lithology	Qz vein No	Qz vein Wd mm	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
	Fractured zone								
152.00		1	2	147	0.10	0.005			
		1	2						
		2	3						
		5	4	148	0.12	0.003			
		3	3						
	Green ～ dark grey andesite	2	10	149	0.11	0.006			
160		5	15	150	0.10	0.013			
		3	15						
		6	13						
		1	4	151	0.06	0.004			
		3	5						
		4	8						
		1	3	152	0.21	0.012			
167.20		3	10						
		7	30						
		3	6	153	0.10	0.010			
170		4	8						
		3	4	154	0.19	0.017			
		6	4						
		3	4	155	0.13	0.012	10	2	1
		1	4						
	Dark green ～ grey basaltic andesite								
		7	3	156	0.14	0.012			
		7	5						
180		5	7						
		2	4	157	0.11	0.007			
		1	4						
		1	5						
		2	8	158	0.17	0.004			
		1	2						
		1	2						
		2	6	159	0.17	0.006			
		2	5						
190				160	0.22	0.011			
		1	4						
		1	4	161	0.19	0.005			
		3	8						
		1	8	162	0.48	0.019	60	4	1
		2	4						
		2	6						
200		3	6	163	0.12	0.004			

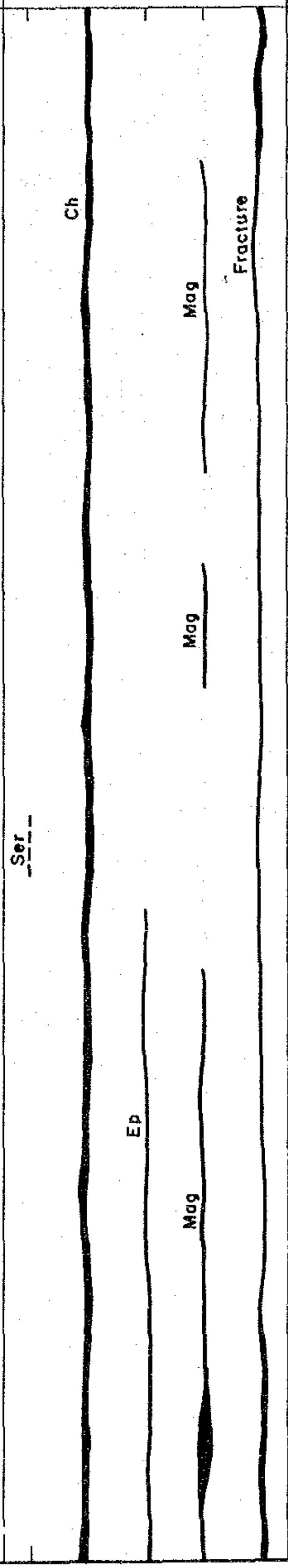


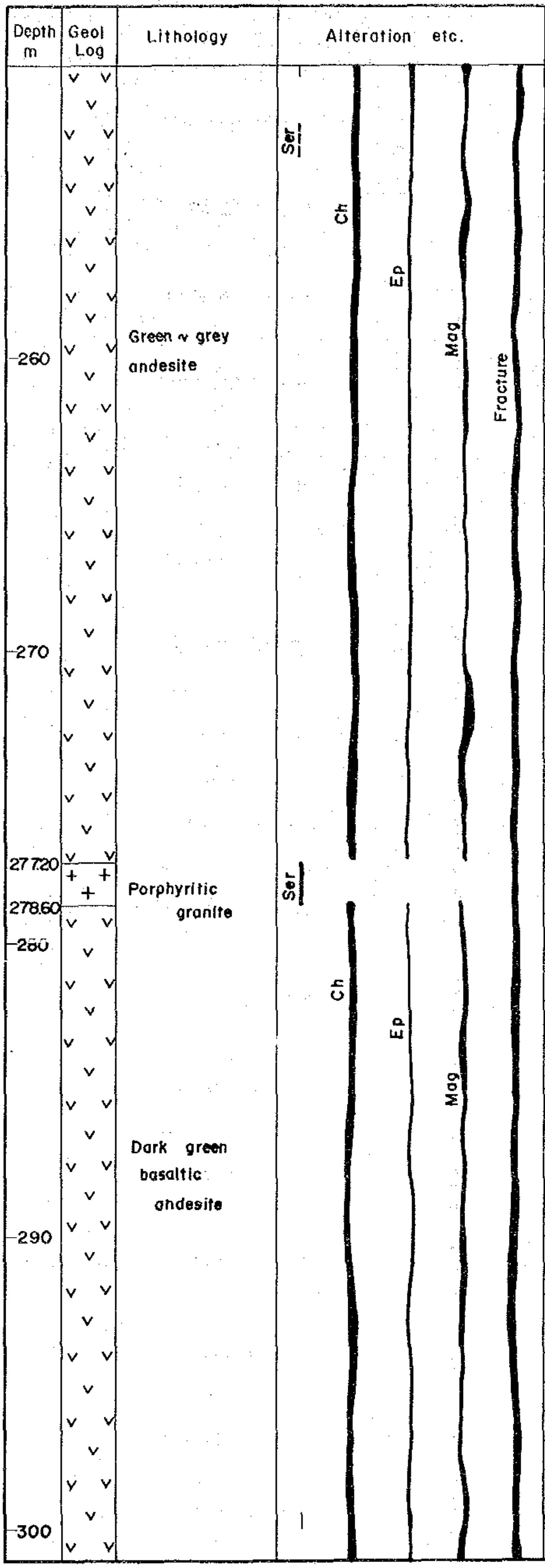
Fig.53 Geological Log of MJT-2(4)

MJT－2 200m ～ 250m

Depth m	Lithology	Alteration etc.	Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
		Ser, Ch, Ep, Mag, Fracture								
					164	0.20	0.009			
			1	5						
			3	6						
			1	5	165	0.24	0.034			
			2	8						
			3	10	166	0.35	0.009			
			3	4						
210	Dark green～grey basaltic andesite		4	8						
			5	8	167	0.15	0.006			
			2	4						
			4	10						
			3	10	168	0.12	0.011			
			4	6						
			2	4						
			3	8	169	0.17	0.016			
			5	8						
			2	10						
220					170	0.92	0.043			
			4	8						
222.00			9	8						
			1	5	171	0.37	0.032	20	1	1
			6	8						
			4	6						
		Ser	2	2	172	0.16	0.034			
			3	2						
			3	4						
	Pale green coarse grained andesite		3	10	173	0.10	0.008			
230			2	5						
		Ser	1	4						
			2	5	174	0.15	0.005			
			1	10						
			1	5						
			1	4	175	0.11	0.026			
			1	4						
					176	0.14	0.004			
			3	2						
240		Ser	2	10						
241.00			2	6	177	0.09	0.010			
			4	4						
	Dark green～grey basaltic andesite									
		Ep			178	0.12	0.011			
			1	3						
		Mag	2	3						
			3	12	179	0.26	0.016			
248.30										
250			1	4						

Fig.53 Geological Log of MJT-2(5)

MJT－2 250 m ～ 301 m



Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
2	15	180	0.19	0.008			
1	3						
1	4	181	0.14	0.005			
2	4						
3	6						
4	5	182	0.13	0.016	15	1	2
2	8						
6	4	183	0.13	0.005			
2	4						
3	10	184	0.12	0.007			
1	4						
2	5						
		185	0.11	0.005			
6	8						
4	4						
6	15	186	0.15	0.016			
4	4						
5	15						
7	6	187	0.12	0.012			
3	6						
2	4						
1	2	188	0.15	0.008			
4	6	189	0.14	0.006			
1	4						
4	4						
2	6	190	0.13	0.002			
4	6	191	0.15	0.011			
2	6						
2	6						
2	3	192	0.23	0.006			
1	5	193	0.15	0.004			
1	10						
2	8	194	0.15	0.026			
2	4						
3	4						
2	4	195	0.11	0.010			
1	5						
4	4						
		196	0.13	0.004			
4	5						
3	4	197	0.07	0.001			

Fig.53 Geological Log of MJT-2(6)

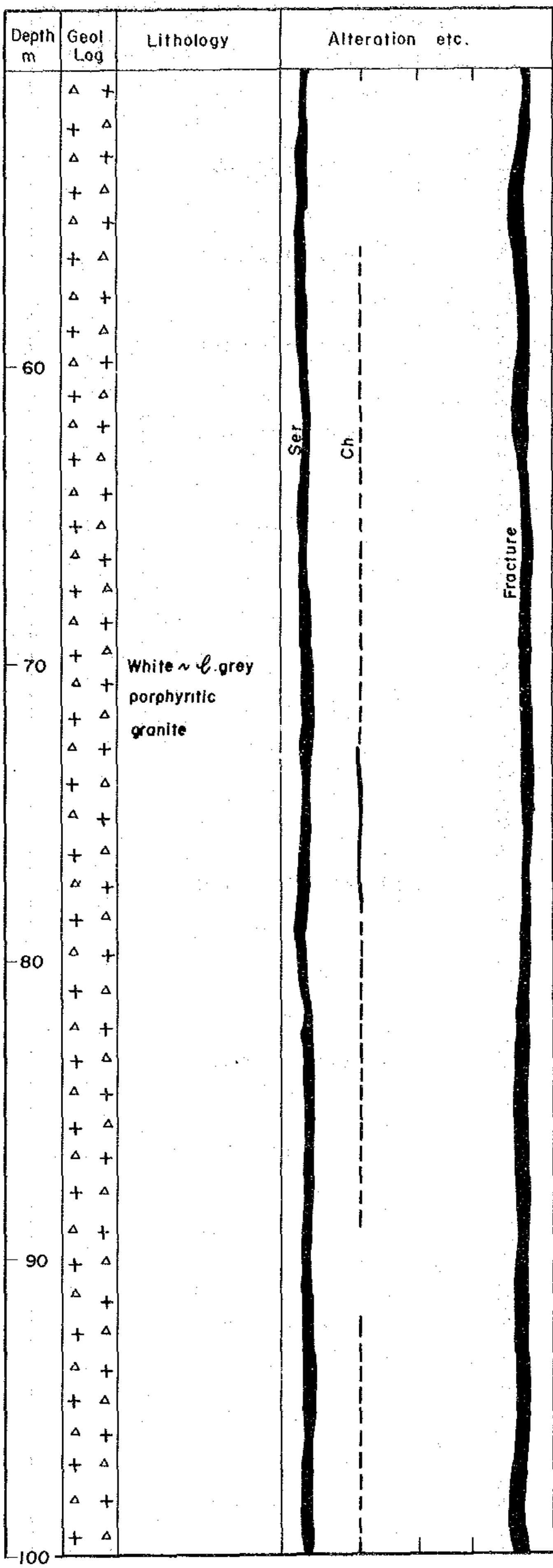
MJT－3　　　　　　　　　　　　　　0 m ～ 50 m

Depth (m)	Lithology	Alteration etc.
0 – 2.30	Limonitzed porphyritic ～ granite	Ser; Fracture
2.30 – 16.50	White ～ ℓ.grey porphyritic granite	Enrichment zone; Ch; Ser; Fracture
16.50 – 30.00	White ～ ℓ.grey porphyritic granite	Ch; Ser; Fracture
30.00 – 50	White ～ ℓ.grey porphyritic granite	Fractured zone; Ch; Ser; Fracture

Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
2	6	198	0.08	0.009			
2	2	199	0.23	0.001			
3	4	200	0.16	0.011			
4, 5, 3	4, 3, 2	201	0.22	0.009			
3	6	202	0.63	0.006	10	1	1
3, 2	2, 4	203	0.24	0.007			
2, 10	4, 3	204	0.21	0.022			
8, 5	2, 2	205	0.20	0.031			
3, 4, 4	3, 6, 3	206	0.17	0.019			
4, 7, 4	3, 8, 4	207	0.19	0.015			
2	2	208	0.16	0.007			
		209	0.15	0.010			
		210	0.33	0.022			
		211	0.19	0.016			
		312	0.21	0.007			
		213	0.026	0.014			
		214	0.29	0.010			
		215	0.19	0.015			

Fig.54　　Geological Log of MJT-3 (1)

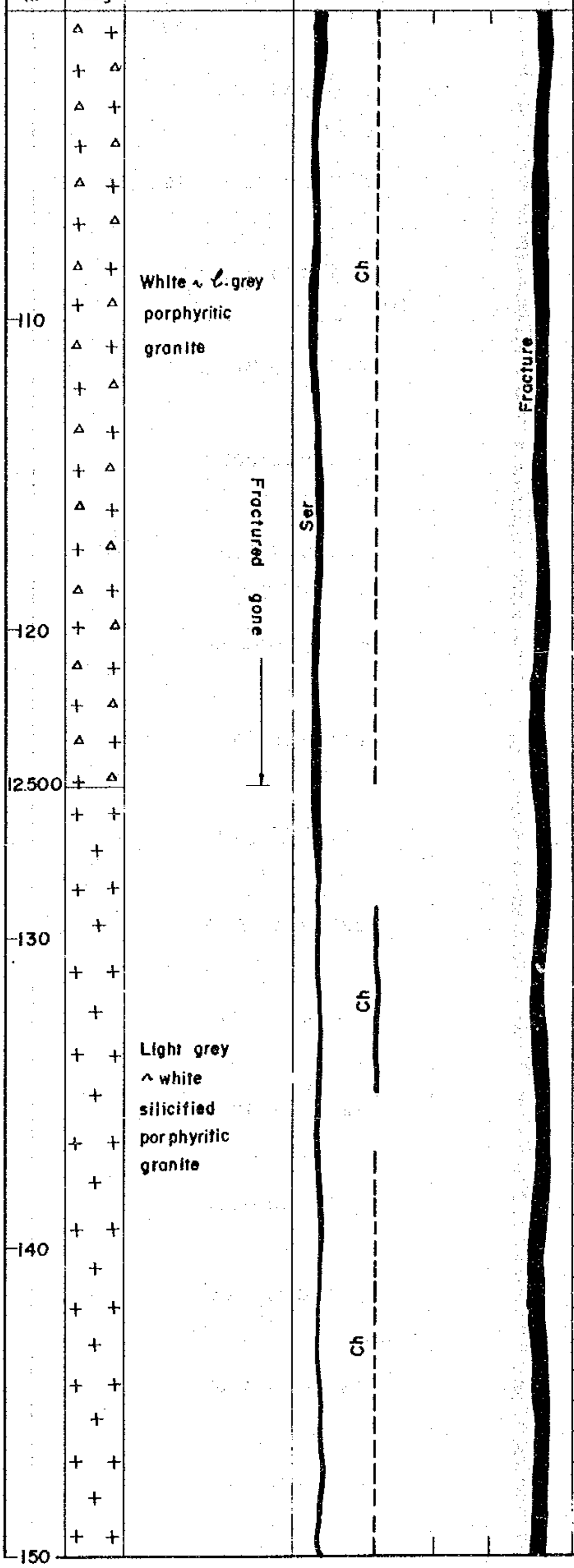
MJT－3 50 m ～ 100 m



Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
		216	0.28	0.010			
		217	0.26	0.014	15	14	1
1	10	218	0.19	0.011			
		219	0.18	0.007			
		220	0.20	0.011			
		221	0.22	0.008			
		222	0.29	0.008			
		223	0.20	0.015	5	1	1
		224	0.19	0.016			
		225	0.18	0.008			
		226	0.23	0.009			
		227	0.19	0.012			
		228	0.38	0.006			
		229	0.29	0.009			
		230	0.38	0.010			
		231	0.22	0.018			

Fig.54 Geological Log of MJT-3(2)

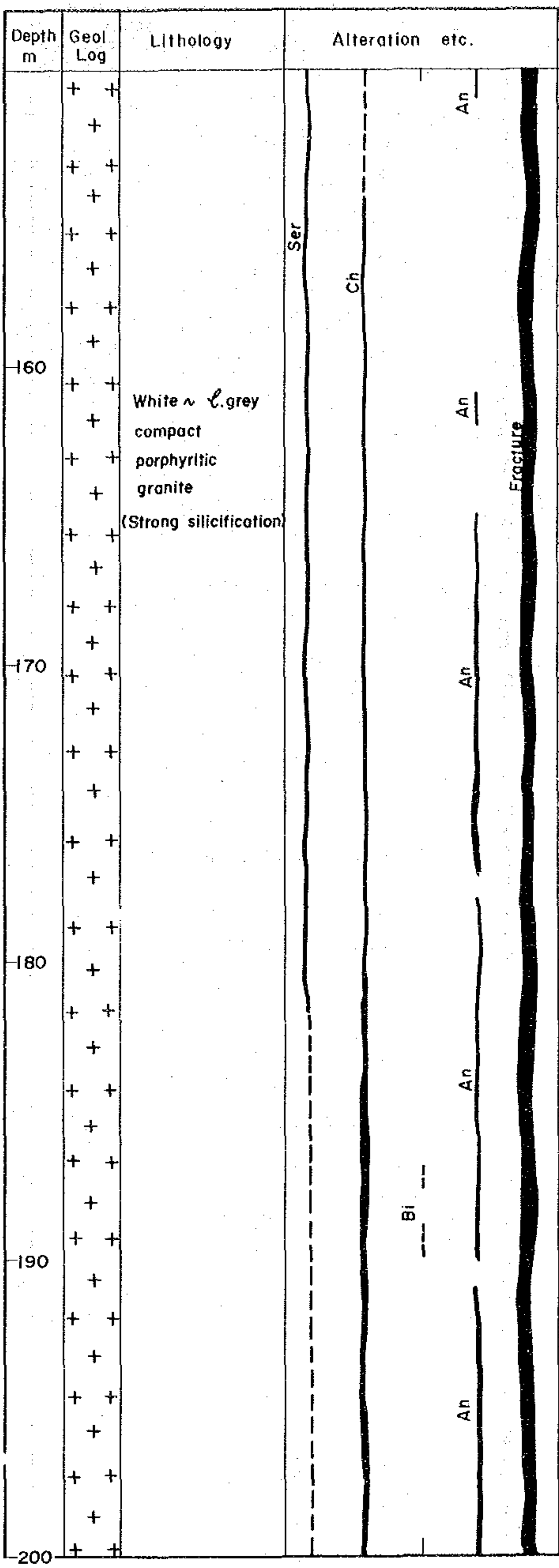
MJT－3 100 m ～ 150 m



Sample No	Qz vein No	Qz vein Wd (mm)	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
232			0.35	0.010			
233			0.38	0.026			
234			0.29	0.014			
235			0.25	0.011			
236			0.25	0.019			
237			0.29	0.013			
238			0.29	0.017	25	1	1
239			0.19	0.005			
240	7	18	0.18	0.007			
241	3 4 2	6 4 4	0.30	0.006			
242			0.28	0.003			
243	3 4	.4 8	0.68	0.009			
244	1 6	20 20	0.19	0.014	<5	11	1
245	2 2 2	4 20 10	0.22	0.004			
246	3 3 2	6 6 4	0.24	0.019			
247	3 2 4	8 8 10	0.18	0.011			
248	5 5 2	15 15 10	0.18	0.007			

Fig.54 Geological Log of MJT-3(3)

MJT－3 150m ～ 200m



Sample No	Qz vein No	Qz vein Wd (mm)	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
249	5; 3	15; 6	0.21	0.006			
250	1; –; 2	10; –; 4	0.21	0.006			
251	2; 3; 1	3; 3; 8	0.19	0.007			
252	2; –; 2	6; –; 3	0.18	0.005			
253	2; 1	8; 12	0.17	0.005			
254	2; 2	10; 5	0.26	0.007	10	1	1
255	2	5	0.17	0.008			
256	1	15	0.33	0.010			
257			0.25	0.006			
258	1; 2; 4	8; 15; 6	0.37	0.009			
259	1	4	0.12	0.007			
260	2	8	0.22	0.006	5	1	1
261			0.16	0.007			
262	3; –; 3	5; –; 2	0.19	0.009			
263	2; 4	4; 6	0.18	0.009			
264	1	8	0.23	0.006			
265	1	10	0.15	0.009			
266	1; 1	2; 4	0.15	0.011			

Fig.54 Geological Log of MJT-3(4)

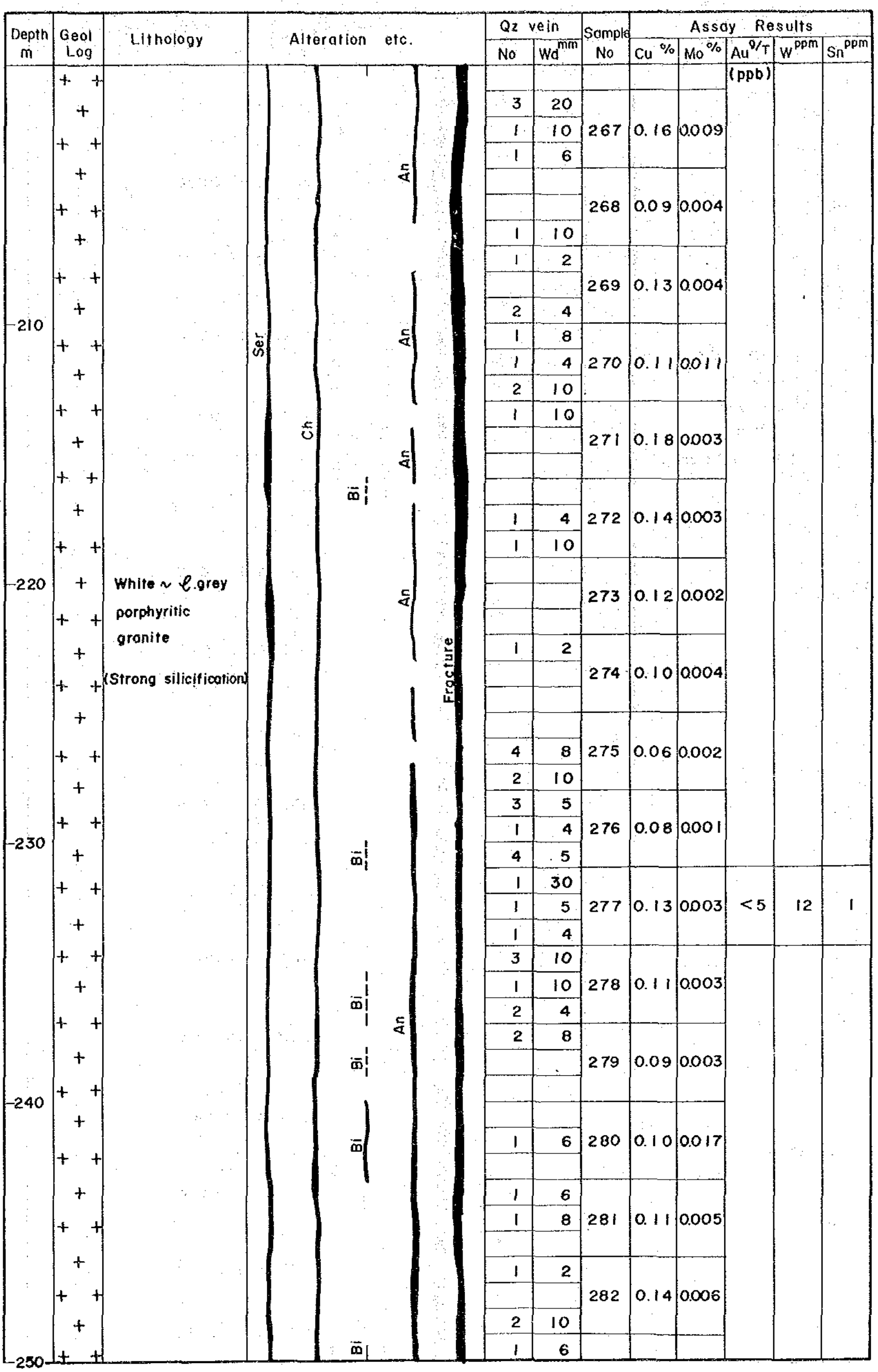


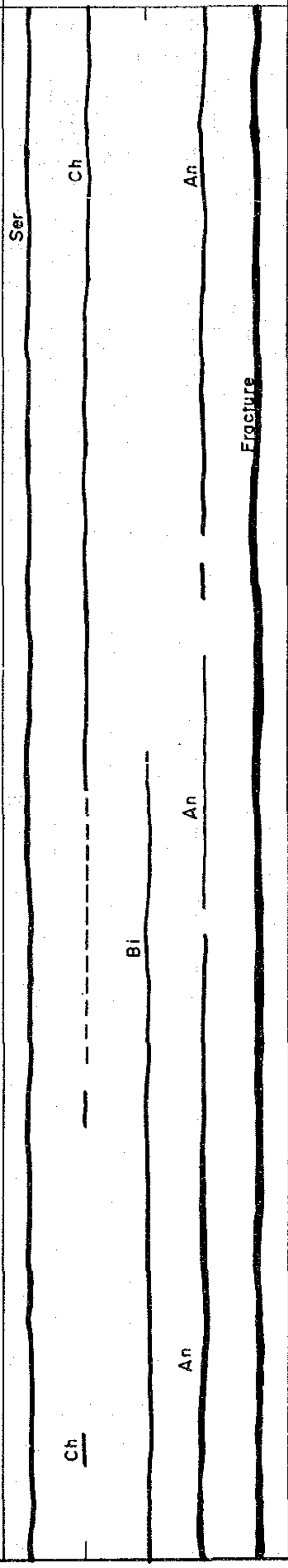
Fig.54 Geological Log of MJT-3(5)

MJT－3 250 m ～ 300m

Geol Log: granite symbol (+ +) from 250 m to 300 m

Lithology: White porphyritic granite

Predominant porphyritic texture



Qz vein (listed from top to bottom, 250 m – 300 m)

No	Wd (mm)
1	3
3	8
3	15
2	4
3	4
4	5
1	4
2	4
1	5
2	30
1	15
2	40
1	20
2	5
2	10
3	8
2	4
2	20
3	10
1	2
1	3
2	6
—	—
2	8
3	10
2	20
1	10
3	4
1	2
1	2
1	10

Assay Results

Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
283	0.13	0.007			
284	0.14	0.009			
285	0.11	0.008			
286	0.18	0.004	<5	3	1
287	0.11	0.003			
288	0.10	0.002			
289	0.13	0.003			
290	0.09	0.001			
291	0.09	0.002			
292	0.06	0.002			
293	0.12	0.003			
294	0.09	0.004			
295	0.07	0.004			
296	0.12	0.002	<5	3	2
297	0.08	0.004			
298	0.08	0.004			
299	0.11	0.003			
300	0.13	0.002			

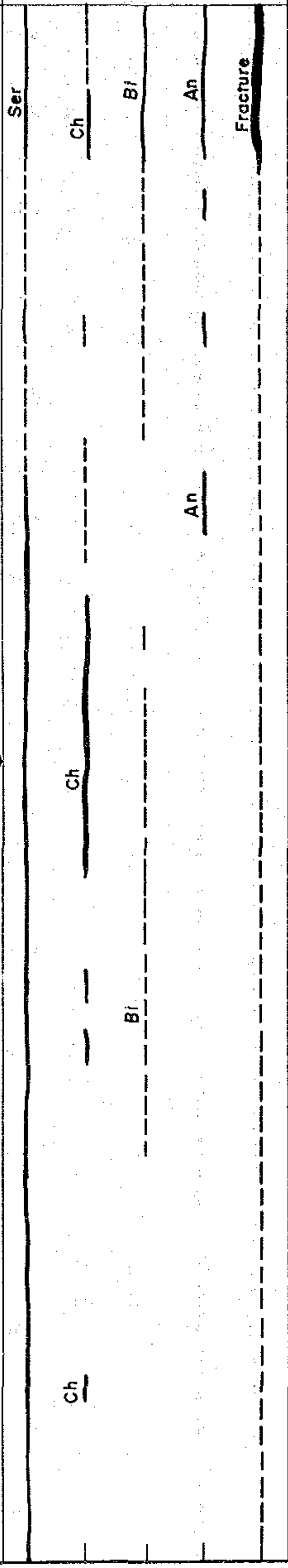
Fig.54 Geological Log of MJT-3(6)

MJT－3　　　　　　　　　　　　300 m ～ 350 m

Depth (m): 300 – 350 (scale marks 310, 320, 330, 340, 350; contact at 304.90)

Lithology: + + (above 304.90); White quartz porphyry (Strong silicification) (below 304.90)

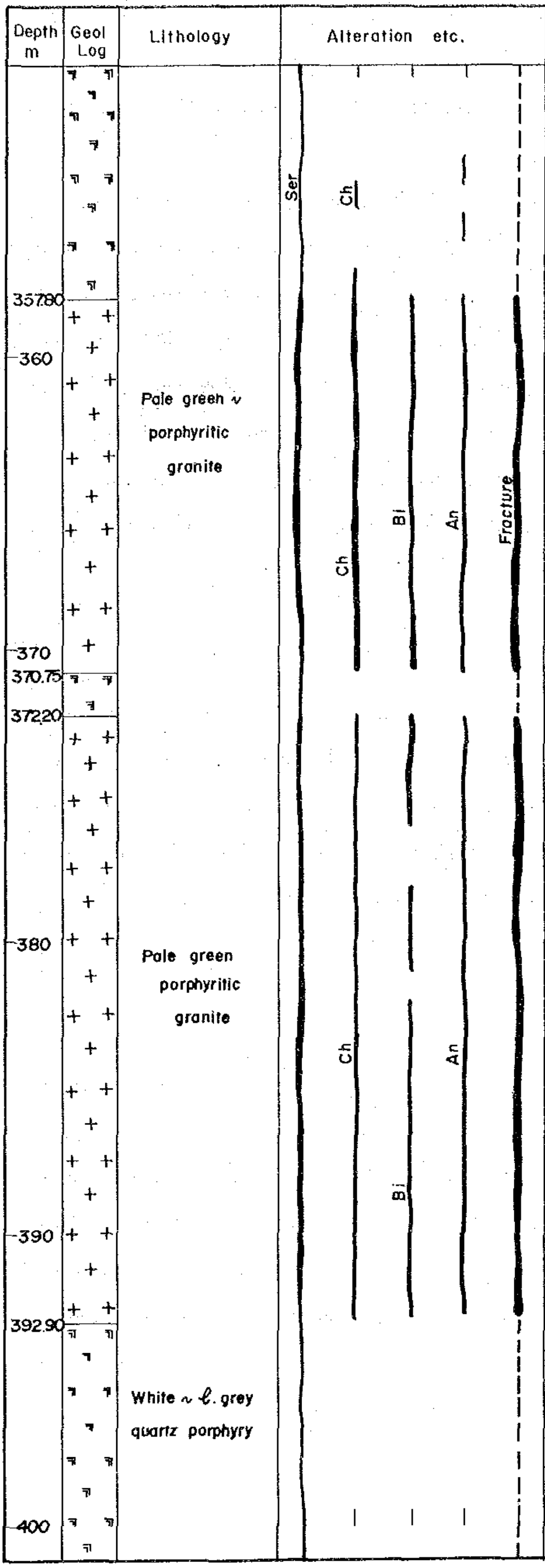
Alteration etc.:



Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
2	15						
1	4	301	0.07	0.004			
1	6	302	0.08	0.002			
		303	0.05	0.006	< 5	17	1
		304	0.05	0.002			
		305	0.38	0.006			
1	4	306	0.23	0.003			
		307	0.20	0.001			
		308	0.22	0.001			
		309	0.04	0.001			
1	4	310	0.05	0.006			
		311	0.04	0.002			
		312	0.04	0.001			
2	10						
		313	0.02	0.001			
		314	0.02	<0.001			
		315	0.02	0.001			
		316	0.01	<0.001			
		317	0.05	0.001			

Fig.54　Geological Log of MJT-3(7)

MJT－3 350 m ～ 401 m



Qz vein No	Qz vein Wd (mm)	Sample No	Cu %	Mo %	Au g/T (ppb)	W ppm	Sn ppm
		318	0.03	<0.001			
		319	0.01	<0.001			
		320	0.11	0.002			
1	12						
3	8	321	0.12	0.002			
2	8						
4	12						
1	10	322	0.11	0.002			
2	10						
4	12						
—	—	323	0.09	0.002			
1	10						
1	10						
		324	0.08	0.002			
1	2	325	0.10	0.001			
1	4						
2	4						
1	4	326	0.08	0.003			
3	6						
		327	0.04	0.004			
		328	0.06	0.002			
1	10						
		329	0.06	0.002			
1	6						
1	5						
		330	0.06	0.002			
2	2						
		331	0.10	0.004			
		332	0.03	<0.001			
		333	0.03	<0.001			
		334	0.05	<0.001			

Fig.54 Geological Log of MJT-3(8)

Density of the fissures tend to decrease, and mineralization also decreases in grade toward the deep part.

304.90 ~ 401.00 m : This range consists of porphyritic granite and intruded quartz porphyry. White silicified quartz porphyry accompanied by sericite has intruded at 304.90 ~ 357.80 m and 392.90 ~ 401.00 m. Few quartz veins in the quartz porphyry-only three quartz vein ranging 4 mm ~ 10 mm in width are observable. Chalcopyrites and molybdenite occur in a few fissures distributed throughout the quartz porphyry. Very minor amounts of disseminated chalcopyrite is partly observed. Even though mineralization of chalcopyrite and molybdenite embedded in porphyritic granite tends to become poor toward the deep part,the mineralization is stronger than mineralization in quartz porphyry.

【Alteration】

The rock has undergone silicification and sericitization throughout the hole from surface to hole bottom (401 m). Small amounts of chlorite are also evenly contained. Potassic feldspar begins to appear from around 130 m in depth, anhydrite from around 150 m in depth and biotite from around 190 m in depth. Judging by this evidence, the alteration of the hole is divided into two zones, namely the potassic zone from 150.00 m to depth and the phyllic zone from 150.00 m to surface.

【Mineralization】

It is an oxidized and limonitized zone from surface to 2.20 m, thus sulpide minerals are not recognizable. The range from 2.20 m to 16.00 m, is regarded as the secondary enrichment zone because of the existance of native copper and chalcosite. Below 16 m, content of sulphide minerals increase, associated with the disseminations of chalcopyrite and molybdenite. Mineralization of chalcopyrite and molybdenite continues to 401 m(hole bottom), but it tends to be weaken toward deep part. The mineralization is mostly emplaced as dissemination and along with fissures, differing from minelalization of MJT-1 and MJT-2. Quartz veins contain comparatively not much chalcopyrite and molybdenite, and mineralization used to be weak.

(4) Assay Result of Core

Drilling survey of the second phase resulted in three holes,totalling 1,003.00 m in length. With the excepting of surface soil (0 m to 9.90 m in MJT-1 and 0 m to 9.50 m in MJT-2) 983. 60 m of core were split, and half of the split core was subjected to chemical analysis on five elements(Au,Cu,Mo,Sn and W).

Taking into consideration that the ore deposit is porphyry copper type, the cores assayed were grouped and pulverized in each meter, then the three samples were combined for chemical assay. These combined samples (334 samples) were analyzed for Cu and Mo, 31 samples which contain much sulphide ore minerals such as pyrite,chalcopyrite and molybdenite, or had undergone strong argillaceous alteration and silicification were selected among all samples and analyzed for Au,Sn and W.

Average grades of these drill holes are as follows ;

Drill hole	Assayed range	Average grade		
		Cu%	Mo%	Equivalent Cu% *
MJT-1	9.90~301.00 m	0.066	0.0024	0.091
MJT-2	9.50~301.00 m	0.172	0.0085	0.257
MJT-3	0.00~401.00 m	0.237	0.0108	0.345

* Equivalent Cu% = Cu% + 10 X Mo%

In Figs.55 ~ 57 are presented histogram of assayed results in each drill holes.

MJT-1 has its best grade from 180 m to 190 m (the section intruded by Pg1) showing 0.001 % to 0.02% Mo and 0.1% to .2% Cu. Other section contain very low grades of Cu and Mo, in spite of the existence of mineralization.

In the case of MJT-2, the part from 9.50 m to 87.00 m contains 0.234% Cu, 0.0069% Mo, and 0.303% equivalent Cu. Except the part from 87.00 m to 195.00 m which contains very low grade, the mean grade from 9.50 m to 301.00 m (a range of 185.50 m) is 0.208% Cu, 0.013% Mo and 0.311% equivalent Cu. However, these grades may be lower than the actual grade because core recovery of some section was not complete owing to well- developed fractures. Core recovery was 81.70 % from 0.00 m to 100.00 m and 93.70% from 100 m to 200 m, and some ores embedded along the fissures may not be recovered from these sections.

As mentioned already, MJT-3 is situated close to the center of mineralization is associated with phyllic to potassic alteration zones, and is mainly characterized by dissemination type mineralization. Thus ore grade of MJT-3 is higher than that of MJT-1 and MJT-2, showing 0.249% Cu, 0.0121% Mo and 0.37% equivalent Cu at a range from 0 m to 147 m.

Only a few amounts of Sn and W are detected through this assay, and only ppb unit grade of Au is also recognizable as similar to other porphyry copper type ore deposits accompanied by Cu and Mo.

1-7-5 Result of the Drilling Survey

(1) MJT-1

Along forest road, constructed on the side of Maden Stream running north-south in central survey area, sericitized and chloritized andesite of Zigana Formation are exposed, and molybdenite and pyrite crop out in quartz veins or fissures in the andesite. The MJT-1 is situated at the most remarkable mineralized showing.

The drilling was completed at 301.00 m in depth. Core recovery was 89.4 % up to 100 m, and 100 % below 200 m. Geology of the hole consists mostly of altered andesite, and intrusive rocks of quartz porphyry and altered porphyritic granite having less than 10 m width occur in some parts. Among the intrusive rocks, quartz porphyry occurring at depth from 101.6 m to 119.90 m has undergone strong alteration (silicification and sericitization), and is accompanied by molybdenite and chalcopyrite in quartz veins and fissures. The altered quartz porphyry (Qp1) is not exposed on the surface, and was first found from the drillholl, MJT-1 and MJT-3. The boundary between andesite and quartz porphyry is distinct and dips about 60°. Two intrusive rocks of Pgl dip 60° to 70° and might intrude from the east or south-east, referring to its extensive distribution on the surface as indicated by geological survey.

Chalcopyrite, pyrite and molybdenite are usually embedded along fissures or in quartz veins in andesite and intrusive rocks. Quartz veins contact sharply with host rock at a depth from 9.90 m to 250 m. Most of the dips have lower than 60° and vertical quartz vein are rare. Below 250 m, segregated quartz veins increasingly occur, and mineralization is not observed in this part. In general, chalcopyrite and molybdenite are observed in chlorite rich section at the boundary of host rock and quartz veins. Mineral assemblages of chalcopyrite-pyrite-quartz-chlorite and molybdenite-pyrite-quartz-chlorite are common, and it indicates that slight stage difference between copper and molybdenite mineralizations might exist. Many magnetites are characteristically contained in andesite as disseminations or veins. Vein type magnetite is pre-mineralization and is cut by chalcopyrite-quartz vein and pyrite-molybdenite-quartz veins.

The area is located in the propylitic zone regarded as the peryphery part of mineralization. The deeper part of the hole gradually become farther from mineraization, even though the surface displays predominant mineralization.

(2) MJT-2

This holle was conducted the vicinity of the junction of Maden and Mat Streams. The drilling site is covered by a sand and gravel bed, and chloritezed andesite is exposed just downstream from the site. Ten m east of the site, altered porphyritic granodiorite crops out.

The hole was completed at 301.00 m in depth. Owing to a stronger fractured condition than MJT-1, core recovery was lower, 81.70% from surface to 100 m, 93.7 % from 100 m to 200 m and 100 % from 200 m to hole bottom (301 m). The rock consists mostly of andesite, and three altered porphyritic granite (Pgl) dykes several meters wide have intruded into the andesite. Their contacts with the andesite are distinct and dip about 60°, the same as that in MJT-1, suggesting intrusion from the east or south east.

Characteristics of mineralization resembles that of MJT-1. As the rock is very brittle from

Table22 Cumulative Average Grade (1)

MJT－1

Sample No	Cu	Mo	Cu+10Mo
1	530	14	670
2	777.059	9.29412	870
3	841.111	10.2963	944.074
4	862.432	9.13514	953.784
5	834.255	16.1277	995.532
6	773.86	22.0702	994.561
7	732.985	23.403	967.015
8	736.493	21.4026	950.519
9	874.828	20.3218	1078.05
10	808.763	19.6701	1005.46
11	792.991	20.1682	994.673
12	769.658	20.4103	973.761
13	756.299	19.748	953.78
14	742.701	21.9562	962.263
15	735.034	21.1429	946.463
16	736.624	25.9745	996.369
17	727.246	25.018	977.425
18	721.186	24.1695	962.881
19	709.893	23.1444	941.337
20	689.848	22.731	917.157
21	678.019	22.0193	898.213
22	655.576	21.1429	867.005
23	641.366	20.652	847.885
24	665.359	19.9072	864.43
25	652.753	19.587	848.623
26	669.767	19.2918	862.685
27	648.839	18.7566	836.404
28	629.892	18.1877	811.769
29	616.516	17.6237	792.753
30	606.599	17.367	780.269
31	615.831	19.7329	813.16
32	618.801	19.8675	817.476
33	604.832	19.5046	799.878
34	593.858	19.2522	786.38
35	591.153	19.1297	782.45
36	583.585	19.1821	775.406
37	609.101	19.8038	807.139
38	617.613	20.7109	824.722
39	616.124	20.2791	818.915
40	621.511	20.0202	821.713
41	622.703	19.6757	819.459
42	646.858	19.7074	843.933
43	658.876	20.1358	860.234
44	662.563	20.5217	867.78
45	655.347	20.6219	861.566
46	657.637	20.4989	862.626
47	656.617	20.2099	858.715
48	663.606	19.9748	863.354
49	661.478	19.729	858.768
50	654.708	19.9155	853.863
51	651.026	19.7396	848.422
52	659.903	20.499	864.894
53	658.767	20.4137	862.903
54	652.775	20.3873	856.648
55	649.982	20.2523	852.505
56	649.982	20.1759	851.742
57	643.704	20.455	848.254
58	645.719	20.8458	854.177
59	649.54	20.8143	857.683
60	677.018	22.6432	903.451
61	689.918	22.9127	919.044
62	696.402	22.7682	924.084
63	693.429	23.3301	926.73
64	691.648	23.1052	922.7
65	690.85	23.3045	923.895
66	694.947	23.2846	927.793
67	693.523	23.0855	924.378
68	698.641	23.0842	929.483
69	697.933	22.9811	927.744
70	699.541	22.924	928.781
71	711.711	23.2928	944.639
72	722.008	24.1116	963.124
73	726.52	24.8391	974.911
74	730.231	24.882	979.05
75	730.094	24.7229	977.323
76	734.188	24.5812	980
77	744.042	24.691	990.952
78	741.287	24.5663	986.95
79	741.906	24.953	991.436
80	739.749	25.1543	991.292
81	734.486	25.0533	985.019
82	727.944	24.8935	976.879
83	721.62	25.6082	977.703
84	716.117	25.4217	970.335
85	711.263	25.2043	963.306
86	707.445	25.0268	957.713
87	705.744	24.842	954.164
88	705.45	24.7412	952.862
89	701.838	24.4961	946.798
90	696.198	24.2676	938.874
91	690.441	24.2095	932.536
92	687.165	24.0218	927.383
93	683.118	23.9461	922.578
94	679.648	24.8645	928.292
95	674.53	24.8342	922.872
96	669.081	24.627	915.35
97	663.206	24.4137	907.342
98	662.851	24.371	906.561

MJT－2

Sumple No	Cu	Mo	Cu+10Mo
99	2950	19	3140
100	2737.27	25	2987.27
101	2353.53	43	2783.53
102	2008.26	38.0435	2388.7
103	1793.45	35.9655	2153.1
104	1691.71	32.7143	2018.86
105	1736.83	31	2046.83
106	1756.38	31.5106	2071.49
107	1717.17	31.4528	2031.7
108	1776.44	34.1525	2117.97
109	2074	40.2308	2476.31
110	2028.03	39.2817	2420.85
111	2099.09	40.5065	2504.16
112	2124.46	47.3373	2597.83
113	2248.88	50.8876	2757.75
114	2242	51.2737	2754.74
115	2279.31	55.3564	2832.87
116	2329.25	59.2617	2921.87
117	2425.93	58.3451	3009.38
118	2497.23	61.2017	3109.24
119	2512.72	62.44	3137.12
120	2492.44	63.7023	3129.47
121	2454.67	63.3212	3087.88
122	2417.97	69.2657	3110.63
123	2363.69	67.9665	3043.36
124	2336.45	69.5936	3032.39
125	2294.1	67.4845	2968.94
126	2281.04	67.8712	2959.75
127	2243.73	66.1716	2905.44
128	2191.49	64.4857	2836.34
129	2139.72	66.8232	2807.96
130	2094.81	65.7701	2752.51
131	2064.2	64.8757	2712.95
132	2025.48	63.4322	2659.8
133	1990.78	62.5415	2616.2
134	1964.88	62.0142	2585.02
135	1923.27	60.7419	2530.69
136	1894.13	59.5381	2489.51
137	1860.48	58.3188	2443.67
138	1832.13	57.6468	2408.6
139	1807.43	56.9087	2376.51
140	1787.33	56.0122	2347.45
141	1769.6	55.3478	2323.08
142	1759.19	54.4826	2304.02
143	1744.49	53.566	2280.15
144	1728.01	52.8229	2256.24
145	1715.7	53.6715	2252.42
146	1695.65	53.5724	2231.38
147	1681.63	53.4152	2215.78
148	1671.02	53	2201.02
149	1658.84	53.1395	2190.23
150	1646.74	54.544	2192.18
151	1627.25	54.1885	2169.14
152	1636.71	55.3323	2190.03
153	1625.69	56.0646	2186.34
154	1631.03	58.1299	2212.33
155	1625.49	59.2315	2217.8
156	1621.37	60.2945	2224.32
157	1612.75	60.4957	2217.71
158	1613.55	60.0986	2214.54
159	1614.16	60.1302	2215.46
160	1623.9	60.9455	2233.35
161	1628.66	60.8016	2236.68
162	1679.18	62.7678	2306.86
163	1670.94	62.4597	2295.53
164	1675.52	62.8977	2304.5
165	1686.32	67.0856	2357.18
166	1713.92	67.397	2387.89
167	1710.2	67.2445	2382.64
168	1703.11	67.8627	2381.74
169	1703.21	69.1758	2394.96
170	1808.97	74.2459	2551.43
171	1834.62	77.6513	2611.13
172	1831	81.2369	2643.37
173	1819.8	81.1528	2631.33
174	1814.88	80.7916	2622.79
175	1805.89	83.1444	2637.33
176	1801.14	82.6372	2627.52
177	1789.62	82.8337	2617.95
178	1781.79	83.1137	2612.93
179	1792	84.0728	2632.72
180	1792.96	84.0719	2633.68
181	1787.57	83.6329	2623.89
182	1782.18	84.5511	2627.7
183	1776.22	84.0931	2617.15
184	1769.45	83.9746	2609.2
185	1761.45	83.5223	2596.67
186	1758.68	84.3996	2602.68
187	1752	84.8034	2600.04
188	1749.63	84.7271	2596.9
189	1746.19	84.4861	2591.05
190	1741.74	83.7569	2579.31
191	1738.9	83.9873	2578.77
192	1744.38	83.7514	2581.9
193	1741.36	83.3186	2574.55
194	1738.51	85.1226	2589.74
195	1732.08	85.2773	2584.85
196	1727.43	84.8216	2575.64
197	1723.78	84.5521	2569.3

Table22 Cumulative Average Grade (2)

MJT − 3

Sample No	Cu	Mo	Cu+10Mo	Sumple No	Cu	Mo	Cu+10Mo
267	2360.29	107.618	3436.47	198	790	90	1690
268	2338.55	106.667	3405.22	199	1530	115	2680
269	2323.14	105.729	3380.43	200	1553.33	111.667	2670
270	2306.06	105.789	3363.94	201	1617	109.6	2713
271	2299.44	104.778	3347.22	202	2394.17	101.833	3412.5
272	2287.53	103.74	3324.93	203	2403.33	96.2667	3366
273	2273.11	102.635	3299.46	204	2359.44	116.889	3528.33
274	2256.53	101.773	3274.27	205	2312.38	144.476	3757.14
275	2235.13	100.737	3242.5	206	2229.58	150.167	3731.25
276	2215.97	99.6104	3212.08	207	2187.41	149.593	3683.33
277	2204.23	98.6539	3190.77	208	2131.67	141.933	3551
278	2190	97.8101	3168.1	209	2071.52	138.121	3452.73
279	2174.38	96.9125	3143.5	210	2173.89	144.944	3623.33
280	2159.88	97.8148	3138.02	211	2150.51	145.718	3607.69
281	2146.59	97.2683	3119.27	212	2145.48	140.524	3550.71
282	2136.99	96.8072	3105.06	213	2173.78	140.489	3578.67
283	2127.26	96.4643	3091.91	214	2217.92	137.958	3597.5
284	2118.71	96.4118	3082.82	215	2200.39	138.667	3587.06
285	2106.98	96.1977	3068.95	216	2233.7	136.519	3598.89
286	2103.45	95.5517	3058.97	217	2255.09	136.702	3622.11
287	2091.7	94.75	3039.2	218	2235.83	135.117	3587
288	2082.67	94.1504	3024.17	219	2214.13	131.873	3532.86
289	2079.89	93.9176	3019.06	220	2204.39	130.652	3510.91
290	2066.67	93.0074	2996.74	221	2205.51	128.275	3488.26
291	2053.63	92.1941	2975.57	222	2235.69	126.097	3496.67
292	2037.28	91.4529	2951.81	223	2227.87	127.053	3498.4
293	2028.39	90.8136	2936.52	224	2215.26	128.128	3496.54
294	2016.81	90.2411	2919.22	225	2199.14	126.457	3463.7
295	2002.84	89.6702	2899.54	226	2200.95	125.226	3453.21
296	1994.58	88.9861	2884.44	227	2188.85	124.874	3437.59
297	1982.06	88.4708	2866.77	228	2241.56	122.544	3467
298	1969.8	87.9354	2849.15	229	2264.09	121.398	3478.06
299	1961.01	87.33	2834.31	230	2313.33	120.729	3520.63
300	1954.5	86.6867	2821.37	231	2310.51	122.525	3535.76
301	1941.68	86.1749	2803.43	232	2344.02	121.863	3562.65
302	1930.1	85.5164	2785.26	233	2384.76	125.667	3641.43
303	1916.21	85.2201	2768.41	234	2400.19	126.065	3660.83
304	1902.6	84.6026	2748.62	235	2403.42	125.496	3658.38
305	1888.05	84.3587	2731.64	236	2405.18	127.193	3677.11
306	1872.38	83.8742	2711.12	237	2418.89	127.265	3691.54
307	1856.7	83.2025	2688.73	238	2431.17	128.333	3714.5
308	1841.55	82.5525	2667.07	239	2417.24	126.374	3680.98
309	1828.32	81.896	2647.28	240	2401.35	125.032	3651.67
310	1815.77	81.6788	2632.56	241	2415.27	123.612	3651.4
311	1803.15	81.1502	2614.65	242	2424.92	121.553	3640.45
312	1790.58	80.5149	2595.73	243	2523.04	120.83	3731.33
313	1776.78	79.8643	2575.42	244	2509.28	121.138	3720.65
314	1762.77	79.1901	2554.67	245	2502.06	119.496	3697.02
315	1749.57	78.5449	2535.02	246	2498.89	120.965	3708.54
316	1735.48	77.8851	2514.33	247	2485.24	120.639	3691.63
317	1724.58	77.2279	2496.86	248	2471.13	119.667	3667.8
318	1712.51	76.5819	2478.33	249	2463.27	118.516	3648.43
319	1699.11	76.0056	2459.17	250	2456.28	117.468	3630.96
320	1693.7	75.5056	2448.76	251	2444.84	116.648	3611.32
321	1689.37	75.022	2439.59	252	2433.09	115.414	3587.22
322	1684.7	74.5383	2430.09	253	2419.94	114.152	3561.45
323	1678.65	74.103	2419.68	254	2423.33	113.274	3556.07
324	1671.16	73.6667	2407.83	255	2410.47	112.637	3536.84
325	1665.95	73.1733	2397.69	256	2426.49	112.368	3550.17
326	1659.64	72.791	2387.55	257	2428.08	111.463	3542.71
327	1650.03	72.5643	2375.67	258	2448.78	111.172	3560.5
328	1642.06	72.1849	2363.91	259	2435.27	110.764	3542.91
329	1633.91	71.8114	2352.02	260	2434.1	110.508	3539.18
330	1625.88	71.4436	2340.31	261	2420.32	109.839	3518.71
331	1621.1	71.1654	2332.75	262	2411.59	109.444	3506.03
332	1611.09	70.6338	2317.43	263	2401.56	109.063	3492.19
333	1601.56	70.1103	2302.67	264	2399.54	108.246	3482
334	1595.95	69.7656	2293.6	265	2386.06	107.939	3465.45
				266	2372.09	107.896	3451.04

MJT−1

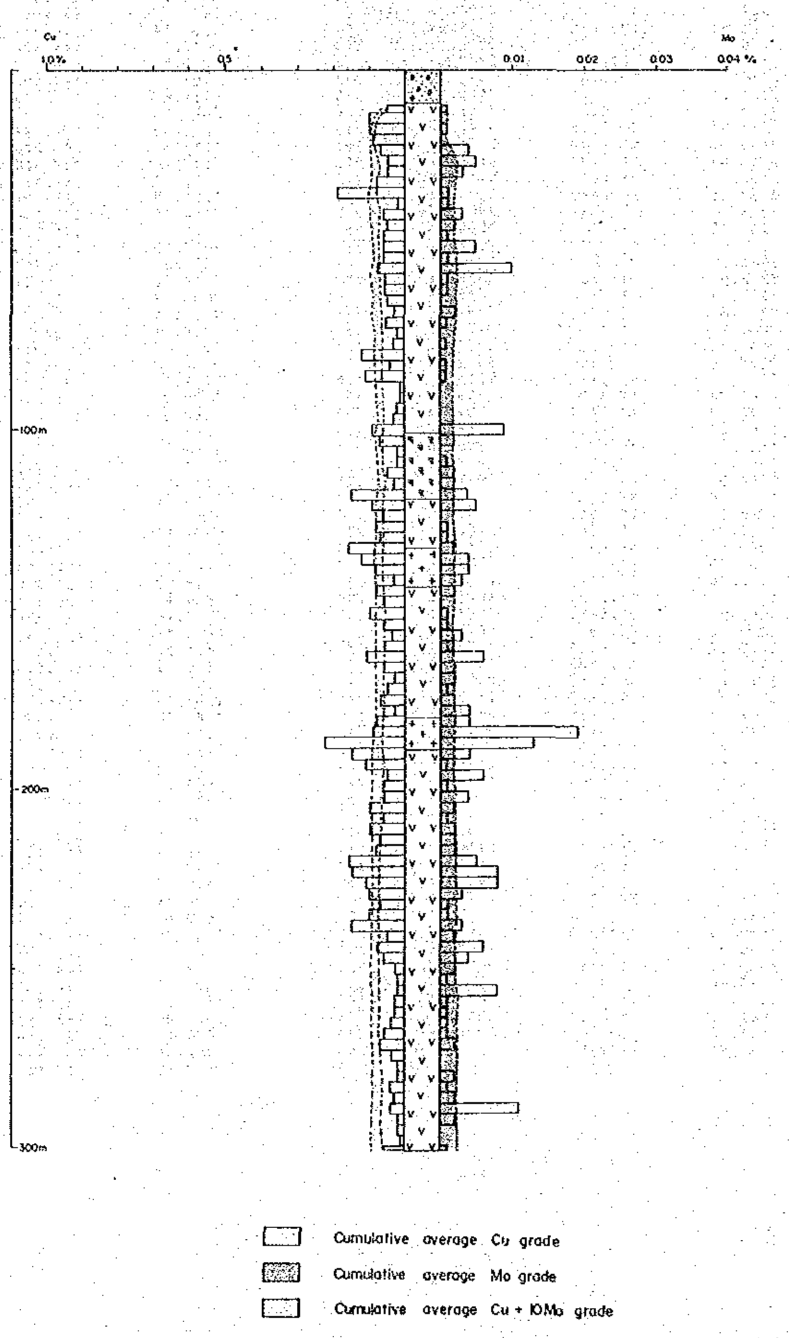


Fig.55 Chemical Analysis Map of Copper and Molybdenum of MJT-1

MJT－2

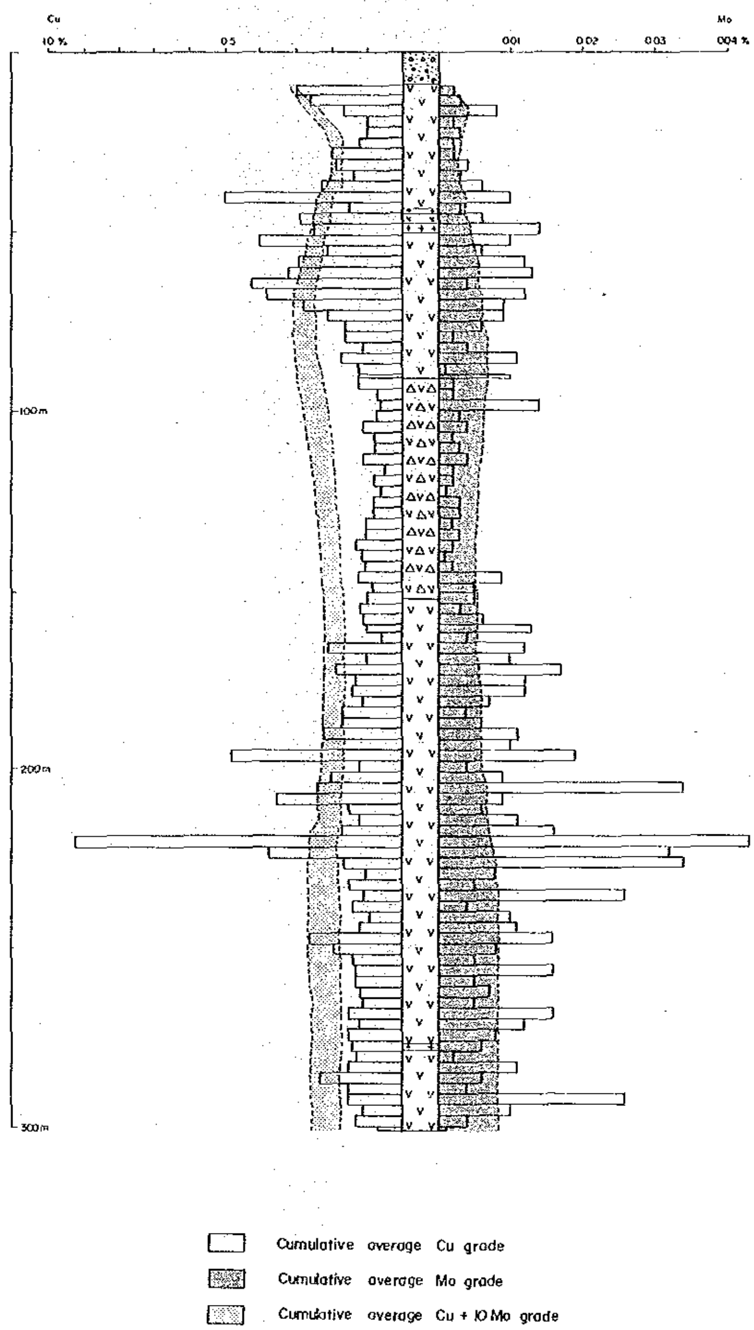


Fig.56 Chemical Analysis Map of Copper and Molybdenum of MJT-2

MJT-3

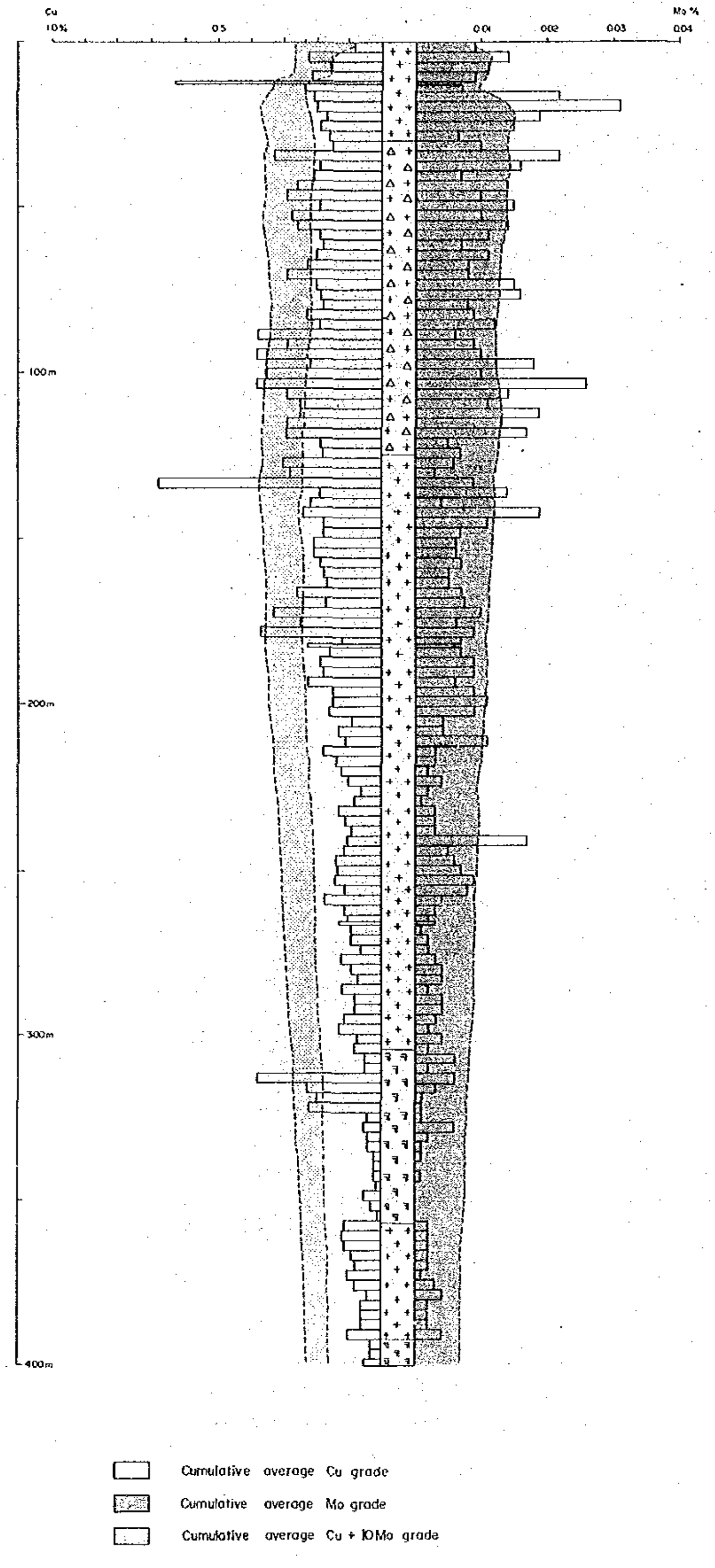


Fig.57 Chemical Analysis Map of Copper and Molybdenum of MJT-3

30 m to 70 m,the core was not completly recovered. Therefor, ore grade is lower than expected, in spite of the recognition of chalcopyrite and molybdenite. At a depth of 190 m to 230 m, ores are, remarkably embedded along quartz veins and fissures, and mineralization is slightly improved. The hole is still in the propylitic zone, but it may be closer to the mineralizationcenter.

(3) MJT-3

The drilling site is the located at the northern margin of altered porphyritic granite (Pgl) as indicated by geological survey ,even though there is poor exposure. Minor amounts of chalcopyrite are observed by the nacked eye in outcrop, but no molybdenite is observed.

Adding 100 m to the planned depth, the hole was completed at 401.00 m in depth. Average core recovery is 97.8 % at the part from surface to 100 m and 100 % below 100 m. The rock consists mainly of altered porphyritic granite (Pgl), and three quartz porphyry dykes (Qpl) have intruded into Pgl. The hole bottom is quartz porphyry. Altered quartz porphyry (Qpl) are weakly fractured compared with altered porphyritic granite (Pgl). Chalcopyrite and molybdenite bearing quartz veins are scarely embedded, while barren fissures and minor amount of chalcopyrite disseminations are observed in altered quartz porphyry (Qpl). Copper grade in Qpl improves to 0.25 % at depth from 312 m to 325 m, but becomes rapidly lower, and alteration changes to weaker argillization, although there is strong silisification toward deeper Qpl. In altered porphyritic granite (Pgl), the section from 357.00 m to 392.90 m is intercalated by altered quartz porphyry (Qpl). Here the copper grade recovers to that of the shallower part (i.e. 304.90 m). It indicates that the altered quartz porphyry(Qpl) intruded at a later stage of mineralization while the unaltered quartz porphyry (unmineralized) which is exposed on the surface, intruded after the episode of mineralization.

1-7-6 Relation between Diamond Drilling Results and Geological Survey Results

(1) Altered porphyritic granite(Pgl)

Porphyritic granodiorite is classified into altered porphyritic granite(Pgl) and unaltered porphyritic granite(Pg2) by differnces in mode of alteration. Porphyry copper type mineralization is embedded in the altered porphyritic granite (Pg1) in the Hasandere Area. The intrusion was inferred to be vertical in form, since it could not be unravelled by the initial phase geological survey. Drilling survey of the second phase reveals that the altered porphyritic granodiorite (Pg1) has intruded into andesite of the Zigana Formation. It dips 60° to 70° east. Alteration zoning indicates that the center of mineralization is situated slightly at east of the intrusion. Investigation of fluid inclusion also reveals that homogenization temperature of the inclusions is higher and boiling phenomena of the inclusions is observed in samples collected from the Mat Dere to Hasan Dere area. This also is in accord with the above conclusion.

Most ore minerals were leached and limonitized on the surface, and primary sulphide ore, especially chalcopyrite and molybdenite, are recognizable only at Hasandere. As mentioned earlier, *ore minerals in the high ridge area were almost completly leached. Only unleached molybdenites* are remained. Drilling results of MJT-3 indicates that ore minerals were leached on the surface at the projected ridge in the altered porphyritic granite area, and mineralization changes to a primary ore zone. A weak secondarily enriched ore zone is intercalated between the leached and primary zones.

(2) Andesite (Zigana Formation)

In the andesite of Zigana Formation (which is distributed in an area from MJT-2 site to upstream of Mat Dere and surrounds altered porphyritic granite(Pg1)), a magnetite-pyrite bearing zone (chalcopyrite may be leached) is obserbed. Andesites of MJT-1 and MJT-2 contain much magnetite as well as surface rock, and surrounds altered porphyritic granite(Pg1). The part having extensive distribution of propylitic zone～magnetite-pyrite zone is regaded as the marginal part of mineralization, regardless of strong or weak mineralization. On the basis of this fact, the prospectable area is 1.8 km X 1.8 km covering the andesite and altered porphyry granite (Pg1) areas.

(3) Ore Minerals

Sulphide ore minerals occur in the following areas ;

① Magnetite : It is distributed in vein and as dissemination in the propylitic zone, and is accompanied by a small amount of hematite.

② Chalcopyrite : Dstribution extends from the potassic zone to the propylitic zone. The mineral assemblage is mainly chalcopyrite-pyrite in fissures, and chalcopyrite-pyrite-quartz in quartz veins. Chalcopyrite content increases toward the center of the mineralization.

③ Pyrite : It occurs along fissures in quartz veins and as disseminations, throughout the mineralized area, but especially in the propylitic zone to the phyllic zone.

④ Molybdenite : It is distributed over the potassic zone to the propyritic zone. Molybdenite assembles are mostly quartz-molybdenite, and quartz-pyrite-molybdenite.

⑤ Sphalerite : Some sphalerite is observed in the potassic zone of MJT-3.

⑥ Chalcosite and native copper : They are present in the secondary enrichment zone of the phyllic zone ranging from 2.3 m to 16 m of MJT-3.

(4) Geologicasl structure

Porphyry copper type ore deposits generally accompany stock-formed intrusive rock. Such intrusives usually intruded along tectonic lines of weakness such as faults and linearments. Rocks and Formation in the area have commonly been displaced by fault movements along tectonic lines. This area was investigated from this point of view, and a survey inferred post-mineralization fault striking north-south was found by this geological survey. Unaltered porphyritic granite (Pg2) extends in an east-west direction, and altered porphyritic granite (Pg1) may be distributed to the southwest～northeast direction. These intrusions may be intruded along latest tectonic lines.

(5) Mineralization

In the potassic zone of MJT-3, inferring as the periphery of the core of themineralized area, mineralization is in the form of dissemination and veinlets. This is also the case for the phyllic zone of MJT-3, which is close to the core. Mineralization in MJT-1 and MJT-2 is vein type in the propylitic zone.

(6) Alteration Zoning

Zoning of alteration in this surveyed area is characterized by X-ray diffraction analysis as follows ;

1) Potassic zone : The zone is usually in the core of the porphyry copper type ore deposit, and biotite and potassic feldspar indicates the alteration mode. The zone of the surveyed area is characterized by the existence of a small amount of biotite and potassic feldspar, and additionally contains quartz and anhydrite.

2) Phyllic zone : This zone consists of quartz sericite with a small amount of chlorite as the altered mineral,and surrounds the potassic zone.

3) Argillic zone : This zone is usually distributed at the periphery of phyllic zone of the porphyry copper type ore deposit, and is represented by a kaolinite and a montmorillonite minerals, but this zone is absent in the surveyed area.

4) Propylitic zone : The zone containing chlorite, epidote and magnetite is located on the marginal section of the alteration in the area.

(7) Fissures in the Mineralized Area

According to the drilling results from MJT-1, MJT-2 and MJT-3, most fractures and shatter cracks have been formed with irregular directions of less than 60° dip, vertical dip is extremely rare. Detailed survey could not clarify a predominant or special direction among the fissures. Furthermore, core collected from 91.2 m to 152. m of MJT-1 and from 30 m to 125 m of MJT-3 were broken into thin plate fragments owing to ribbon structure. Chalcopyrite and pyrite were found along these fractures. Ore grade of this section was quite good although core recovery was low.

1-7-7 Relation Between Drilling Survey and Geophysical Survey Results

Results of the drilling survey and geophysical survey (SIP method) using drilling holes, reveals their relation as follows ;

① Zone consisting of high PFE and high phase value were found on the survey Line A connecting MJT-1 and MJT-2 holes along Mat Dere.

② By the SIP survey on the survey Line connecting MJT-2 and MJT-3 holes, the western side of the inferred fault striking north-south, has low PFE and low phase value. The part between MJT-2 and MJT-3 sites has a somewhat high of PFE and phase value. These values fall slightly at east of the MJT-3 site.

③ Among SIP responses obtained from laboratory tests of cores and rock samples, PFE and phase values are in proportional correlation, while both values and resistivity values have inversely proportional correlation.

④ The relation between copper or molybdenum grades and SIP response is that there is no correlation. Phase spectra of the higher copper grade section is similar to spectra type of the non mineralized area (general type spectra).

The above mentioned SIP method survey result indicates that the high PFE value (Phase value) anomaly is caused by pyrite emplacement. Determination of a pyrite rich zone by geophysical survey and by consideration of geological and alteration conditions is very useful for finding of copper rich zones which may surround the pyrite.

1-7-8 Porphyry Copper Ore Deposit in Turkey

The survey area is located at the eastern part of the Pontid Belt. This belt is a part of the zone where the African Plate is subducted under the Eurasian Plate. This zone extends from Iran and the Minor Caucasus of USSR throuth the Pontid Belt to Bulgaria. Porphyry copper ore deposits have been discovered along this belt. Both old granite, which intruded during the Hercynian Orogeny (Carboniferous according to age determination), and young granite, which intruded during the Alpine Orogeny, occur in the surveyed area. The former is the Gümüşhane Granite and the latter is the Torul, Kürtün, Kopus and Hasandere Granodiorite.

The intrusion period of the granodiorite is from Late Cretaceous to Early Tertiary.

Porphyry copper type ore deposits reported from the Europe to Turkey are Dereköy, Sükrüpaşa, İkiz Tepe around Demirköy near the Bulgarian border.

Dereköy is situated 20 km northwest of Demirköy and a 25 hole (approximately more than 8, 000 m) drilling survey was carried out. The potential of the deposit is more than 200 million tons with the grade ore of 0.27 % equivalent Cu (Cu+Mo). MTA is studying the feasibility of the deposit. At Şükrüpaşa, 20 holes were drilled, and it is said that a skarn type porphyry copper ore deposit (Cu, W, Mo) has been reported to be several million tons with an equivalent Cu of 0.80 %. It is also said that porphyry copper type mineral showings have been discovered at İkiz Tepe near Demirköy, which has higher molybdenum grade and been worked by a private company.

In the eastern Pontid Belt, mineral showings at Bakırçay, Ulutaş, Maçka, and Merzifon are reported to be porphyry copper type deposits. At Ulutaş, 19 holes were drilled to 300 m in depth. An intrusive stock of granodiorite porphyry (4.5 km X 0.60 km in size is present, and mineralization is embedded between this stock and the host meta-sedimentary rock and volcanic rocks. The Ulutas deposit is said to be 200 million tons of 0.20 % Cu and 0.012 % Mo. The alteration pattern of the mineral showing is potassic, phyllic, propylitic zoning from the center to the marginal part, the same pattern as in the Hasandere area. The mineral showing was also found by geochemical survey of the stream sediment conducted by the United Nations Development Project.

As above mentioned, porphyry copper type ore deposits in Turkey accompany granodiorites intruded during the period from upper Cretaceous to Paleogene. The granodiorites belong to a magnetite series granitoid. The result of the past surveys show low Cu-Mo grade and workable ore deposits have not yet been found. This is believed to be due to the fact that the major exploration effort for copper in Turkey has been directed to relatively high grade mineralized zone. The newly discovered Hasandere ore deposit is also one example. Others such as new discoveries of porphyry tungsten ore deposits near Uludağ and at Keban near Elazig are also known. It is said that the latter has a potential of four million tons of ore with 0.60 % Cu and 0.62 % WO_3. The mineralized area is extensively distributed, and it is expected that the porphyry tungsten ore deposit will increase in volume. The mineralized belt is re-evaluated with respect to its potentiality, and it becomes a very interesting and promising area for large scale porphyry copper type ore deposits.

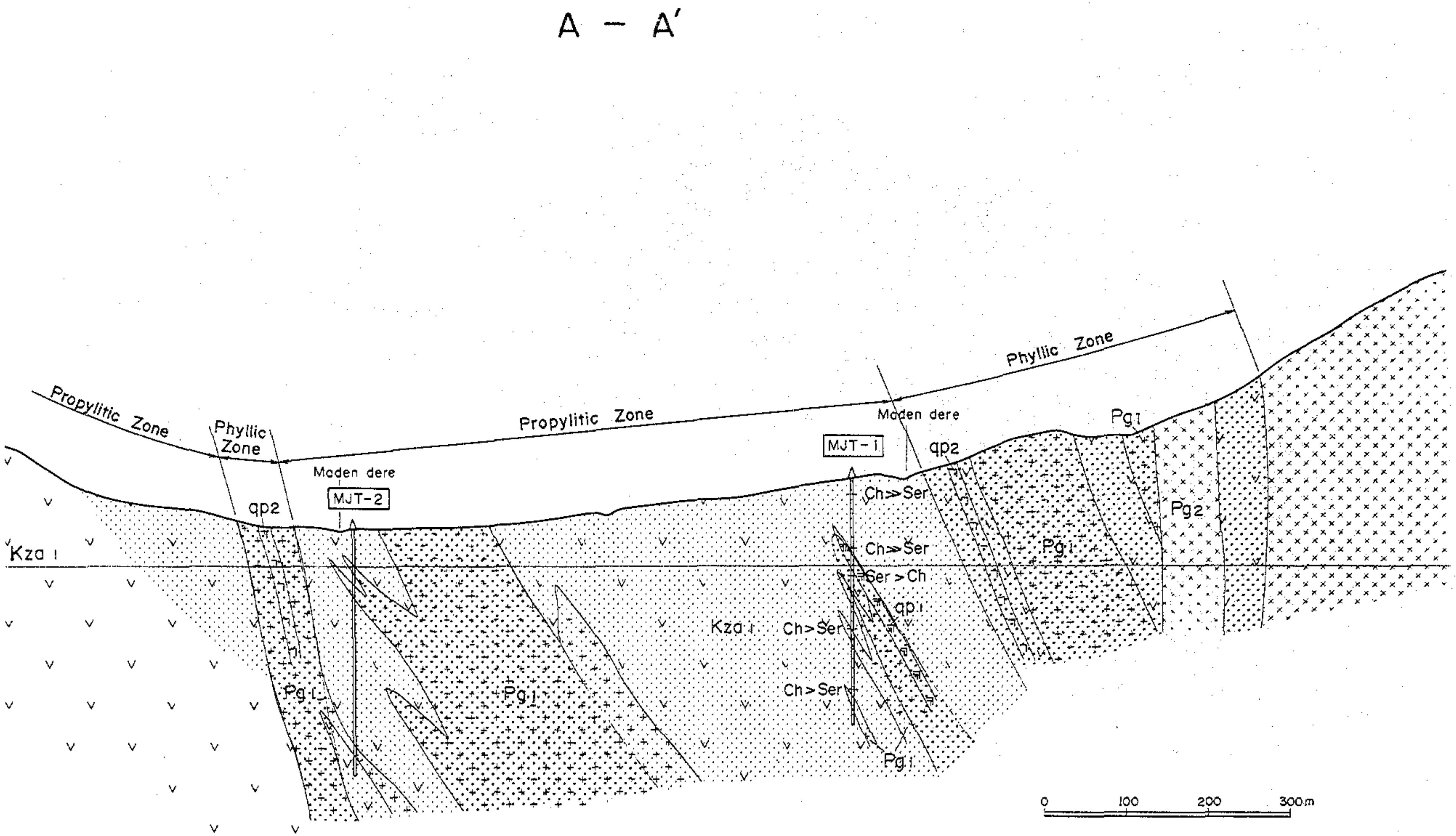


Fig.58 Relation Map between Geological Profile and Alteration zoning of drilling Holes (1)

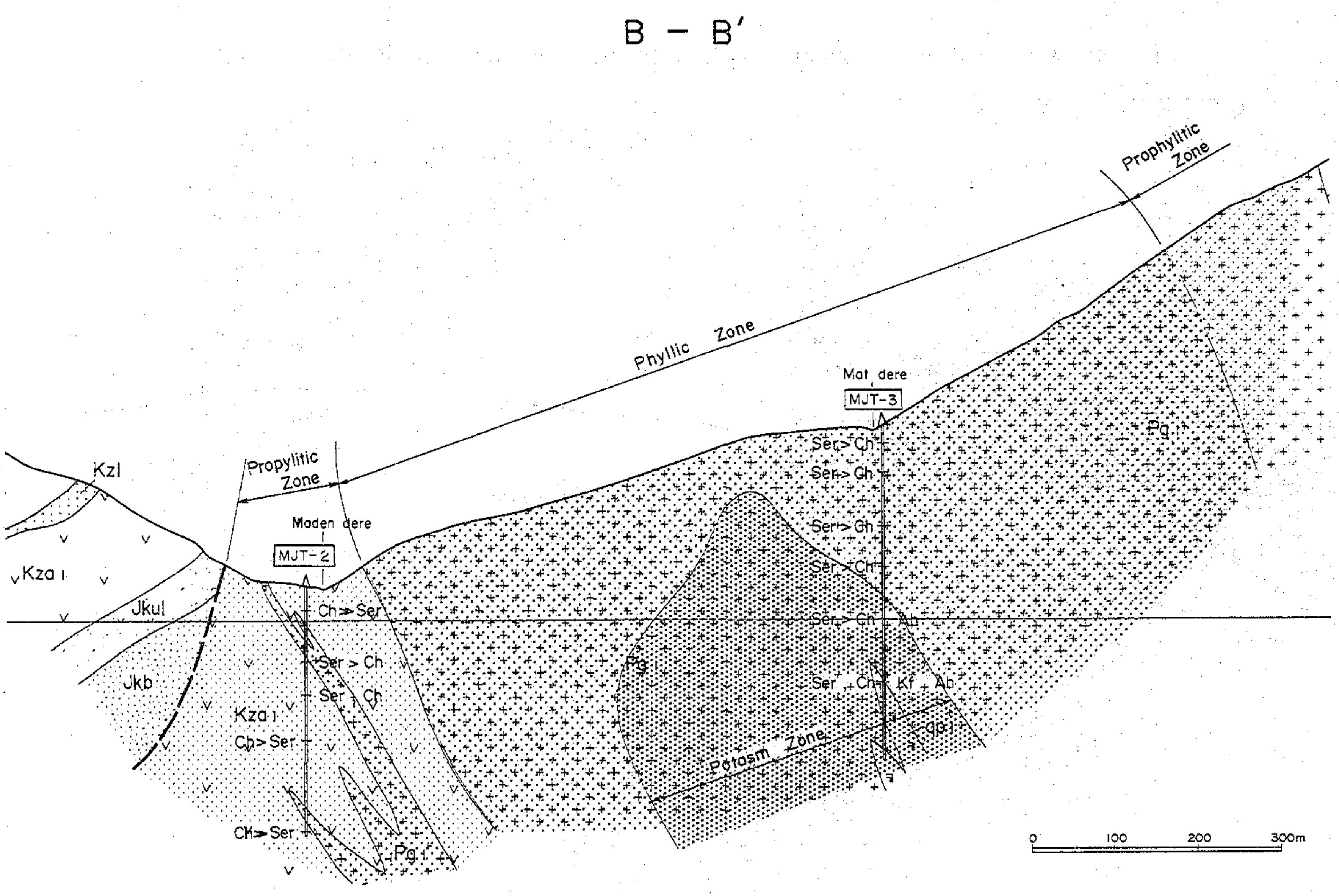


Fig.58 Relation Map between Geological Profile and Alteration zoning of drilling Holes (2)

Chapter 2 Karadağ Area

2-1 Outline of Karadağ Area

2-1-1 Summary of the Initial Phase Survey

This survey area is situated in the Pontid Belt, and is characterized by plutonic intrusion activity in the period from Late Cretaceous to Eocene of Tertiary .

The surveyed area is located 8 km west of Altıntaşlar and is up stream of the Galis Dere. The old Karadağ mine is at around 2,500 m above sea level. The geology around the old mine consists of Gümüşhane granite constituting the basement in the area, and Upper Cretaceous andesite and Limestone (A1 Member) of the Zigana Formation. Quartz porphyry and granodiorite have intruded into the above mentioned basement and Formations. Andesite and limestone of the Zigana Formation have undergone skarnitization, and an ore deposit may be embedded in the skarn. Primary sulphide ores, such as chalcopyrite and sphalerite, were found at the old mine site, but most ore minerals of outcrops have been oxidized, accompanied by secondary oxide copper. Such an oxide ore zone is distributed along the limestone bed extending north-west over 1 km.

The Karadağ Mine might have been worked underground in very ancient times (Before Christ ?), and it seems that the high grade part was selectively mined. The ore mined was smeltered at the mine site, and a very large amount of slag estimated at 150,000 tons is scattered there.

Boulders containing mainly copper ore and a small amount of magnetite and pyrite scattered around the old mine indicate that the Karadağ mine might have been operated as a copper mine.

A geochemical survey of stream sediment was conducted in the initial phase, and marked geochemical anomalies of Ag, Cu, Mo, Pb, Zn, and W were found in the surveyed area. High anomalies of Pb and Zn indicating five to ten times threshold value were especially detected around Cilaz Mountain. However, the high anomalous area may be caused by contamination from waste rock coming from the old mine. There is no old data or information left on the mine except for the preliminary survey report by MTA and the geochemical survey report by UNDP. At the present time, additional exploration surveys have not been carried out. However, the Karadağ ore deposit could be a large scale deposit of copper(and iron) , considerating its geology and the condition of the ore deposit. It is inferred that the mine is of similar type to the disseminated ore associated with tactite in the USA since rocks intruded are limestone and andesite which is the same as the condition in USA.

2-1-2 Purpose of Second Phase Survey

The second phase survey aimed at unravelling detailed geology, distribution of quartz porphyry related to mineralization, and characteristics of mineralization in the Karadağ Area (surveyed area : 12.0 km^2) which is expected promising porphyry copper type ore deposit accompany by skarn type ore deposit, and also investigating emplacement condition and scale of the ore deposit, with studying complehensively together geophysical survey result.

2-1-3 Survey Method and Amount of Works

The topographic maps of scale of 1:2,000 were enlarged using map of scale of 1:5,000 produced by Mineral Research and Exploration Institute , and survey route map was compiled in these maps. Survey results were compiled in the map on a scale of 1:5,000.

Samples for laboratory test, namely microscopic observation (rock thin section and ore polished specimen) chemical analysis (Cu and Zn), X ray diffraction analysis, were collected in order to study and clarify characteristics of mineralization and hydrothermal alteration.

2-2 Geology

2-2-1 General Geology

The geology of the Karadağ Area is divided roughly into Late Paleozoic Gümüşhane Granite, Lower Cretaceous to Lias Stage Kırıklı Formation, and Upper Cretaceous Zigana Formation. The Zigana Formation is further divided into, five stratigraphic units, namely Kermut, A1, D1, A2, and D2 Members in ascending order. Only the A1 Member (lowest Member of Zigana

Formation) is distributed in the surveyed area. Quartz porphyry, granodiorite and diorite have intruded into Zigana Formation, and mineralization accompanied by skarnization is embedded at the boundary of the limestone and andesite of Zigana Formation.

The geological map, geological profile, and schematic geological column are respectively shown in Figs. 59 ~ 61.

2-2-2 Stratigraphy

(1) Gümüşhane Granite

This granite which is the basement in the area, is widely distributed stretching in a southwestern direction south of Gümüşhane city. It covers an elliptical area 37 km E-W and 15 km N-S, and the surveyed area is located at the western end of the granite batholith. The granite was dated as 406 Ma by the radiometric Rb-Sr method, indicating intrusion in Early Devonian time.

This rock is generally massive and grayish white, yellow white to pink, and its compornent minerals vary from fine to coarse grained, but the general tendency of the grain size is to be finer toward the periphery and coarser toward the inner part of the granite. Coarse-grained granite is brittle and consists of quartz 2-3 mm in diameter, and abundant biotite. The apritic part of the granite is compact, massive, and abundant in quartz, plagioclase and feldspar.

(2) Kırıklı Formation

This Formation unconformably overlies Gümüşhane granite of Paleozoic rock, and consists of basaltic lava. Basal conglomerate lies locally at the lowest horizon of the Formation, and the basalt lava contains thin intercalated beds of sandstone and mudstone.

Basal conglmerate : This rock is locally distributed and is uncontinuous. It is pale pink in colour and contains mostly granite pebbles, several to tens of centimeters in diameter and rounded to sub rounded in shape, the matrix is of pale green to grayish white quartz and feldspar grains.

Basalt lava : Basalt lava is generally dark green to reddish brown in colour and has undergone chloritization and epidotization. The lava contains thin intercalated beds of sandstone and mudstone. It uncomformably overlies Gümüşhane granite, and is a thin layer on the west side of the granite, while on the east side of the granite, it is a thick layer and widely distributed..

(3) Kuşakkaya Limestone Formation

The Formation is distributed in a small square at the north part of the surveyed area. It seems to unconformably overlie the Kırıklı Formation. This rock is massive without bedding, and grayish to white in colour.

It is reported that fossils correlating with Dogger and Malm stages of the Upper Jurassic, have been discovered at Ucbacali located at approximately 3 km north east form Altıntaşlar village.

(4) Zigana Formation

This Formation was divided into the Kermut dere, A1, D1, A2, and D2 Members in ascending order by the geological survey of the initial phase. Only the A1 Member is widely distributed in Karadağ Area.

A1 Member consists of basaltic lava, and a limestone-sandstone bed. Basalt lava is deposited in the lower horizon and its rock facies gradually changes upward to andesite. Basaltic lava exists in the area from the surveyed area to Avliyana.

The basalt lava is dark green and contains amygdaloidal texture. Phenocrysts of plagioclase and a small amount of pyroxene are observed through the microscope. These phenocrysts are all altered to chlorite , and only the outline of these crystals remain as unaltered rims. The ground mass of the rock has hyalopilitic texture containing lath shaped plagioclase filled with intersertal glass, but most of them have undergone chloritization and calcitization.

The andesite lava is massive, pale green to dark green in colour, and partly are brecciated. Under microscopic observation, the rock consists characteristically of pyroxene and epidotized plagioclase on the west side of IP survey line B, whereas hornblende with epidotized and chloritized plagioclase is on the east side of IP line D.

In the surveyed area, limestone and sandstone beds are intercalated in volcanic rock, and basaltic lava lies at a lower horizon. Andesite lava is in the at upper horizon, in contact with the intercalation. The limestone-siltstone, striking N-S with 20° ~ 30° dip, consists of crystalline

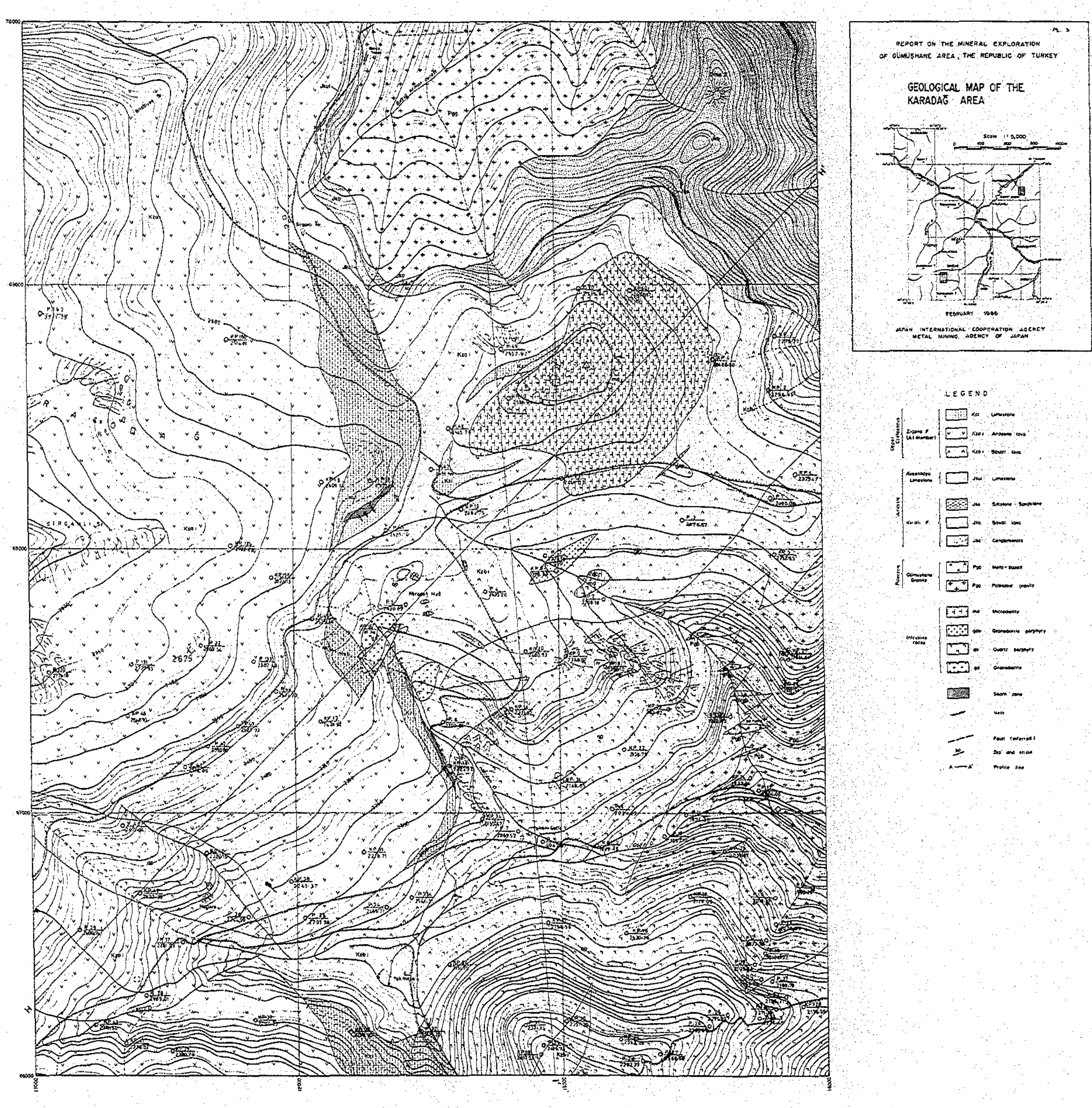


Fig.59 Geological Map of the Karadağ Area

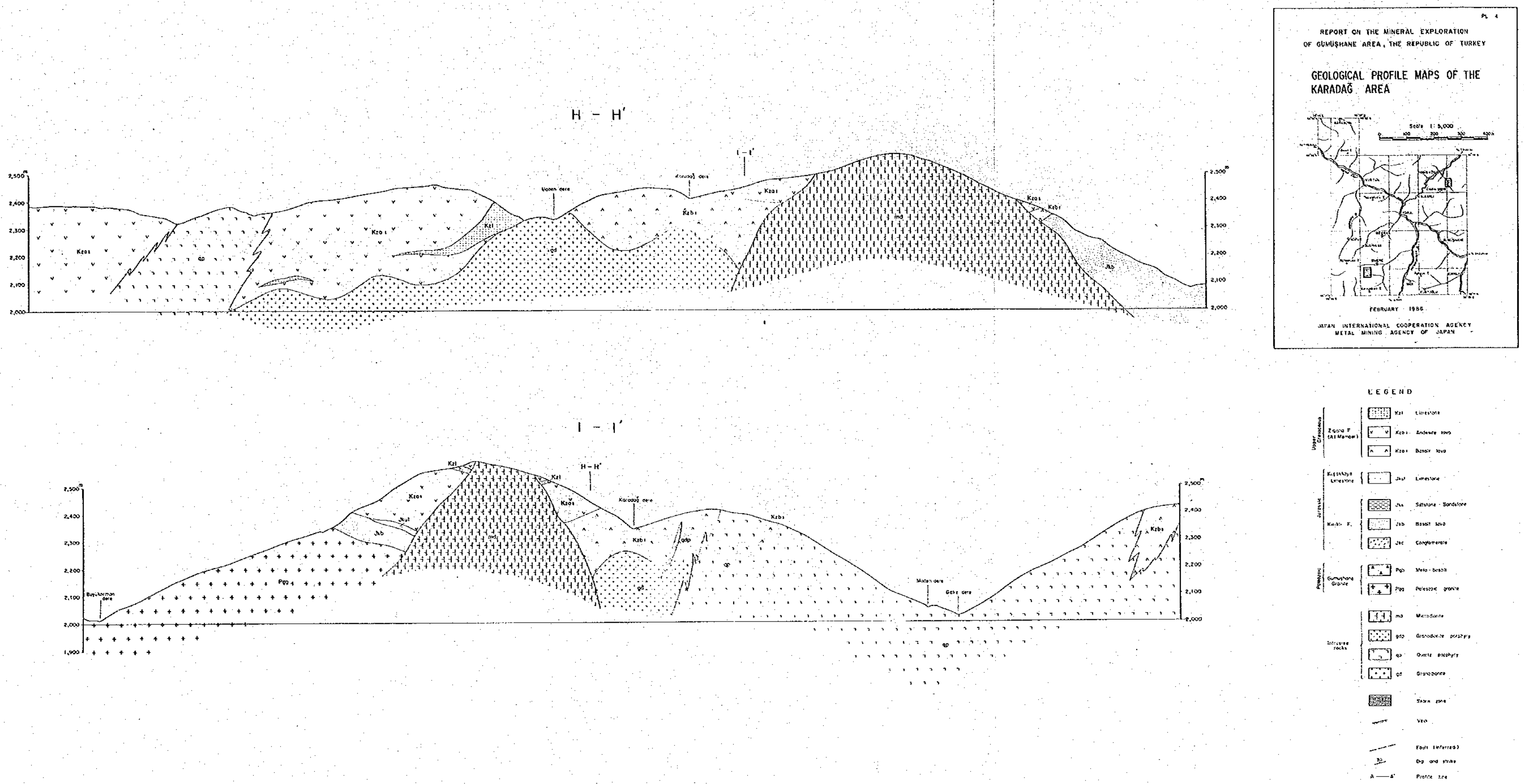
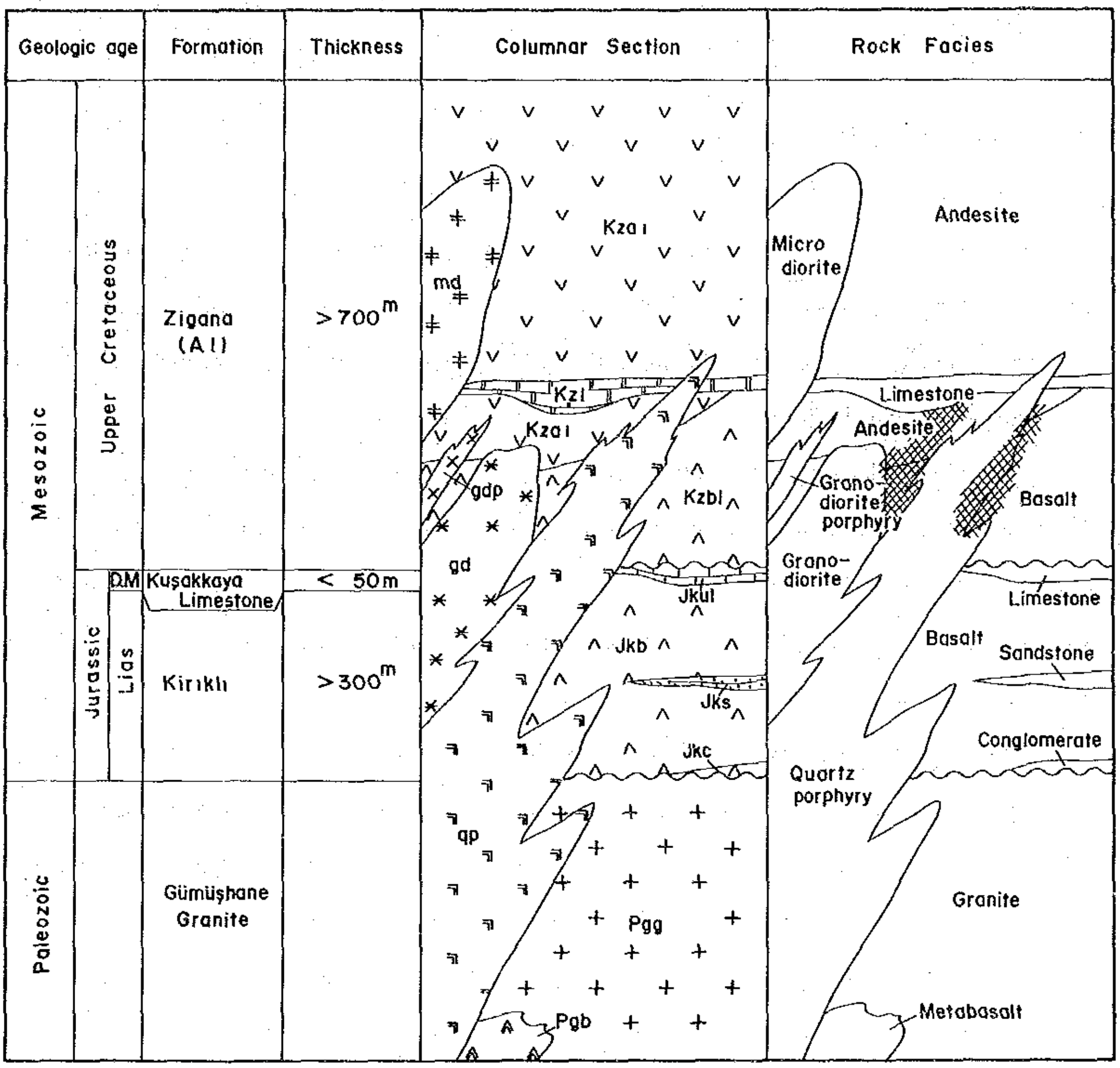


Fig.60 Geological Profile Maps of the Karadağ Area



D.M : Dogger ~ Malm

Mineralization

Fig.61 Schematic Geological Column of the Karadağ Area

and massive limestone, black siltstone, and argillaceous mudstone. Limestone exposed at the old Karadağ mine has been crystalized and has undergone skarnitization accompanied with epidote The south extention of the limestone is dislocated 250 m to the east by a NE-SW fault at center part of the surveyed area.

2-2-3 Intrusive Rock

Intrusive rocks of the Karadağ Area are classified into altered granodiorite, altered quartz porphyry, diorite and granodiorite. These rocks are independently distributed, thus their intrusion order is not evident. However it is inferred that altered granodiorite and quartz porphyry are the older intrusions and diorite and granodioritic porphyry are younger intrusions.

Altered granodiorite : The rock is exposed up stream of Maden Dere in the central part of Karadağ Area, as a small ellipsoidal stock. The rock divides a limestone bed extended N-S direction into two parts Under microscopic observation, it is a hornblende granodiorite consisting of hornblende, plagioclase, and biotite, but these constituent minerals have undergone chloritization and epidotization.

Altered quartz porphyry : The rock is distributed along the west side of Gümüşhane granite, extending in a NEN-SWS direction. The brecciated part of the intrusion is accompanied by tourmaline, muscovite, and quartz veins. As sulphide ores have been limonitized owing to oxidation on the ground surface, it is difficult to identify the primary sulphide ore. Constituent minerals in the groundmass except for quartz phenocrysts have been severely altered to quartz, sericite, epidote and hematite as observed through microscope.

Diorite : The intrusive rock outcrops as a stock in the north east section of the Karadağ Area, forming a hill 800 m X 500 m in scale. Its microscopic texture is equigranular, and constituent minerals of the rock are albitized plagioclase, and chloritized and epidotized common- pyroxene in part.

Granodiorite porphyry : The rock is exposed as a dyke striking NE-SW in the area from the north east side of Maden Dere. The rock consists of slightly chloritized plagioclase and hornblende in equigranular texture.

2-2-4 Geological Structure

The Karadağ Survey Area is situated on the north west side of Gümüşhane granite which is the basement rock in the area. Zigana Formation uncomformably overlies the Gümüşhane granite, lacking Kırıklı Formation and Kuşakkaya Limestone Formation between both rocks. Rock facies of the Zigana Formation in the area are basalt in the lower horizon and andesite in the upper horizon. A limestone bed with greatly varying thichness is intercalated at the boundary between these two facies and extends south and north.

The limestone bed is divided into two parts by an intrusion of granodiorite at center part of the surveyed area. A fault striking NE-SW is inferred to be at the intruded part. All intrusive rocks have intruded along the geologically weak zone (inferred fault zone). By tracing the distribution of exposed intrusives and followig their emplacement direction, it is presumed that two parallel weak zones exist.

2-3 Mineralization and Alteration

As mention above, data and information on the old Karadağ Mine are scarece, although the an underground mine was operated in ancient times. However, scattered ore blocks around the mine site indicate that the Karadağ ore deposit may contain copper,lead, and zinc ores with a few amounts of magnetite and pyrite The Karadağ mine probably produced mainly copper.

The Karadağ area is situated in the highlands and its climatic condition is inland type, and it is dry, has extremely temperature differeence, and in the winter season there is over 3 m of heavy snow. These climate conditions cause severe oxidation of sulphide ores, and primary sulphide ores are barely visible on the surface. X ray diffraction analysis detected cerucite ($PbCO_3$) which was not identified through naked eye observation from samples HH-145 and HH-154. Locations and result of chemical analysis of 31 chipped ore samples collected in Karadağ Area are shown in Fig.19 and Table 7. These samples indicate that copper oxide ore is observed in skarn around the old Karadağ mine site and along Maden Dere. Samples from such places usually contain high grades of copper. The maximum grade among ores collected from around the old Karadağ Mine is 19.8 % Cu and 13.50 % Zn. Ore from Maden Dere is 14.80 % Cu, but low grade zinc. Lead content of ore was not chemically analyzed, but some lead can be expected in the ore since lead ore was detected by X ray diffraction analysis.

Based on results of chemical and X ray diffraction analyses, the ore deposits can be classified into two types : copper, lead, and zinc bearing ore deposits around the old Karadağ Mine, and copper ore deposits along Maden Dere. This is to say, there are different two types of ore deposits in the surveyed area.

Quartz porphyry is characteristically accompanied by tourmaline, muscovite, quartz and limonite. Its groundmass has undergone remarkable sericitization. The sericite is $2M_1$ type and well crystallized, as detected by X ray diffraction analysis and microscopic observation. It is not of hydrothermal mineralization type.

Quartz porphyry and granodiorite may be the ore-bringer intrusions. It is supposed that many fissures are distributed centering around the inferred fault, and that mineralization is emplaced along these fissures.

The mineralization is oxidized on the surface, and limonite ore outcrops on the hill, while pyrite remains only in streams.

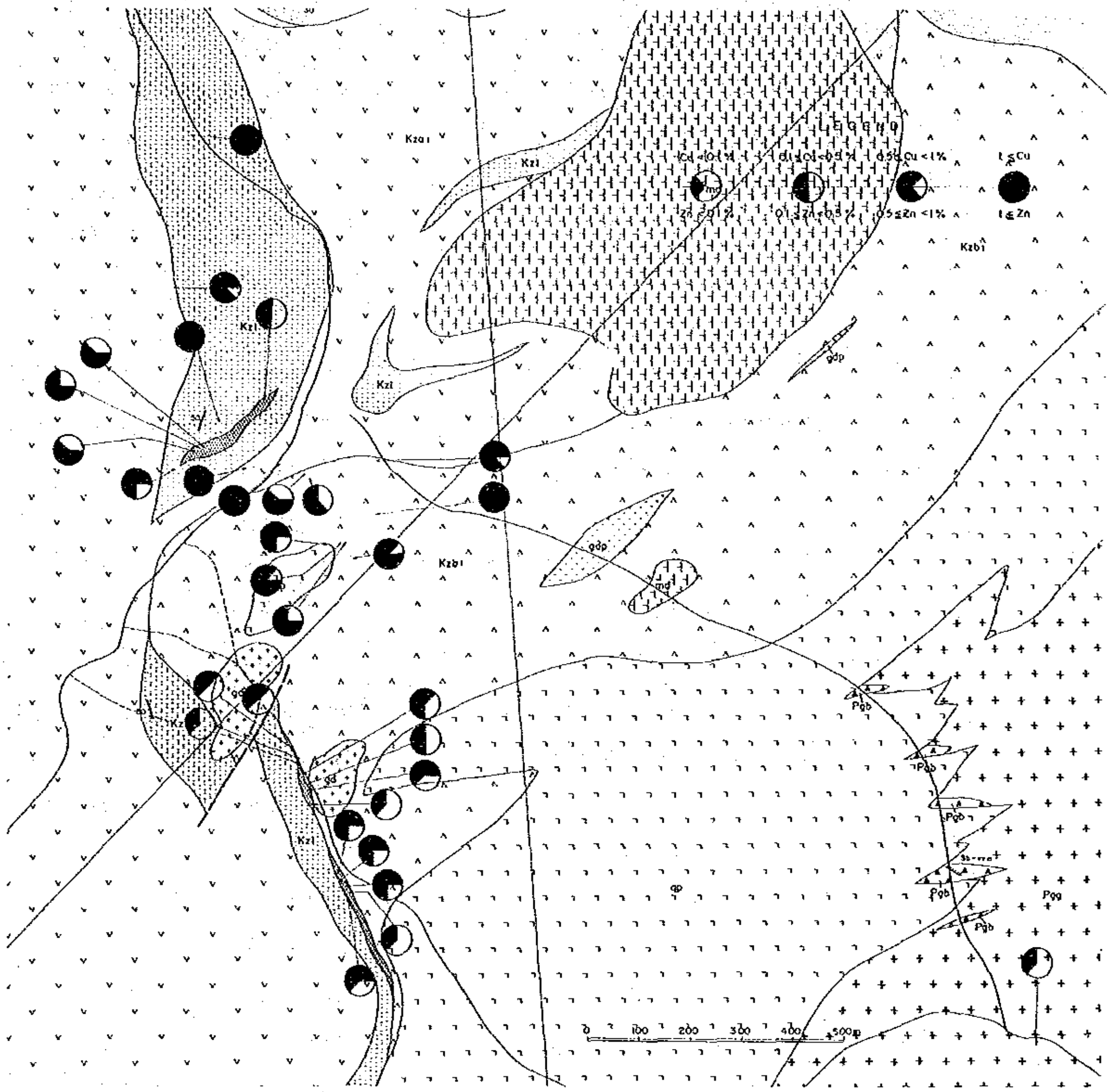


Fig.62 Chemical Analysis Result (chipped Sample) Map of the Karadağ Area

Table23 List of Chemical Assay Result of Ore Samples of the Karadağ Area

Sample No	Description	Location	Cu %	Zn %
HH-104	Skarn with oxcp	Eski Maden	13.80	0.85
HH-140	Pourous slag with oxcp	Eski Maden	0.67	2.57
HH-141	Slag with oxcp	Eski Maden	0.47	2.06
HH-142	Pourous slag with oxcp	Eski Maden	0.84	1.95
HH-143	Slag with oxcp(cur,native cp)	Eski Maden	14.80	0.13
HH-144	Oxidized skarn	Eski Maden	0.28	0.56
HH-145	Sil garnet skarn with galena&cp	Eski Maden	0.03	1.17
HH-146	Oxcp	Eski Maden	19.80	13.50
HH-148	Oxcp	Eski Maden	13.50	1.34
HH-149	Sil skarn with oxcp	Eski Maden	0.25	0.31
HH-150	Limonitized skarn with magnetite	Eski Maden	1.26	12.50
HH-151	Qz-garnet skarn with sp and cp	Eski Maden	0.09	1.64
HH-152	Garnet skarn with oxcp	Eski Maden	0.33	3.15
HH-153	Garnet with cp	Eski Maden	0.07	1.17
HH-154	Oxcp and blakish coloured meneral	Eski Maden	1.44	0.22
KK-142	Tour qz breccia with gal and py	Main stream	0.20	0.02
MM-119	Slag(pourous,blakish)	Eski Maden	1.12	1.59
MM-120	Siliceous skarn with oxcp	Eski Maden	3.73	0.64
MM-126	Py-strong ore with oxcp	Maden dere	1.00	0.02
YY-110	Skarn with oxcp	Eski Maden	1.80	3.10
YY-131	Lim garnet and sil skarn with oxcp	Maden dere	0.55	0.01
YY-132	Limonite py ore	Maden dere	0.40	0.02
YY-133	Limonite	Maden dere	0.89	0.10
YY-134	Limonite with qz	Maden dere	0.16	0.16
YY-135	Skarn(garnet) with oxcp	Maden dere	2.61	0.04
YY-136	Skarnized ls with oxcp	Maden dere	0.17	0.01
YY-139	Garnet with oxcp	Maden dere	1.26	0.26
YY-140	ditto	Maden dere	14.80	0.19
YY-141	ditto	Maden dere	2.62	0.19
YY-142	ditto	Maden dere	0.20	0.02
YY-143	ditto	Maden dere	10.40	0.08

Ditection Limit :Cu 10 ppm,Zn 10 ppm

Analytical method :Atomic Absorption and Common Assay

2-4 Geophysical Survey (SIP ・IP Metheds)

2-4-1 Outline of the Survey

(1) Purpose of the Survey

The survey area is of an area where a mineralized zone of copper, zinc and lead, associated with intrusions in granodiorite and quartz porphyry, has been delineated during geological and geo-chemical surveys of the initial phase.

In expectation of disseminated types of ores, conventional Induced Polarization (IP) and Spectral Induced Polarization (SIP) methods were applied to detect an anomalous area and to study the continuity of mineralization at depth by unravelling properties of the anomaly.

(2) Area of the Survey

The target area of this survey is located about 15 km south-west of Bülüb Loğlu Mah. There are two routes to reach the survey area. It is accessible by car to the confluence of Maden and Galiz Streams by travelling along the latter from Bülüb Loğlu Mah.via Altıntaşlar Köy. Another route is, to leave the car at Altabel Köy in a location upstream of Dorene Stream and to walk 3 km to getto the northern part of the area as shown in Fig.3. The location of survey lines is shown in Fig.63.

(3) Survey Specifications

Field work specifications for IP method are shown below :

a. Electrode configuration	:	Dipole-Dipole array
b. Electrode Separation	:	100 m
c. Electrode Separation Coefficient	:	n = 1 ~ 5

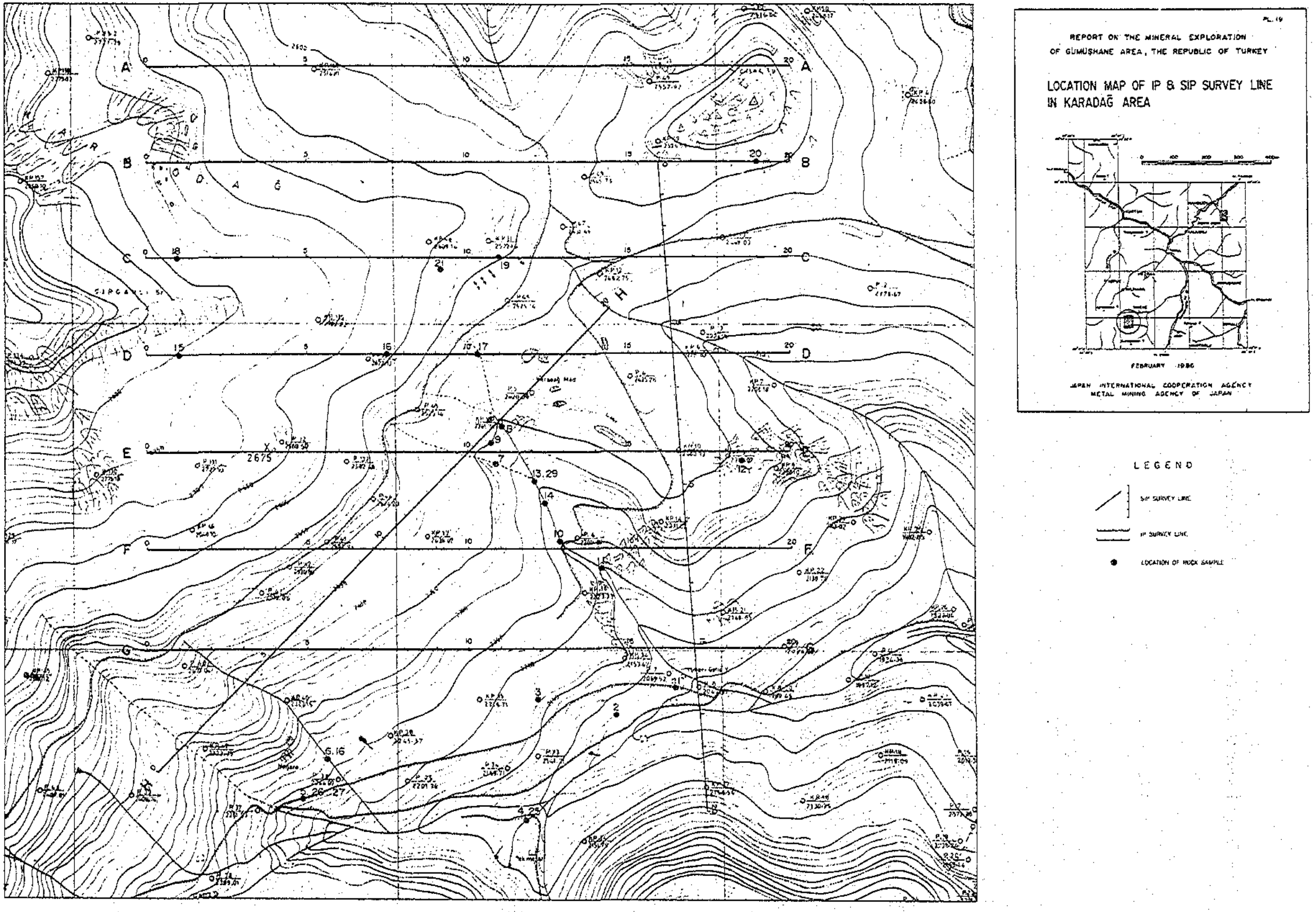


Fig.63 Location Map of IP and SIP Survey Line in the Karadağ Area

d. Measurement Method	:	Frequency Domain
e. Frequency	:	0.125 Hz and 1.0 Hz
f. Line Spacing	:	300 m
g. Line Length	:	14 km in seven lines
		2 km each from lines A to G

Two survey Lines for SIP method were laid over the anomalies detected by IP survey. Survey specifications are as follows :

a. Electrode Configuration	:	Dipole-Dipole array
b. Electrode Separation	:	100 m
c. Electrode Separation coefficient	:	n = 1 ~ 5
d. Measurement Method	:	0.125 Hz ~ 88 Hz(8 frequencies)
f. line Length	:	4 km in two lines with 160 stations
		2 km in line H with 80 stations
		2 km in line I with 80 stations

(4) Survey Method

The IP method in this survey is that of conventional frequency domain at two frequencies of 0.125 Hz and 1.0 Hz. The SIP method is the same as the method used at the Hasandere Area discussed in paragraph 1-6-1 (4).

(5) Measuring Equipment

The set of IP equipment is similar to the set for SIP method used at the Hasandere Area as shown in Table 9. Different programs are loaded, depending on the method of the IP survey. An illustrated diagram of the IP survey is shown in Fig.64.

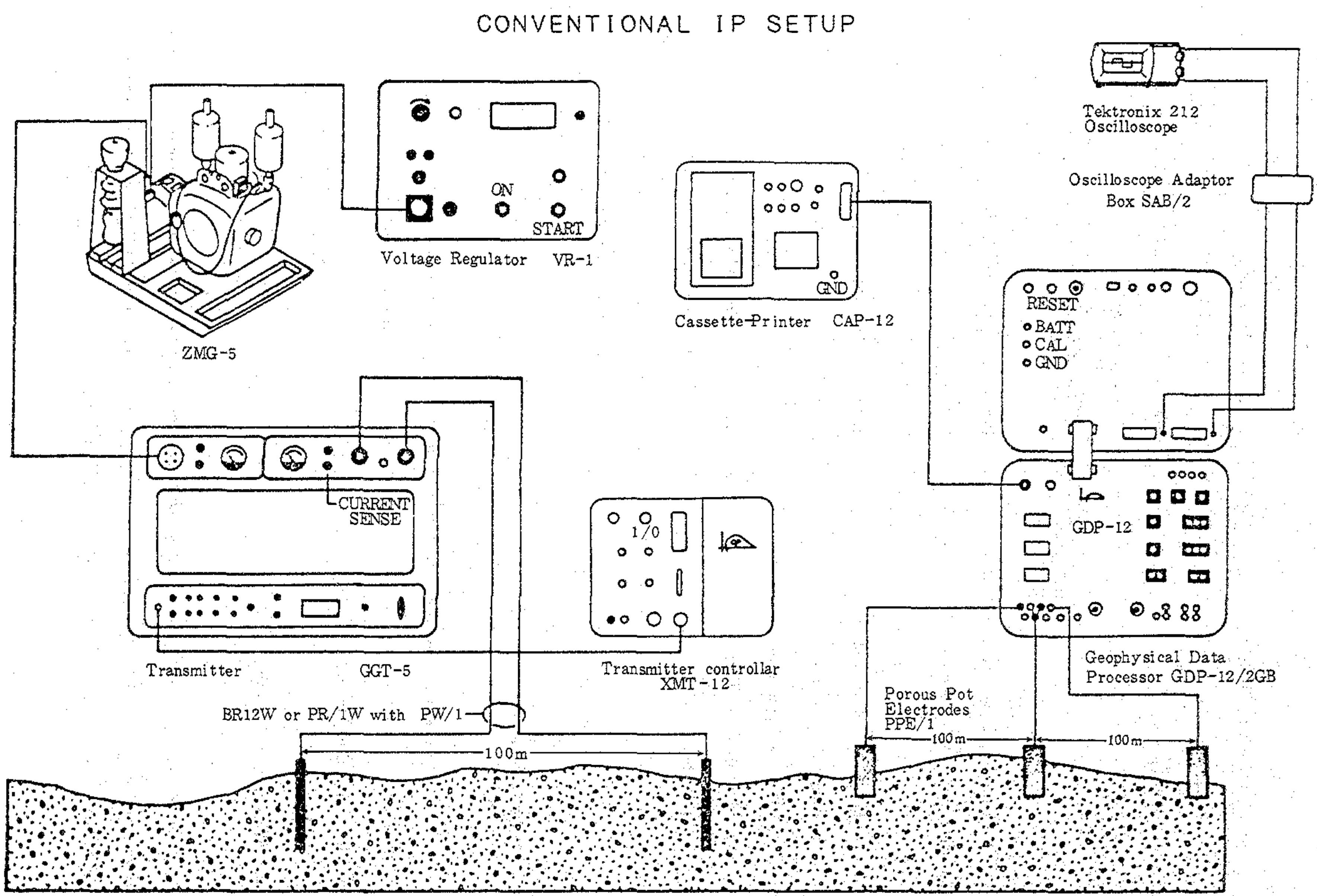


Fig.64 **Illustrated Diagram for IP Equipments**

2-4-2 Data Processing and Rock Sample Measurement

(1) IP Data Processing

Panel Diagrams of percent frequency effect (PFE) and apparent resistivity (AR) were provided from pseudo-sections of each line. Three plan maps were prepared on each electrode separation coefficient of n = 1, 3, 5.

A) P F E

A value of PFE is calculated by magnitudes (M) at 0.125 Hz and 1 Hz as follows :

$$PFE = \frac{M(0.125\ Hz) - M(1.0\ Hz)}{M(0.125\ Hz)} \times 100 \qquad (\%)$$

B) A R

A value of AR is callculated by the following equation :

$$AR = \pi a \cdot n(n+1)(n+2) \cdot V/I \qquad (ohm\text{-}m)$$

where, a : electrode separation in meters

n : electrode separation coefficient

V : received voltage in volts

I : transmitted current in amperes

In the present survey, the apparent resistivity at 0.125 Hz was calculated and topographic correction is made with conductive paper.

(2) SIP Data Processing

The processing precedure is explained in the previous chapter under the Hasandere Area (paragraph 1-6-2).

(3) Decoupling Data Processing

All SIP data were applied to the same data processing as for the Hasandere Area. The decoupling pseudo-sections of each SIP data set are shown with pseudo-sections of raw data.

(4) Rock Sample Measurement

The measurements were carried out on 25 samples taken from the ground surface of the survey area. These location sampled are shown in Fig. 63 and plate 19.

The results of the measuremnts are shown in Table 24 for total samples, and in Table 25 for each rock type. Results from these samples can be categorized by their spectra into six types like those of the Hasandere Area.

The following facts evident :

① Phases range from 1.7 mrad to 86.9 mrad. They are larger in the mudstone and smaller in the limestone and the andesite lava. The mean value in the former is about eight times the mean value in the latter.

② Values of PFE range from 0.20 % to 13.8 %, and they are larger in the mudstone, smaller in the limestone and the andesite lava. The mean value of t he former is about eight times that of the latter.

③ Resistivity values range from 404 ohm-m to 11,244 ohm-m, smaller in the quartz porphyry (2,035 ohm-m), and larger in the andesite lava (6,605 ohm-m) and the limestone (4,611 ohm-m).

④ On the phase spectra, ten samples belong to A-type while X-type, connected with mineralization, is present in a quartz porphyry sample and in two mudstone samples.

Table24 Results of Rock Sample Measurement (Karadağ Area)

Sample No.	Rock	Phase (-mrad)	PFE (%)	Resist. (ohm-m)	Spectrum Type	Remarks
3	Andesite lava	5.1	0.78	5,996	A	Propylization
15	Andesite lava	4.6	0.73	11,244	C	Compact
16	Andesite lava	7.3	1.41	5,049	Special	Propylization
18	Andesite lava	3.9	0.59	4,129	A	Propylization
	(Average 4 pcs)	5.23	0.88	6,605		
4	Limestone	6.2	0.91	4,718	A	Garnet-epidote
7	Limestone	4.8	0.67	4,488	A	
11	Limestone	1.7	0.20	1,625	Special	
12	Limestone	3.6	0.68	7,202	A	
14	Limestone	12.9	2.07	3,542	A	Sericite,diss.pyrite
19	Limestone	1.9	0.23	4,063	C	
21	Limestone	2.1	0.34	5,252	A	
25	Limestone	6.7	0.99	5,999	A	Garnet-epidote
	(Average 8 pcs)	4.99	0.76	4,611		
8	Mudstone	5.6	0.82	11,068	C	Diss.pyrite
9	Mudstone	78.4	10.4	2,875	B	Sil.,epidote,fine grained pyrite
29	Mudstone	8.1	1.53	3,870	Special	Filmy pyrite
10	Black mudstone	27.8	6.18	454	X	magnetite
13	Black mudstone	86.9	13.8	2,552	X	Quartz,diss.pyrite
	(Average 5 pcs)	41.36	6.55	4,164		
1	Qz. porphyry	11.3	1.59	1,060	X	Sericite-limonite
2	Qz. porphyry	5.2	0.62	2,459	A	Porous,tourmalinization
5	Qz. porphyry	10.0	1.39	2,821	B	Porous,sericite-limonite
6	Qz. porphyry	19.5	2.61	3,308	B	Ditto
17	Qz. porphyry	4.9	0.50	404	Special	Limonite
26	Qz. porphyry	8.6	1.36	1,927	B	Porous,sericite
27	Qz. porphyry	5.3	0.71	2,267	B	Tourmalinization
	(Average 7 pcs)	9.26	1.25	2,035		
20	Diorite	11.4	1.61	2,254	A	
	(1 pc)					

REMARKS Resist. : Resistivity , Sil. : Silicious , Qz. : Quartz

Table25 SIP Responce in the classification of Rock (Karadağ Area)

Rock	No. of samples	Phase(-mrad)	PFE (%)	Resistivity (ohm-m)	Phase spectrum type						
					A	B	C	D	X	Y	Others
Andesite	4	3.9 ~ 7.3 (5.23)	0.59 ~ 1.41 (0.88)	4,129 ~ 11,244 (6,605)	2		1				1
Qz. porphyry	7	4.9 ~ 19.5 (9.26)	0.50 ~ 2.61 (1.25)	404 ~ 3,308 (2,035)	1	4			1		1
Diorite	1	11.4	1.61	2,254	1						
Limestone	8	1.7 ~ 12.9 (4.99)	0.20 ~ 2.07 (0.76)	1,625 ~ 7,202 (4,611)	6		1				1
Mudstone	5	5.6 ~ 86.9 (41.36)	0.82 ~ 13.8 (6.55)	454 ~ 11,068 (4,164)		1	1		2		1
Total No.	25				10	5	3		3		4

(   ) : Average value

2-4-3 Results of Interpretation

The conventional IP survey was conducted prior to execution of the SIP survey. Data-processing results of the IP survey were compiled in plans of apparent resistivity and PFE on each electrode separation coefficient of n = 1, 3, 5. Panel sections of each survey line(Line A ~ Line G) were also drawn. SIP survey results were illustrated in pseudo-sections of apparent resistivity (AR) and PFE along with the geological sections. In the case of SIP data-processing, the data were shown in maps formed similarly to the case of the Hasandere Area.

Results of the interpretation are explained on the basis of these maps .

(1) Plan Map and Pseudo-Section of Apparent Resistivity

The apparent resistivity in the surveyed area shows values ranging from 0.93 ohm-m to 1,983 ohm-m, and its arithmetic mean value (M) is 154.8 0hm-m. Values of M+σ and M-σ are respectively calculated as 615 ohm-m and 39 ohm-m based on 0.599 standard deviation (σ). Values of 500 ohm-m and 50 ohm-m are regarded as the limiting values of high and low resistivity.

Plan Map of Apparent Resistivity

Plan map of n = 1 (Fig. 65)

High resistivity zones over 500 ohm-m are sporadically present in the area from the central part to the western part of the survey area while resistivity zones below 50 ohm-m are distributed at the northern part of the surveyed area in extensive scale, and at a location upstream of Maden Stream (the eastern part of Line F) in small scale.

Plan map of n = 3 (Fig. 66)

Three high resistivity zones are present in extensive distributions from the central part to the western part, and in small scale at the south western part of the surveyed area. On the other hand,

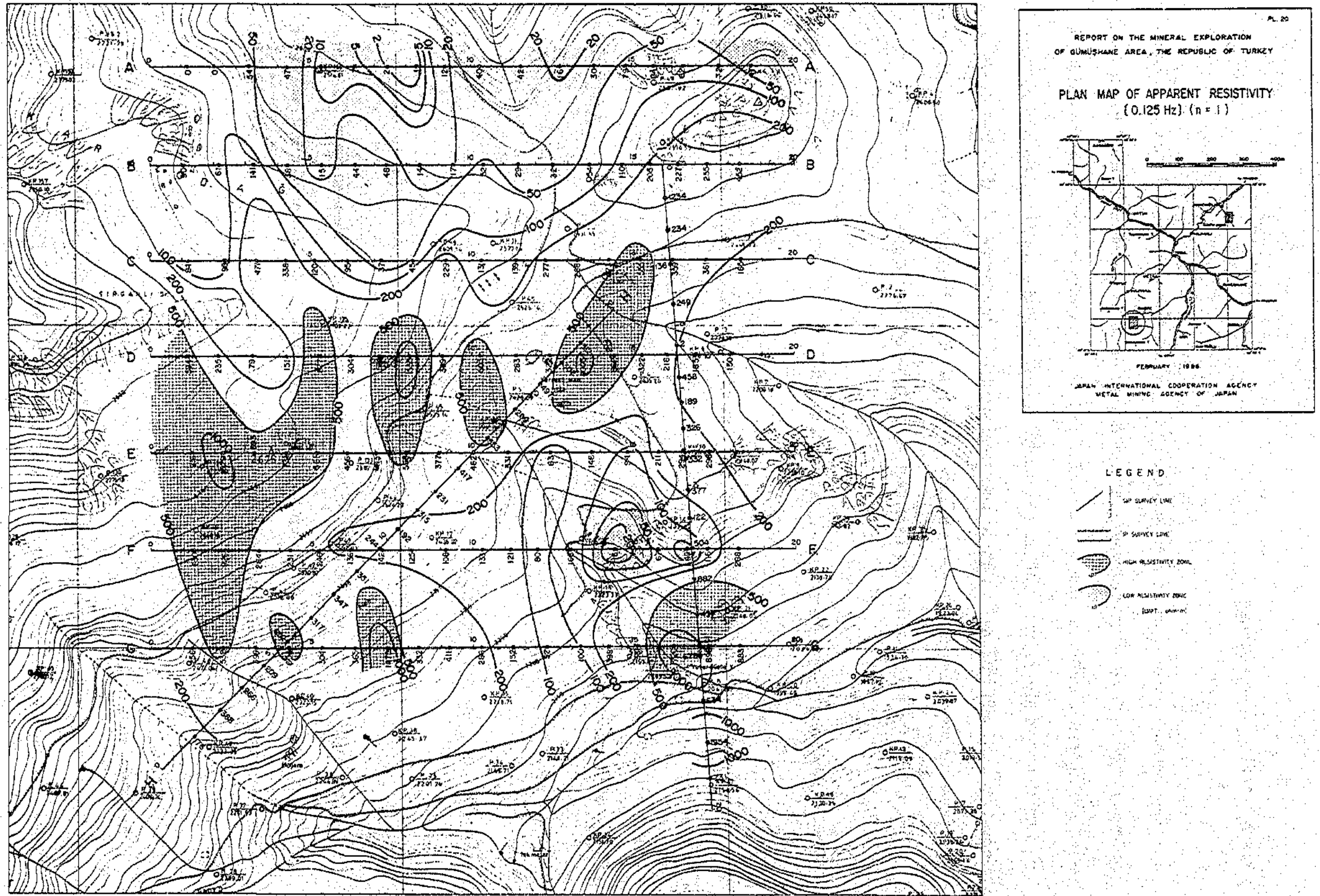


Fig.65 Plan Map of Apparent Resistivity [0.125 Hz] (n = 1)

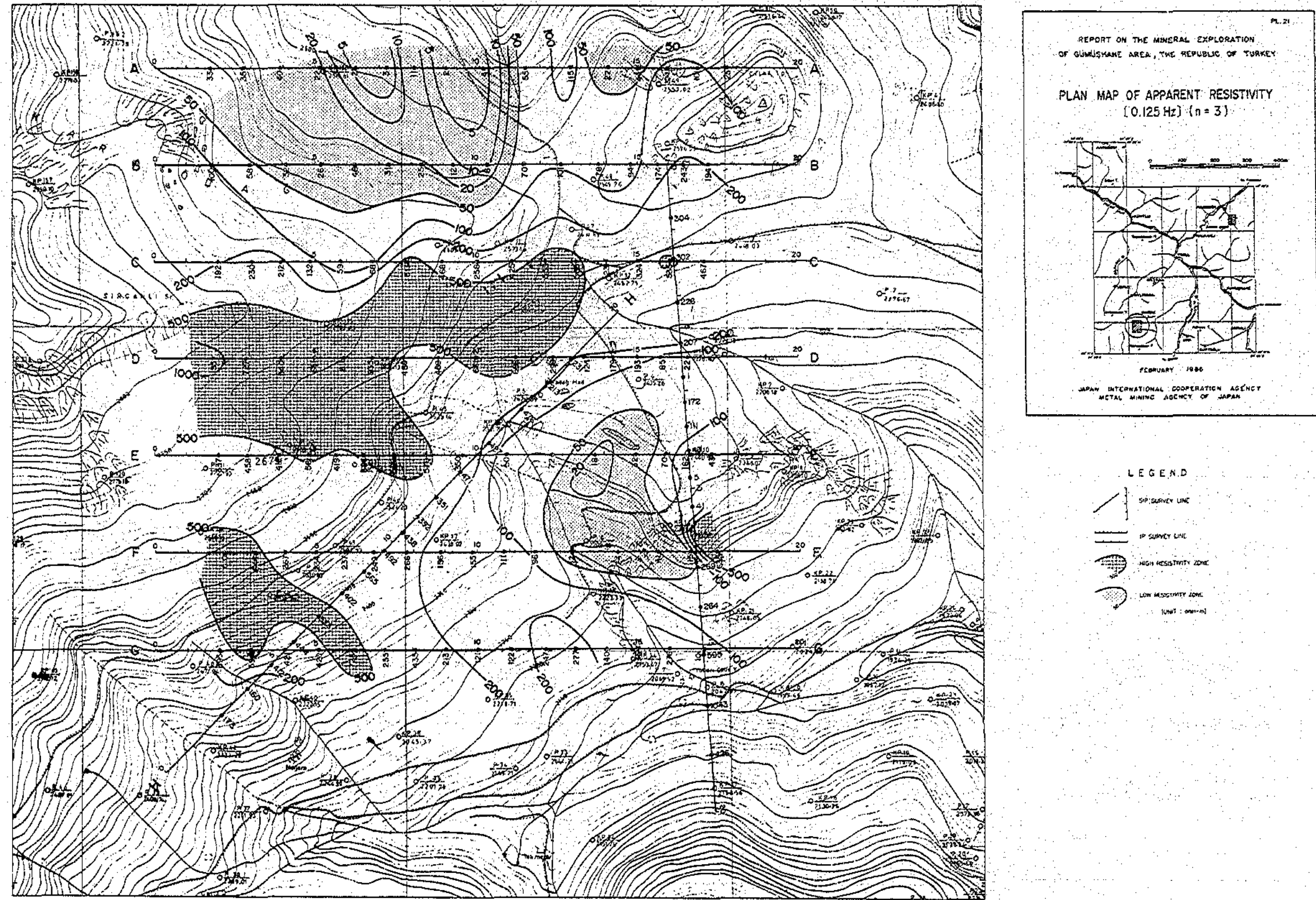


Fig.66 Plan Map of Apparent Resistivity [0.125 Hz] (n = 3)

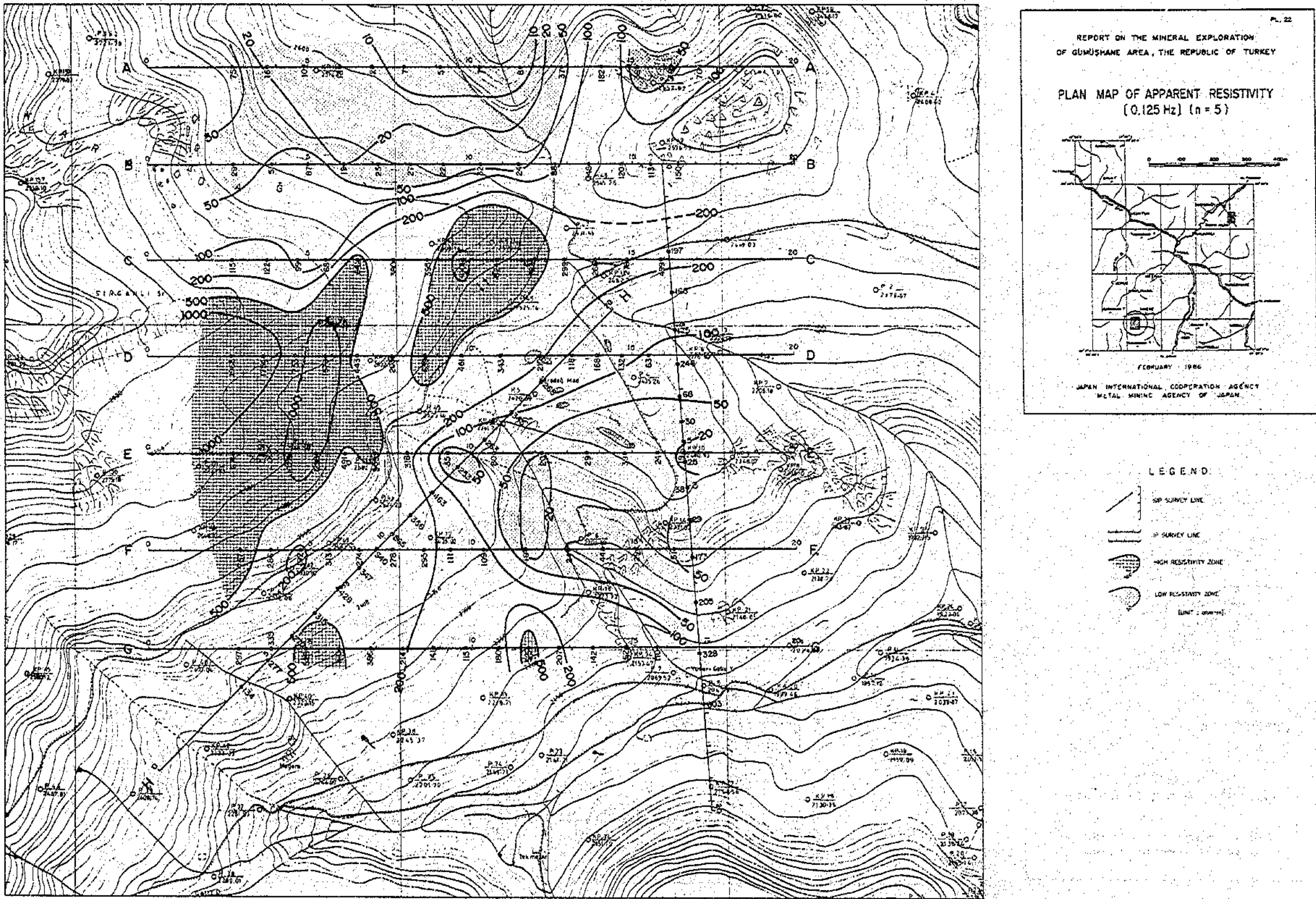


Fig.67 Plan Map of Apparent Resistivity [0.125 Hz] (n = 5)

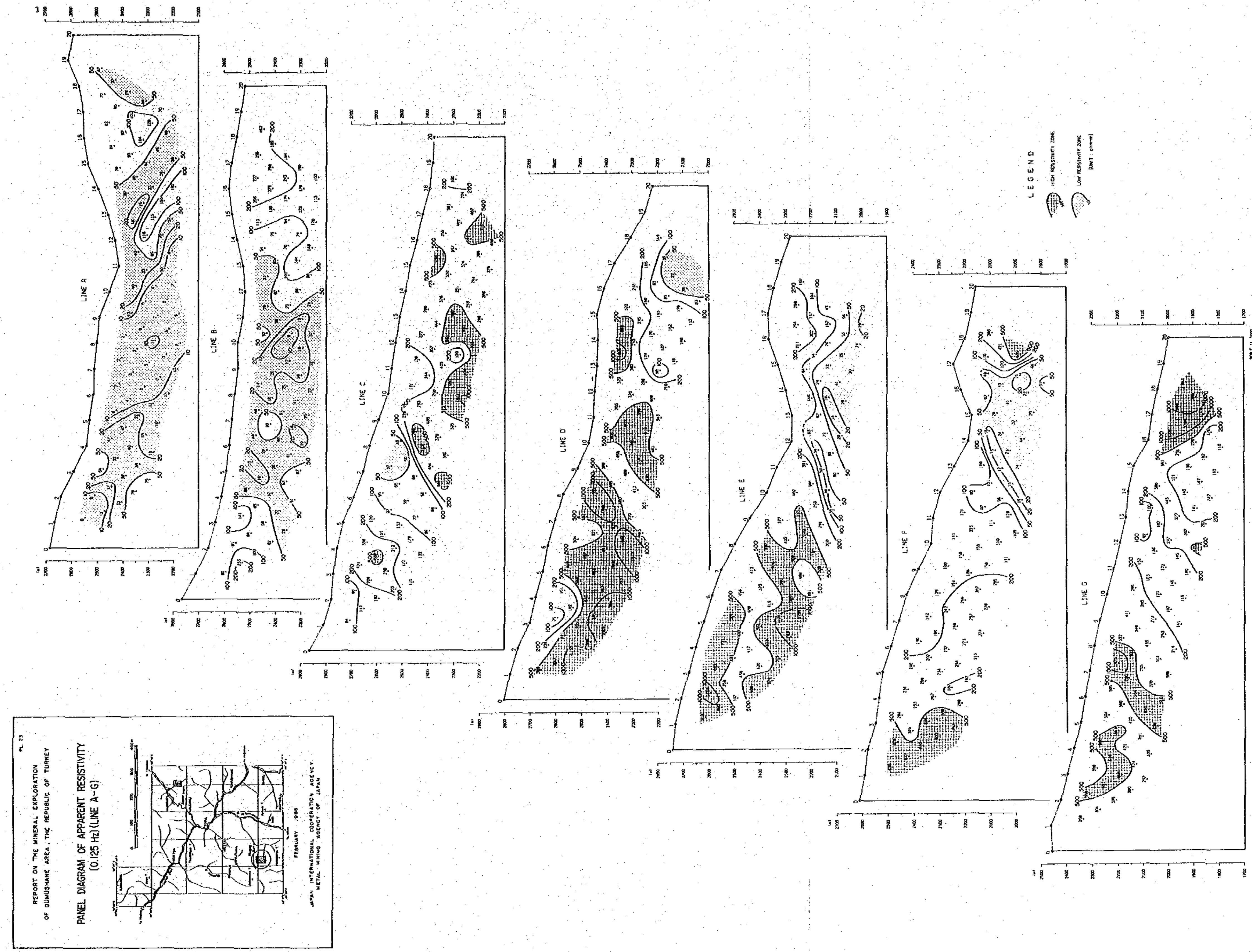


Fig.68 Panel Diagram of Apparent Resistivity (Line A - G)

a low resistivity zone was detected in the same area as the n = 1 map, along Maden Stream, but extending further than the zone in the plan map of n = 1.

Plan map of n = 5 (Fig. 67)

A extensive high resistivity zone is distributed in an area from the centralto the south-western part of the surveyed area. Two small high resistivity zones were detected along Line G.

Pseudo-section of apparent resistivity (Fig. 68)

Pseudo-sections of apparent resistivity were drawn along each Line (Line A ~ Line G), and they were copmpiled on a panel map in order to give a three dimentional interpretation.

A low resistivity zone is extensively distributed in the northern part of the surveyed area. The whole section extends continues to depth, to an especially low zone of 10 ohm-m located apart from No.5 to No.11, in Line A. On Line B, the low resistivity zone is limited in an area from No.3 to No.12, and shows the same tendency as that of Line A. A small distribution of the low resistivity is also present in the deeper part from No.7 to No.9. Another low resistivity zone was detected in an area from Line C to Line F, distributed along Maden Stream.
A low resistivity zone of less than 20 ohm-m is recognizable in survey Line F.

On the other hand, a high resistivity zone of over 500 ohm-m is observed in the area from the central to the western parts centered at Line D, and at the eastern part of Lines F and G, indicating an extention further in the eastern part of the surveyed area. However no high resistivity zone was detected on Lines A and B.

Line H (Fig. 69 AR)

Three small high resistivity zones were detected under the background valuesof 200 ohm-m to 300 ohm-m over the whole line.

Line I (Fig. 70 AR)

A low resistivity zone of less than 10 ohm-m, shaped in an up-side-down pant-leg pattern, is distributed at the center part of the line, whereas a high resistivity zone occupises the quartz

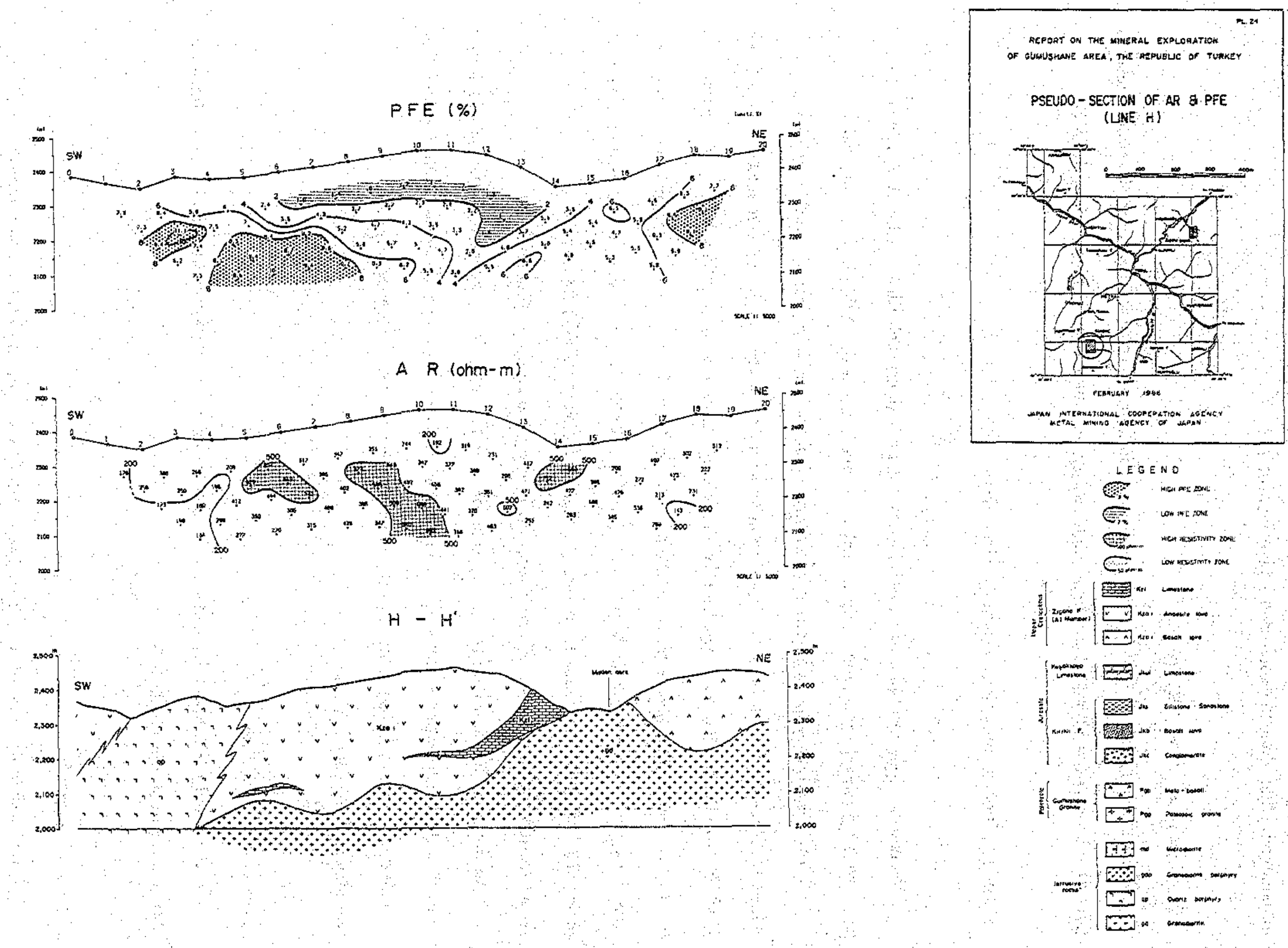


Fig.69 Pseudo Section of AR and PFE (Line H)

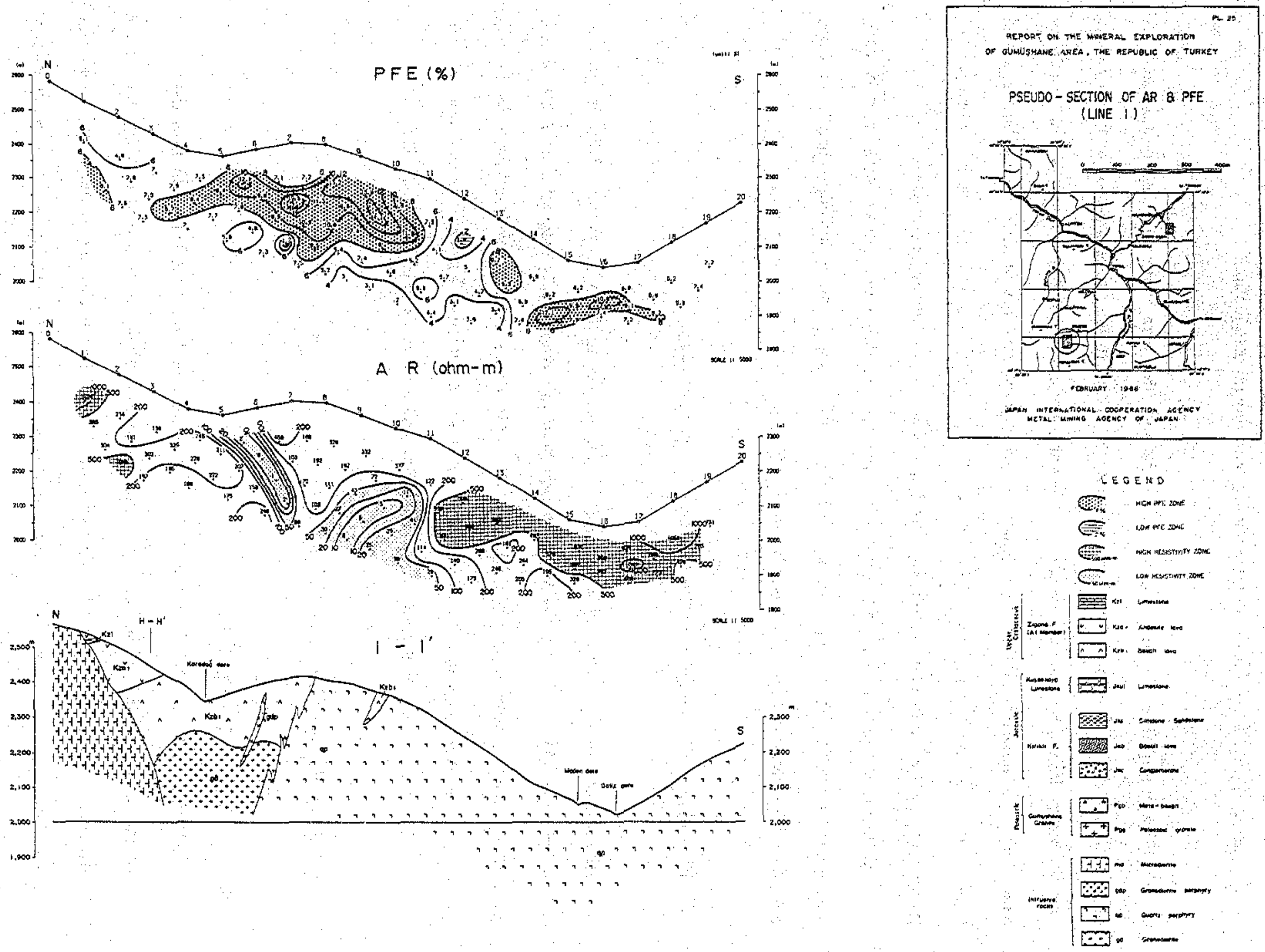


Fig.70 Pseudo Section of AR and PFE (Line I)