Chapter 4 Geophysical Survey (SIP,IP Methods)

4-1 Outline of the Survey

(1) Purpose of the Survey

The survey refers to an area where a mineralized zone of porphyry copper type has been found through geological and geochemical surveys of the initial phase. In the second phase, semi-detailed geological, geophysical and drilling surveys were successively carried out aimed at exploration of the mineralized zone. The SIP survey lines were survyed for the purpose of determining continuity of the mineralized zone between three drill holes.

This year,the geophysical methods of SIP and IP were used to unravel emplacement condition and continuity of the mineralized area.

(2) Area of the Survey

The area of the SIP survey is situated around the confluence of Maden Stream and Hasan Stream, some 4 km southeast of Hamusiköy Village. Seven survey lines 200 m apart were laid parallel with Line B connecting holes MJT-2 and MJT-3 drilled in the second phase survey. The area and arrangement of the survey lines are illustrated in Figs. 2 and 9.

(3) Survey Specifications

Field work specifications were set as follows :

a. Electrode Configuration		dipole-dipole array		
b. Electrode Separation		100 m		
c. Electrode Separation coefficient		n = 1 ~ 5		
d. Measurement Method		Frequency domain		
e. Frequencies	SIP	0.125 Hz~ 88 Hz(18 frequencies)		
	IP	0.125 Hz/ 1.0 Hz		
f. Length of Survey Line		18.0 km in nine lines		
	SIP: Line D,G,I	6.0 km in three lines	240 points	
	IP : Line B,C,E,F,H,J	12.0 km in six lines	480 points	

(4) Survey Method

The SIP method is the abbreviated name of Spectral Induced Polarization and operates on the same principal as the conventional IP method. The SIP method

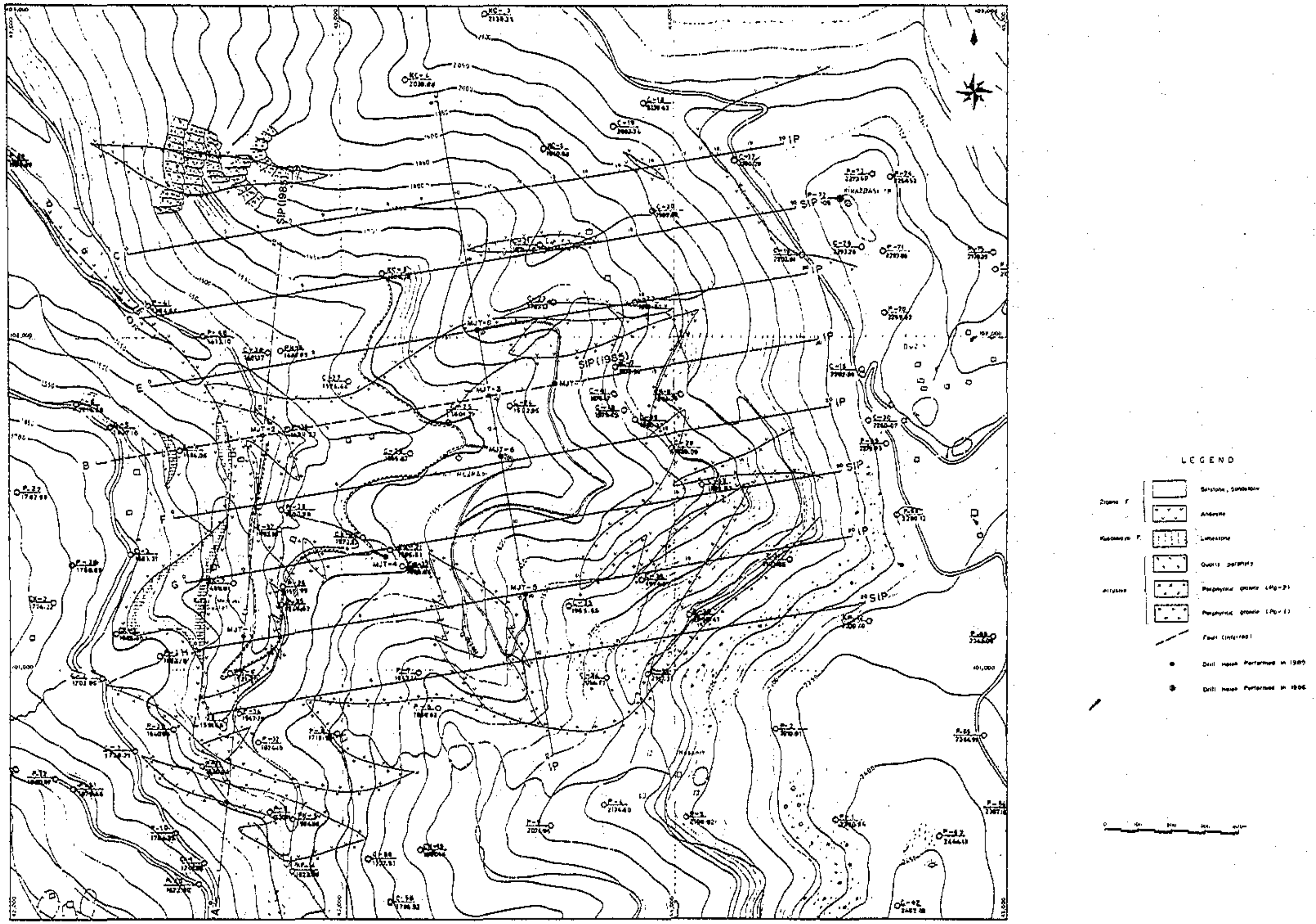


Fig. 9 Location Map of IP and SIP Survey Lines in the Güzelyayla Area

measures apparent resistivity and phase difference over a frequency range of 0.01 Hz to 100 Hz, while the conventional IP method measures a difference in apparent resistivity expressed in percentage of two frequencies. The measurement data are expressed in spectral diagrams of phase and magnitude, and in Cole-Cole diagrams. Analysis of these responses gives discrimination of minerals or types of mineralization and eliminates electromagnetic coupling which occurs at low resistivity in the ground, at wide electrode separations, and with a large number of electrode coefficients.

In this survey, the Harmonic System of Zonge (USA) was applied. The IP responses over a range of 0.125 Hz to 88 Hz are measured through calculation and extraction of high frequency, using the Fast Fourier Transform of 3rd, 5th, 7th, 9th and 11th harmonics from three fundamental frequencies of 0.125 Hz, 1.0 Hz and 8.0 Hz.

Observation of a wave form is necessary for measurement of phase , and a communication cable which connects transmmiter with receiver was laid down parallel with the survey line separated by 25 m to 30 m. At the receiving station, response is amplified through three porous pot-electrodes in copper saturated solution with a copper rod. Amplified responses are transmitted through a communication cable to the receiver(GDP-12/2GB). Data is processed and printed out.

(5) Measuring Equipment

The equipment used in this survey are listed in Table 1. The illustrated diagrams of the equipment for IP and SIP measurements are shown in Fig. 10 and Fig. 11 respectively.

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.

Table 1 Measuring Equipment for SIP and IP Surveys

Item	Specification		Quantity.
Zonge GGT-5 Transmitter	Output Voltage Output Ampere Wave Form Frequency Weight	: 250, 500, 750, 1,000 V : 1.2 - 20 A : Square wave : 1/8 - 2,048 Hz : 61 Kg	1
Zonge XMT-12 Transmitter controller	Frequency Weight Power Supply	: 1/8 - 2,048 Hz : 58 Kg : 12 V Battery	2
Zonge ZMR-5 Engine generator Honda G-400 Engine	Output Power Output Voltage Frequency	: 5 Kw : 115 V : 400 Hz : 10 hp 4 cycles	1
Zonge GDP-12/2GB Receiver	Input Frequency Senstivity Weight Power Supply	: 2-Channel : 1/8 - 2,048 Hz : 0.2 μV : 15 Kg : 12 V Battery	2
Zonge CAP-12 Mini Cassette Recorder	Weight Power Supply	: 6.2 Kg : 12 V Battery	2
Tektronic 212 Oscilloscope			1
Zonge ISO/1 Isolation Amp.	Weight	: 1 Kg	3
Zonge FP-1 Feild Preamp.	Gain	: 1, 10	3
Electrode	Current Electrode Potencial Electrode	: Stainless steel : Cu-$CuSO_4$ non-polarizable Porous Pots	200 rods 10 pcs.
Cable	Current Communication	: : 640 m length	10 Km 3 rolls

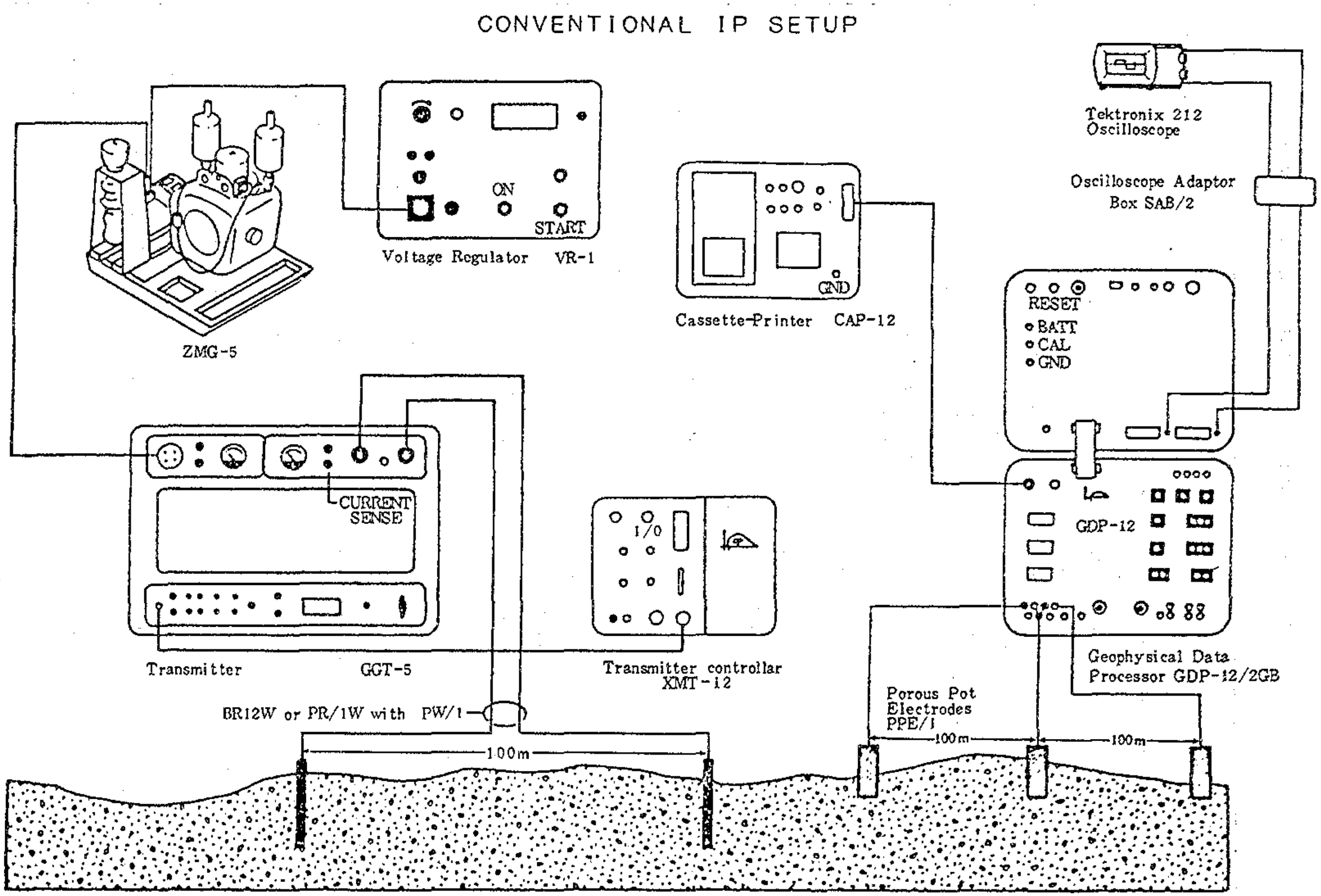


Fig. 10 Illustrated Diagram for IP Equipment

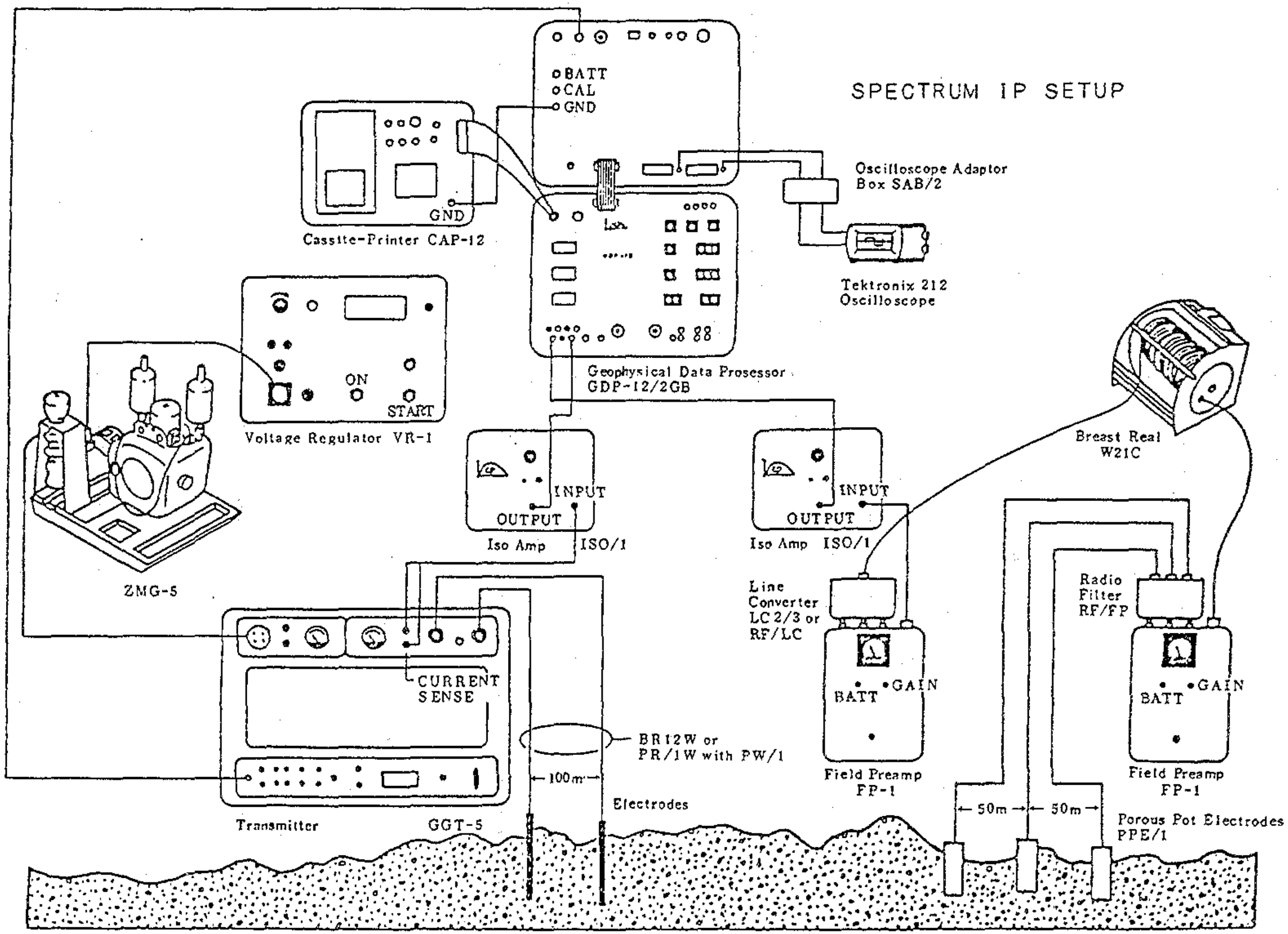


Fig. 11 Illustrated Diagram for SIP Equipment

A) PFE

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) AR

A value of AR is calculated 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 : voltage received in volts
I : transmitted current in amperes

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

(2) SIP Data Processing

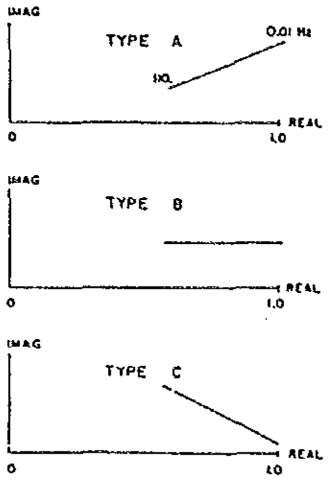
Data obtained in the field consist of real and imaginary parts of complex resistivity response at each frequency, apparent resistivity, phase and magnitude of received basic frequency, and so on. The following figures are determined using these data :

① Cole-Cole Diagram
② Magnitude Spectrum
③ Phase Spectrum
④ Raw Phase at five freqencies
⑤ PFE Pseudo-section
⑥ Apparent Resistivity Pseudo-section

Data processing and method of analysis are given as follows .

A) Cole-Cole Diagram

In a Cole-Cole diagram, print-out data for each frequency are plotted on a coordinate by setting the negative imaginary part on the vertical axis and the positive real part on the horizontal axis. An example is shown in Fig.12. θ i and Mi on the figure are, respectively, called phase angle and magnitude. The Cole-Cole diagram is known to display a special spectrum depending on the kind of mineral or rock.



According to Zonge et al, there are three types of spectra as illustrated in the left- hand figure. Type A, showing a pattern of ascent to the right, indicates existence of sulphide minerals, graphite or strong alteration. The flat line pattern of Type B indicates moderate alteration, and the Type C pattern of descent to the right indicates weak alteration, alluvium sediment, fresh igneous rock or limestone. Discrimination of Cole-Cole diagrams of this survey was based on this classification of the three types.

B) Magnitude Spectrum

The magnitude refers to Mi and Mj of Fig. 12, and is easily obtained from positive real and negative imaginary components of field data. The values are normalized by dividing by Magnitude M_0 of minimum frequency (0.125 Hz). A magnitude spectrum figure is plotted by setting the magnitude value on the vertical axis and frequency on the horizontal axis.(Fig. 13) In the figure, a flat line indicates fresh rock without mineralization or alteration, whereas the spectrum line descending to high frequency indicates strong alteration, sulphide minerals and graphite.

C) Phase Spectrum

In a phase spectrum, the vertical axis is phase angle θ of Fig. 12, and the horizontal axis is frequency. (Fig. 14 a). Data obtained in the field survey are a combination of original IP responses (solid line A in Fig. 14 b) and pseudo-IP responses (dotted line B in Fig. 14 b) derived from electro-magnetic coupling. Line C (-x---x-) in Fig. 14 b shows the combined IP responses. The phase spectrum indicated in Fig. 14 a was obtained through measurement.

(3) Decoupling Manipulation

Decoupling denotes the removal of a false component in IP responses originating from electromagnetic coupling. The decoupling process was conducted on data over the whole lines of A and B. The decoupling procedure on the SIP measurement in this area was based on the method provided by P.G.Hallof and W.H.Pelton. The analytical method is summarized below. A complex impedance ZA(f) obtained from the SIP survey is approximated by the following equation.

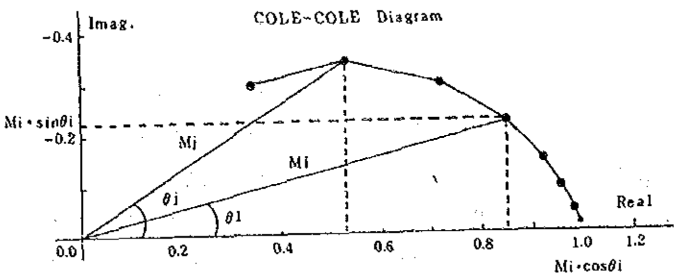


Fig. 12 Cole-Cole Diagram

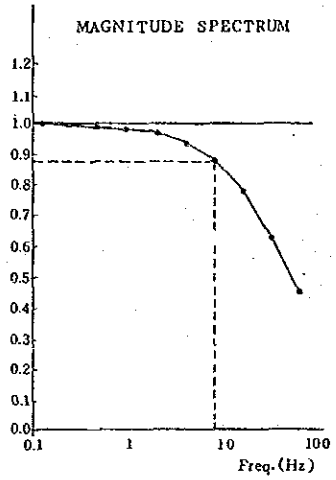
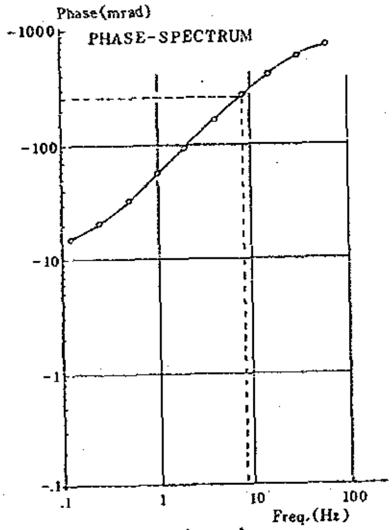
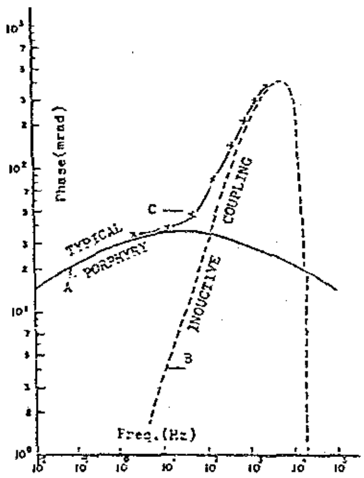


Fig. 13 Magnitude Spectrum



(a)



(b)

Fig. 14 Phase Spectrum

$$ZA(f) = Ro[1 - m_1\{1 - \frac{1}{1+(i2\pi f\tau_1)^{c_1}}\} - m_2\{1 - \frac{1}{1+(i2\pi f\tau_2)^{c_2}}\}$$

$$+ m_3\{1 - \frac{1}{1+(i2\pi f\tau_3)^{c_3}}\}]$$

where, m ; chargeability

τ ; time-constant

c ; frequency dependence

f ; frequency

The equation can be separated into three parts as follows :

$$1 - m_1\{1 - \frac{1}{1+(i2\pi f\tau_1)^{c_1}}\} \quad (1)$$

$$- m_2\{1 - \frac{1}{1+(i2\pi f\tau_2)^{c_2}}\} \quad (2)$$

$$+ m_3\{1 - \frac{1}{1+(i2\pi f\tau_3)^{c_3}}\} \quad (3)$$

The first nominal refers to an IP response, the second indicates electromagnetic coupling derived from a homogenous earth and the third represents the value of electromagnetic coupling in a conductor. Ten parameters (Ro, m_1, τ_1, c_1, m_2, τ_2, c_2, m_3, τ_3, c_3) of the equation above are determined from the SIP measurement using the least squares method of a non linear type. The nominals (2) and (3), being the values of electromagnetic coupling, are removed from the equation , and only the complex impedance Zco(f) of the IP response is obtained.

$$Zco(f) = [1 - m_1\{1 - \frac{1}{1+(i2\pi f\tau_1)^{c_1}}\}]$$

(4) Rock Sample Measurements

In the analysis and interpretation of the survey results, it is essential to understand the SIP features of main rocks and ores distributed in the surveyed area. The measurement of SIP was conducted over samples totaling 35 pieces - 25 pieces of drill core in the Hasandere area and 10 pieces of core samples in the karadag area - to investigate spectra of phase and magnitude, Cole-Cole property, percent frequency effects and resistivities. The procedure of measurement is as follows :

① Sample preparation : A cube of 3 cm is prepared.

② Saturation with water : The samples are soaked in distillied water for 24 hours.

③ Measurement : Instruments used are illustrated in Fig. 15. Except for the laboratory transmitter, all instru ments and measuring methods are the same as those used in the field. Standard value of current was set at 50 μ A.

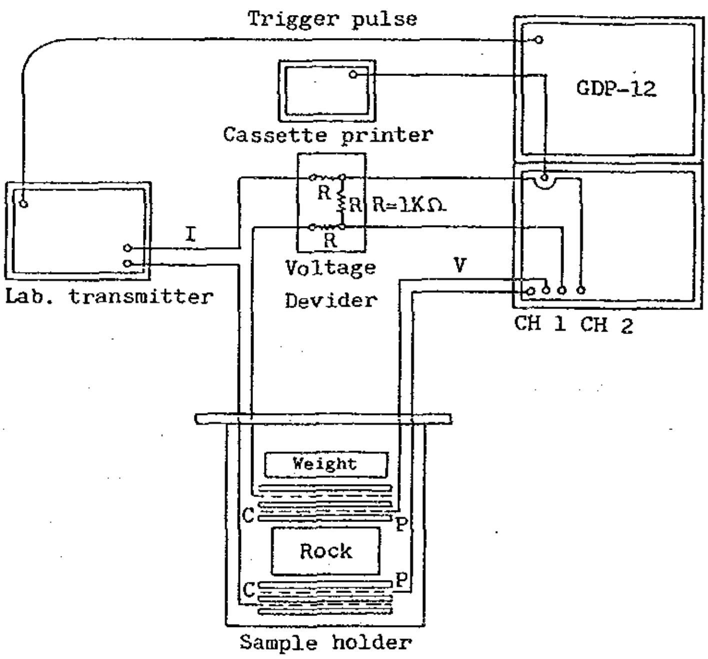


Fig. 15 Laboratory Equipment for Rock Samples

Results of Rock Sample Measurements

Results of the laboratory measurements are shown in Table 2 for total samples, and in Table 3, which includes 35 samples from 1985, for each rock type. The results from these samples can be categorized by their phase spectra which fall into seven types as A, B, C, D, E, X and Y which are shown in Fig.16.

Table 2 Results of Core Sample Measurement (Güzelyayla Area)

No.	Location (m)	Rock	Phase (-mrad)	PFE (%)	Resistivity (ohm-m)	Phase spectrum	Minera-lization	Alteration
1	16.5	Pg1	31.1	4.3	797	B	Py	ser-bio
2	52.0	Pg1	83.1	13.3	990	D	Cp, Py	bio-ch
3	100.0	Pg1	8.5	0.4	360	E		ser-bio-ch
4	150.0	Pg1	41.8	6.3	1,390	D	Py	bio-ser
5	200.0	Pg1	17.7	2.3	258	D		ser-ch-bio
6	250.0	Pg1	28.7	3.7	852	Y		bio-ser
7	300.0	Pg1	19.5	2.4	1,100	Y, (E)		ser-bio-ch
8	49.0	Pg1	63.0	9.3	3,560	A	Cc, Cp	ser
9	99.0	Pg1	41.2	6.6	2,160	D		ser
11	13.3	Pg1	27.9	3.8	1,440	B		ser
13	100.05	Pg1	18.7	2.5	892	D, (E)		ser-ch
16	250.0	Pg1	27.6	5.2	889	D		
18	16.0	Pg1	16.4	2.7	7,300	D		ser, Qz vein
19	55.0	Pg1	54.5	10.2	2,530	D		ser
20	255.0	Pg1	47.9	8.3	1,600	D		ser, Qz vein
21	300.0	Pg1	62.7	8.7	4,200	Y		ser-anhydrite
22	36.5	Pg1	24.0	3.7	6,700	A		ser
24	146.35	Pg1	20.3	2.7	911	E		ser, Qz vein
25	190.1	Pg1	31.2	3.9	195	E		ser, Qz vein
(Average value)			35.0	5.28	2,000			
12	49.8	Pg2	24.7	3.6	1,630	B	Py	
14	150.0	Pg2	17.5	2.6	3,720	B		
15	198.8	Pg2	40.1	6.0	1,580	B		
17	301.0	Pg2	20.5	2.4	405	E		silicified
(Average value)			25.7	3.65	833			
10	195.0	BA	114.0	20.2	5,690	D, (B)		
23	46.6	Qz	13.8	2.2	3,120	A		

Abbreviation

Pg1: Porphyritic granite
Pg2: Porphyritic granite (Intrusive)
BA : Basaltic andesite
Qz : Qurtz vein
Py : pyrite — ser: Sericite
Cp : Chalcopyrite — bio: Biotite
Cc : Chalcocite — ch : chlorite

Table 3 SIP Response in the Classification of Rock (Güzelyayla Area)

Rock	Sample No.	Phase	PFE	Resistivity	Phase spectrum type						
		(-mrad)	(%)	(ohm-m)	A	B	C	D	E	X	Y
Andesite											
Andesite	13	-4.3~56.16	-0.19~144.57	126~10,068	4			4		3	2
		(109.6)	(25.68)	(1,753)							
		(10.1)※	(1.73)※	(1,976)※							
Basaltic Andesite	6	3.5~376.2	0.45~88.31	547~7,164	2	1		1		2	
		(108.5)	(22.20)	(3,970)							
		(14.3)※	(2.19)※	(5,408)※							
Pyroclastic Andesite	3	3.9~5.1	0.58~0.73	1,819~4,996	3						
		(4.4)	(0.63)	(3,828)							
Porphyritic granite											
Pg-1	28	7.8~208.8	0.40~38.71	195~7300	5	4		11	3	2	3
		(38.5)	(5.97)	(2,281)							
Pg-2	5	17.5~40.1	2.40~ 6.00	405~6,551	1	3			1		
Qurtz Porphyry	1	6.5	0.84	5,207			1				
Qurtz vein	1	13.8	2.20	3,120	1						
Calcareous mudstone	1	10.1	1.16	4,322			1				
Siltstone	2	1.9~ 2.4	0.32~0.34	3,273~12,649	2						
Total	60				18	8	2	16	4	7	5

( ) Average value

※ Excepted anomalous value

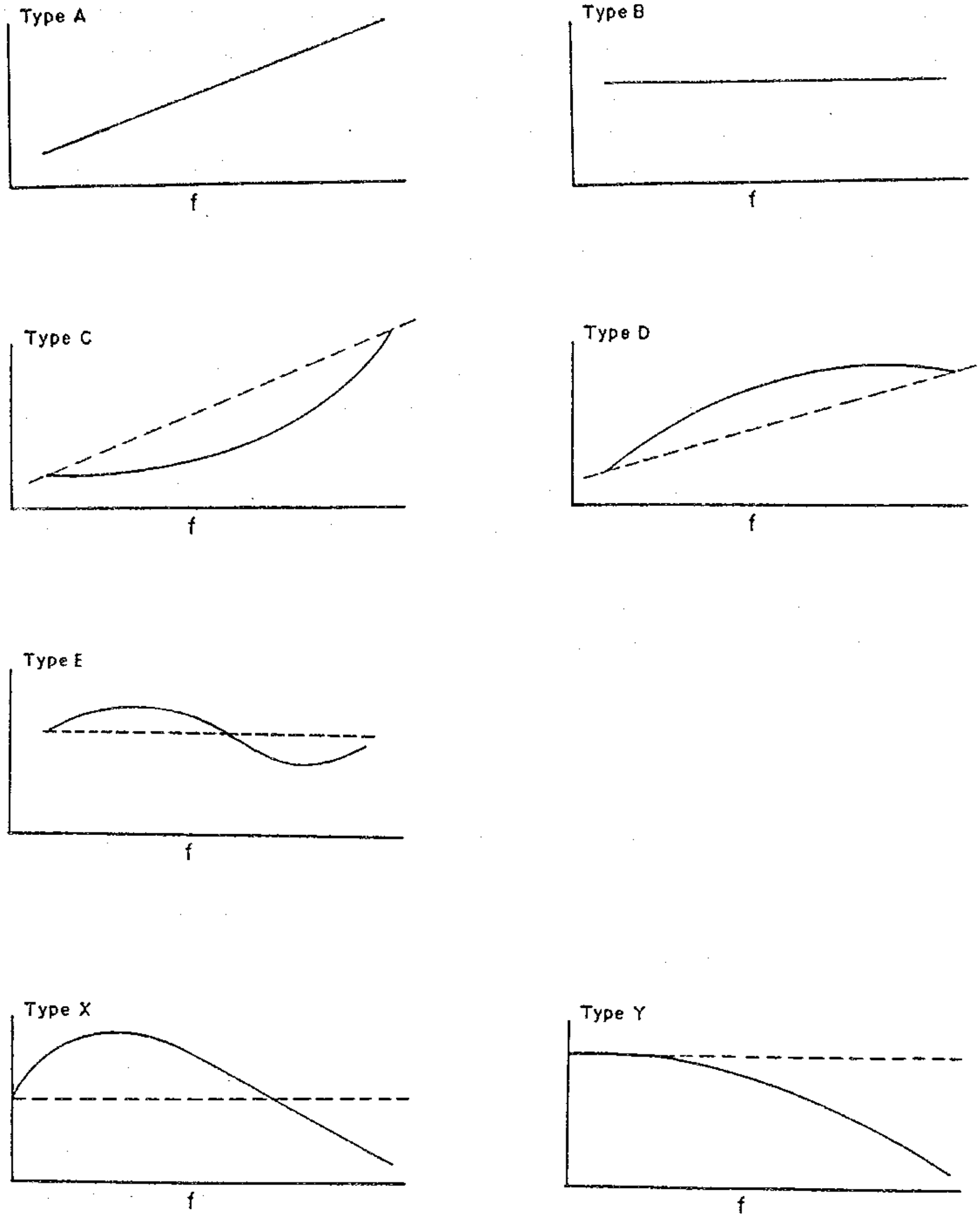


Fig. 16 Phase Spectrum Types of Rock Samples

In comparison, types in the Cole-Cole diagram are divided into two groups; one belonging to type C in the Cole-Cole diagram contains A,B,C and D types of phase spectra and the other belonging to type A in the Cole-Cole diagram contains E, X and Y types of phase spectra.

The result indicates the following :

① Phase and PFE values of andesite and basaltic andesite are the highest. The next is porphyritic granite. In the same rock, these values vary extensively in range depending on condition of alteration and pyrite dissemination.

② Phase and PFE are proportionately correlated.

③ Resistivity values are in a wide range from 126 ohm-m to 12,650 ohm-m. Most values are generally high, but 10 samples (17 % of the total 60 samples) are below 500 ohm-m.

④ In the case of the phase spectrum, samples of high phase and PFE belong to the X and Y types. Resistivity is not correlated with the phase spectrum.

⑤ On the other hand, weakly mineralized or fresh rock samples are higher than 2,000 ohm-m in resistivity, and mostly belong to A and D types of the phase spectrum.

4-3 Results of Interpretation

Three plans of AR and PFE were provided for each electrode coefficient of n= 1,3 and 5. Pseudosections of each line were illustrated by a panel diagram. Terrain correction on AR was made with carbon conductive paper to eliminate an effect caused by topographic undulations. As for the SIP responses, phase variation at five frequencies ranging from 0.125 to 3 Hz, phase spectrum, magnitude spect-rum and Cole-Cole diagram were shown on a pseudosection of each line. Phase variation after decoupling was also presented.

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

The AR in the area ranges from 10 to 4,217 ohm-m and gives the arithmetic mean (M) of 269 ohm-m. The standard deviation(σ) after common logarithms stands at 0.476, giving the values of $M+\sigma$ and $M-\sigma$ of 804 and 90 ohm-m respectively. Reference values of high and low resistivity were set at nearest contour values of 1,000 and 100 ohm-m. Due to a broadness of AR values, contours were drawn at 10, 20, 50, 100, and so on, to give a uniform interval under logarithms.

Plans of AR

N=1 Plan (Fig.17): A broad distribution of low AR of less than 100 ohm-m was

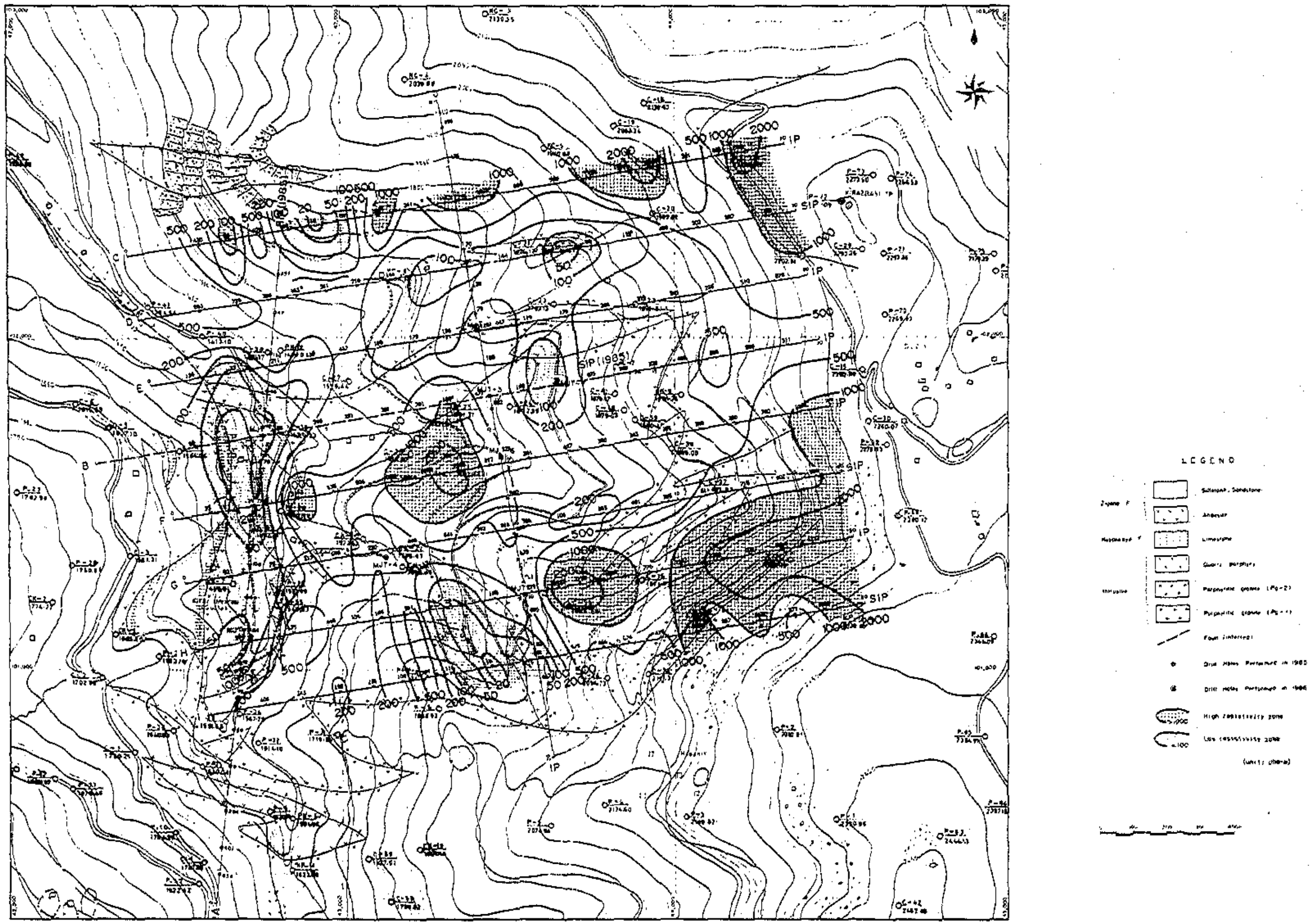


Fig. 17 Plan Map of Apparent Resistivity [0.125 Hz] (n = 1)

delineated in two places in the west at Maden River (in the vicinity of the boundary between andesite and porphyritic granite) and at Hasan River (in an area of andesite). A small zone of low AR is observed in the north.

The most prominent high AR, being more than 1,000 ohm-m, is widely distributed in the southeast (andesite and porphyritic granite Pg-2). Smaller zones are scattered in the central and northeastern parts of the area.

N=3 Plan (Fig.18): The two zones of low AR at Maden and Hasan Rivers on Plan N=1 merged to form a broad area in the southeast (mainly in an area of the porphyritic granite, Pg1). An area of medium scale of low AR is observed in Line E and west of line B.

A zone of high AR is detected at the same place as on N=1, but is smaller in scale.

N=5 Plan (Fig.19): The zone of low AR has a similar pattern with that of N=3, but the zones on Line E and in the middle of line B have a tendency to become wider.

The zone of high AR decreases its size and is detected at three places in the southeast, northeast and northwest.

Section of AR (Fig.20)

Distribution of zones of high and low AR to depht is examined on the panel diagram.

The zone of high AR appears in three places at:

(a) east (andesite) and west (andesite and quartz porphyry) of Lne C

(b) in shallow depth between Nos.6 to 9 (porphyritic granite Pg1) on Line F.

(c) on Line H and east of Line H (andesite and porphyritic granite Pg1 & 2).

The first and the last give continuous patterns to depth and the pattern in (b) is assumed to reflect an effect of high AR at shallow depth.

The zone of low AR is observed in four places at:

(d) east of Line C

(e) at the western ends of lines E, B, F, H, (andesite and porphyritic granite Pg1)%

(f) the centers of lines F and B (rock types as above)

(g) Line H and the section from No.6 to No.9 (andesite) on Line I which was detected in Hasan river.

The zone of low AR of (e) is situated along Maden river and the zone of (g) is located on Hasan River. Most of them coincide with alteration zones delineated on the surface. No alteration zone is known in relation with (d) and (e) which are situated in topographic depressions. These are probably related

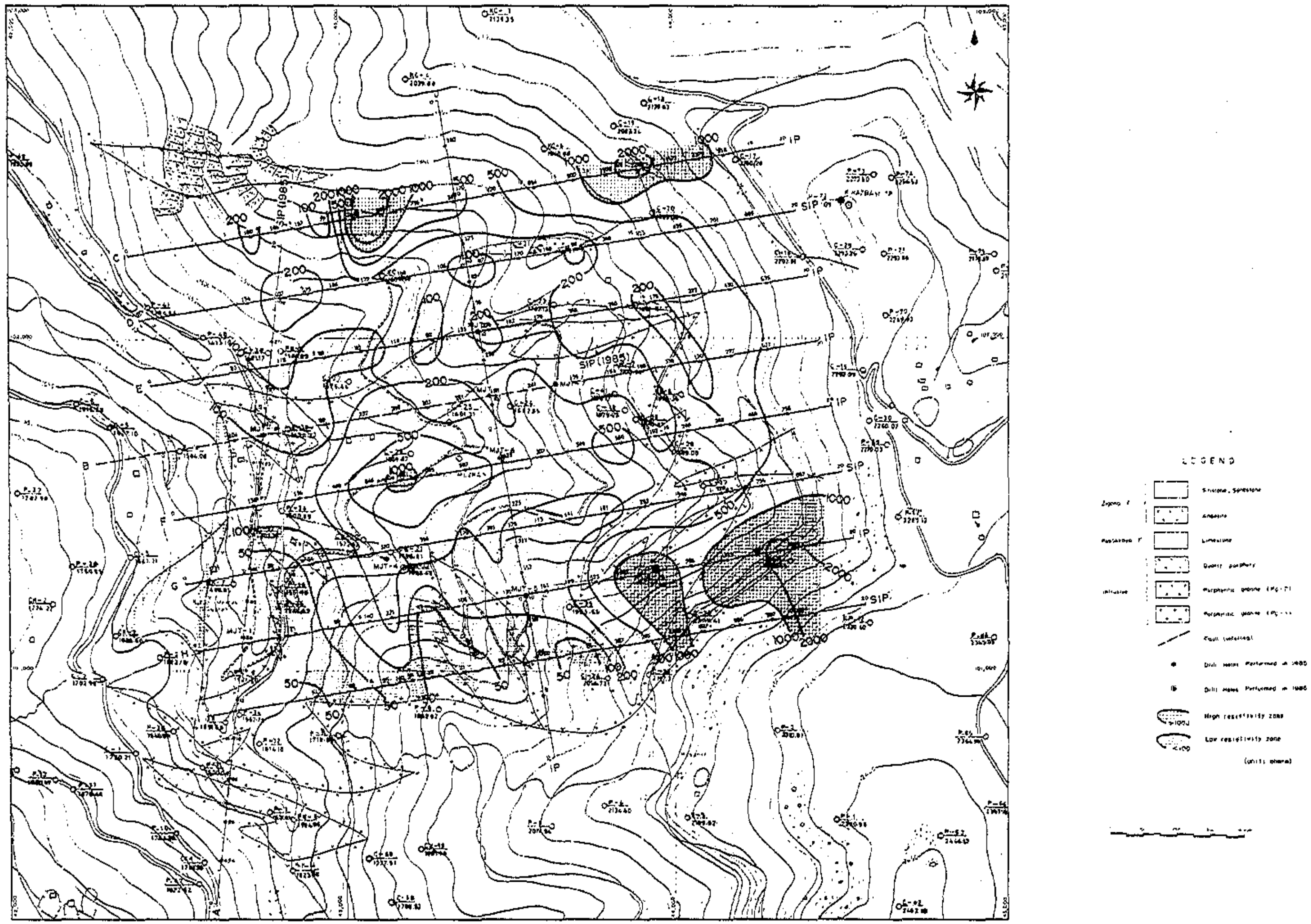


Fig. 18 Plan Map of Apparent Resistivity [0.125 Hz] (n = 3)

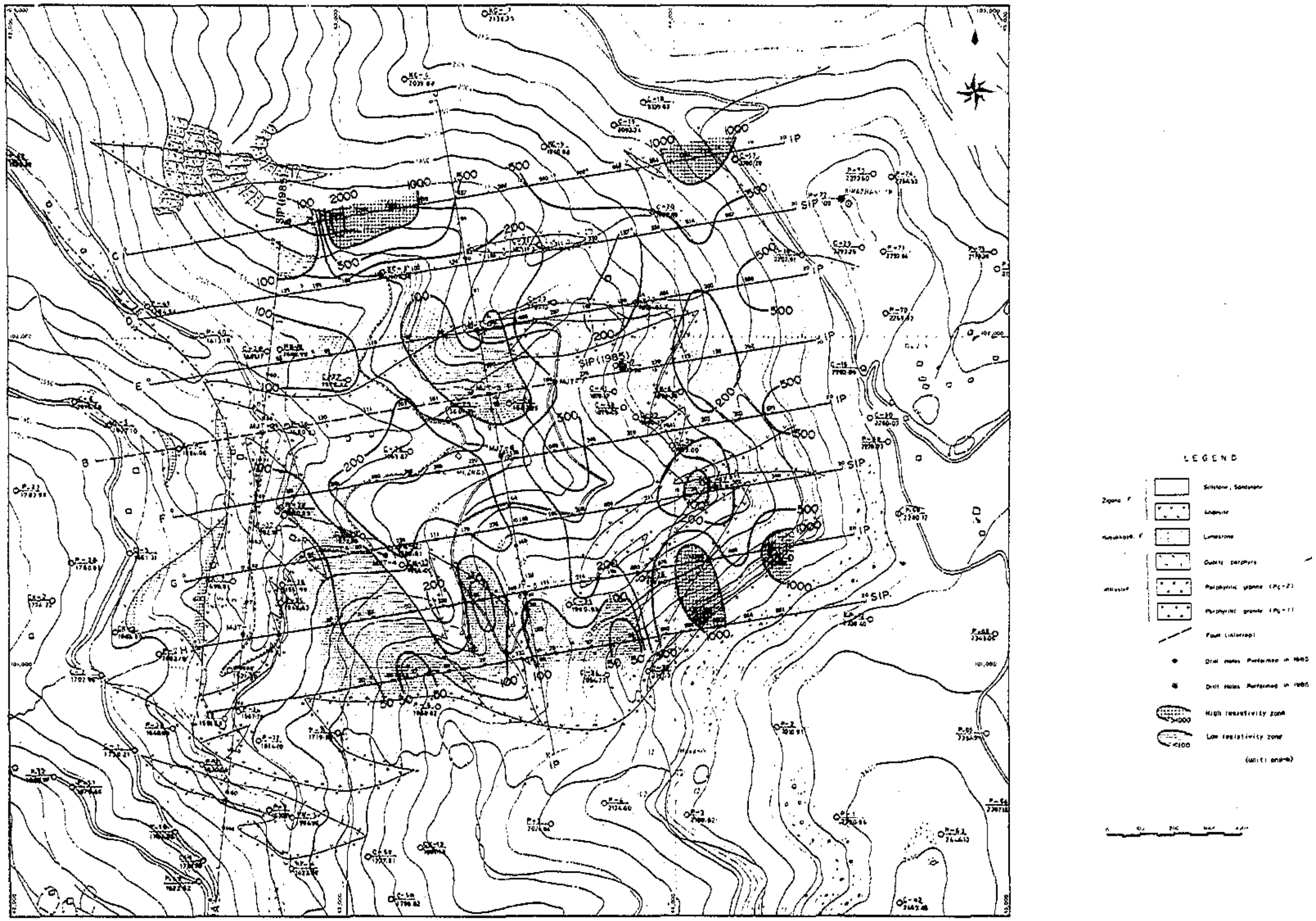


Fig. 19 Plan Map of Apparent Resistivity [0.125 Hz] (n = 5)

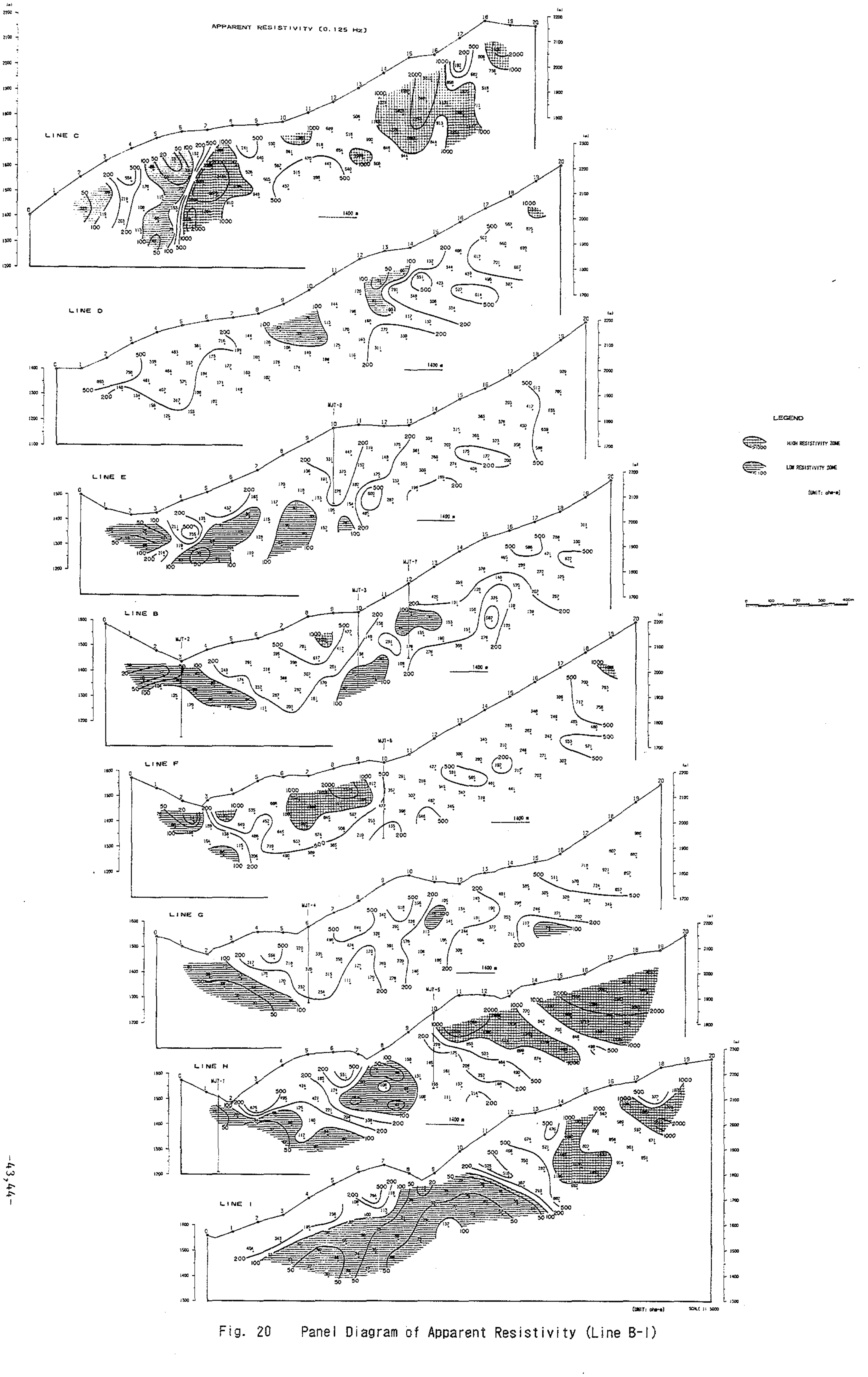


Fig. 20 Panel Diagram of Apparent Resistivity (Line B-I)

with ground water to some extent. The zones of low resistivity are situated at shallow depth except the sections between No.7 and No.9 on line E and between No.2 and No.5 on line I.

The characteristics of the resistivities in the area are low compared with the results of laboratory measurements. They range from 200 to 500 ohm-m of the medium range. The distribution of AR cannot be related with a specific rock but the zone of low AR can be deemed to be related to alteration zones or ground water.

(2) Plan Map of Pseudo-Section of Percent Frequency Effect

The PFE value of the area ranges from -0.3 to 18.3% and the arithmetic mean (M) stands at 2.720, giving $M+\sigma$ and $M-\sigma$ at 10.12 and 4.68% respectively. A histogram at the 2% interval gave a logarithmic normal type distribution. Measurements of rock property indicate that PFE values over 4% are anomalous, although 90 % of field measurements exceed this level. Consequently, most of the area can be deemed anomalous. Of these, strongly anomalous areas with a PFE value over 10% are discussed below.

Plans of PFE

N=1 Plan(Fig.21): A prominent area of PFE above 10% is observed west of Lines C, D and E and extends from the middle of Line C to west of Line E in a direction of NE-SW. A high anomaly south of Line A, which was detected in the previous year, can be observed at the western end of Lines G, H and I but does not extend towards the north or east. Small anomalies of high PFE are found at No.14 of Line E,at the eastern end of Line B, at No.11 of Line F and at No.17 of Line H. The first two run in a line of NW-SW direction with a zone of more than 8% PFE and stretch to the middle part of Line C. This anomaly forms, with the anomaly of NE-SE direction of Line C, a horseshoe shape opened to the south. In the middle of this, there exists another anomaly which extends from the vicinity of drilling site MJT-3 southward.

N=3 Plan (Fig.22): The zone of high PFE over 8% can be divided into two areas. The first extends from the north, then in a NE-SW direction, and has a broad zone of more than 10% PFE in the north where andesites occur and it becomes smaller on Line B where porphyritic granites (Pg1) exist. Another is a zone located in the east with an elongation of N-S trend. An area of more than 10% at the eastern end of Lines D,B and E over andesites and porphyritic granites (Pg1) is conspicuous. The central part of Lines H and I on the area of porphyritic granites (Pg1) is also distinguished.

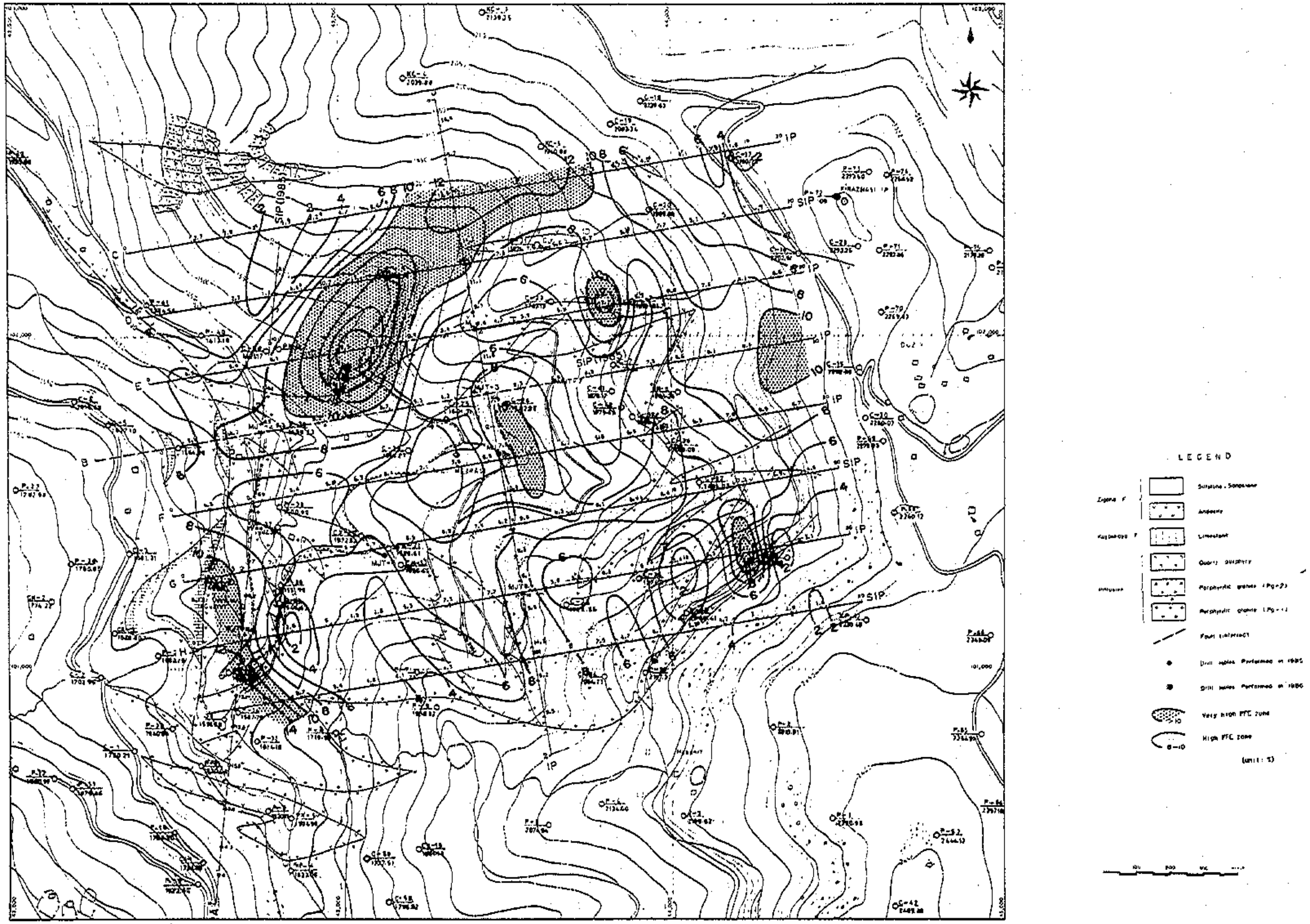


Fig. 21 Plan Map of PFE [0.125 - 1.0 Hz] (n = 1)

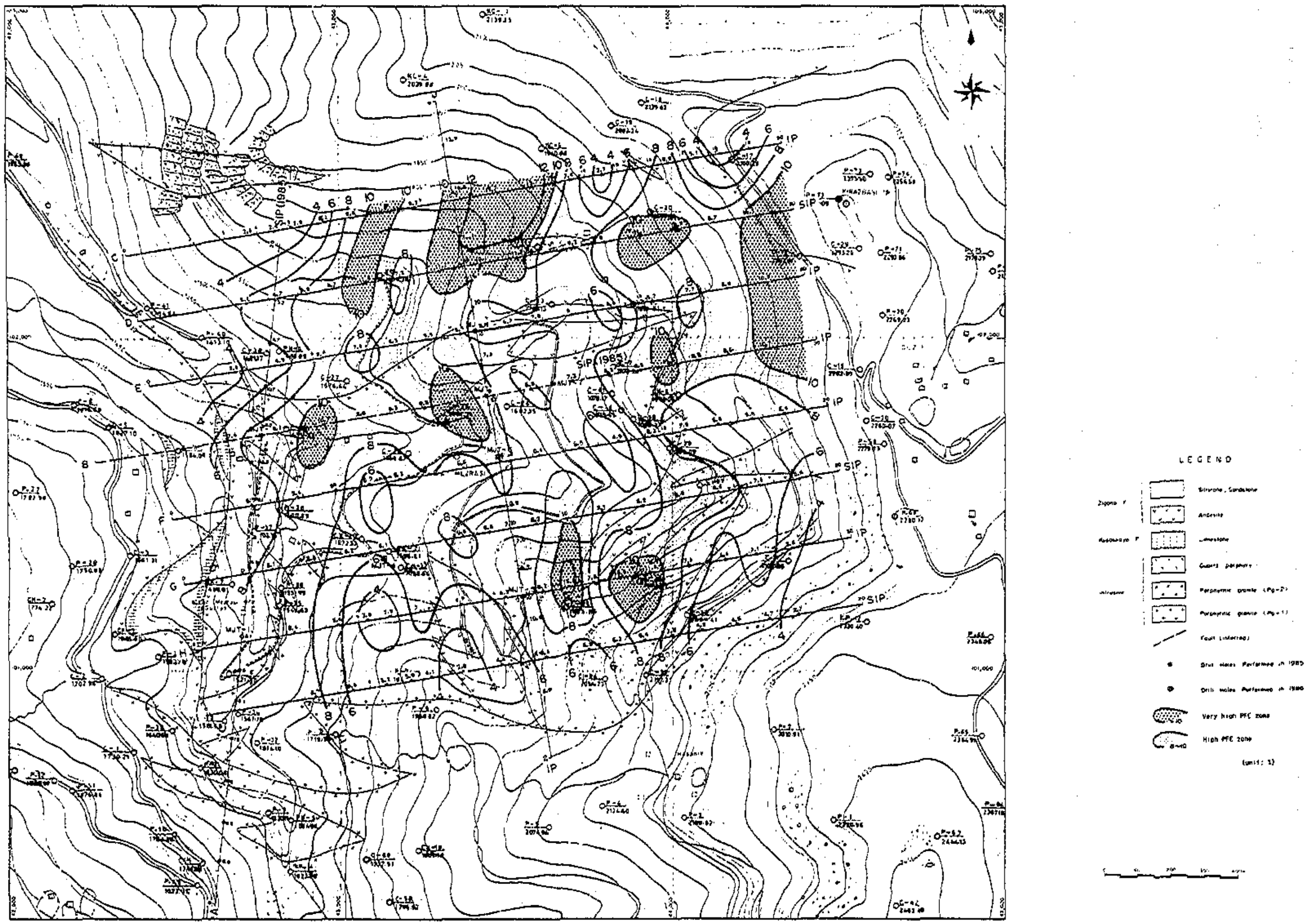


Fig. 22 Plan Map of PFE [0.125 - 1.0 Hz] (n = 3)

N=5 plan (Fig.23): Areas of high PFE are similar to those of N=3 but zones of more than 10% are small in scale. They are at the central part of Lines C and D, in the vicinity of Nos.8-9 on Lines F and B, No.15 of Line B, No3 and No.16 of Line G, and in the vicinities of Nos.11 and 12 of Line H. They form a small U-shape.

Section of PFE (Fig.24)

Continuity of anomalies of high PFE to depths is illustrated in the panel diagram.

The anomaly from the centre of Line C to the west of Line E originated from a source of anomaly at shallow depth. The anomaly extending towards the southeast shows a contour pattern derived from a source at a shallow depth. Anomalies of Nos.7-10 and 12-16 of Line B come from sources at medium to deep depths. The anomaly extending from the central part of the area to the south is also deemed to have been derived from a source at medium to deep depths.

Distribution characteristics gave three anomalies, namely, the horseshoe shape in the north, one extending from the central part to the south, and an anomaly along Maden River. Their origins are assumed to be situated at shallow depths except for the one in the centre of the area.

(3) Pseudo-Section of Phase

Sections were provided for each phase of 0.125, 0.375, 0.625, 1 and 3 Hz to investigate reliance of phase on frequencies. Phase sections after decoupling were also given.

Line D (Fig.25):

Sections of five frequencies shows similar patterns indicating that electromagnetic coupling was rare. Between No.5 and No.11, an area of 80 mrad shows a tendency to increase in accordance with an increase of frequency showing a little electromagnetic coupling. As observed in Figs.17-20, low values of AR less than 10 ohm-m are scarce and 86.4% of resistivities of rocks and cores exceeded 500 ohm-m. Consequently, it can be assumed that the resistivity of the area is large and that electromagnetic coupling phenomena are rare.

Phase sections after decoupling gave almost identical patterns at five frequencies. These patterns coincide with a phase pattern of fundamental frequency at 0.125 Hz indicating that electromagnetic coupling had been eliminated.

Line G (Fig.26):

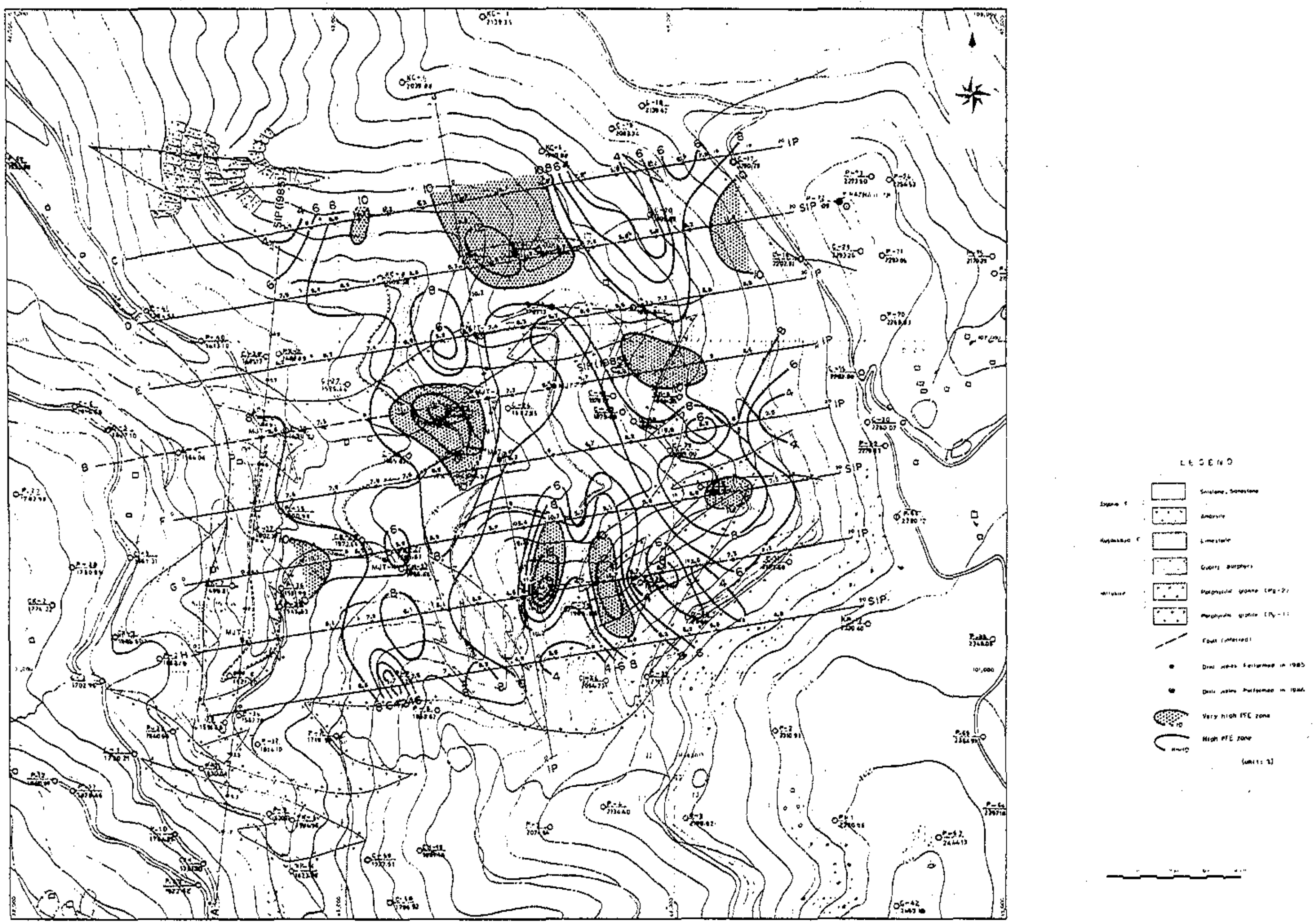


Fig. 23 Plan Map of PFE [0.125 - 1.0 Hz] (n = 5)

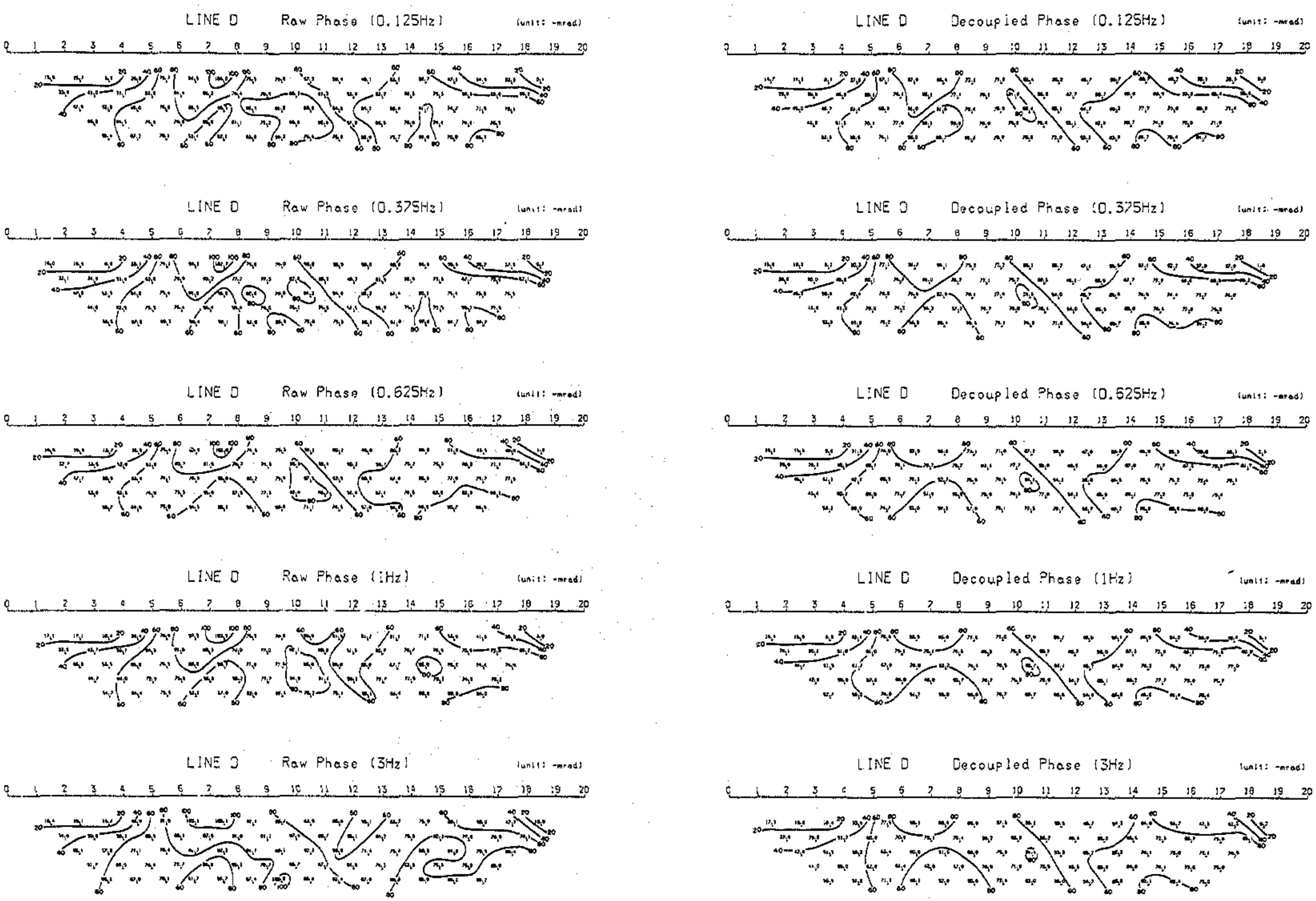


Fig. 25 Phase Difference at Five Frequencies (Line D)

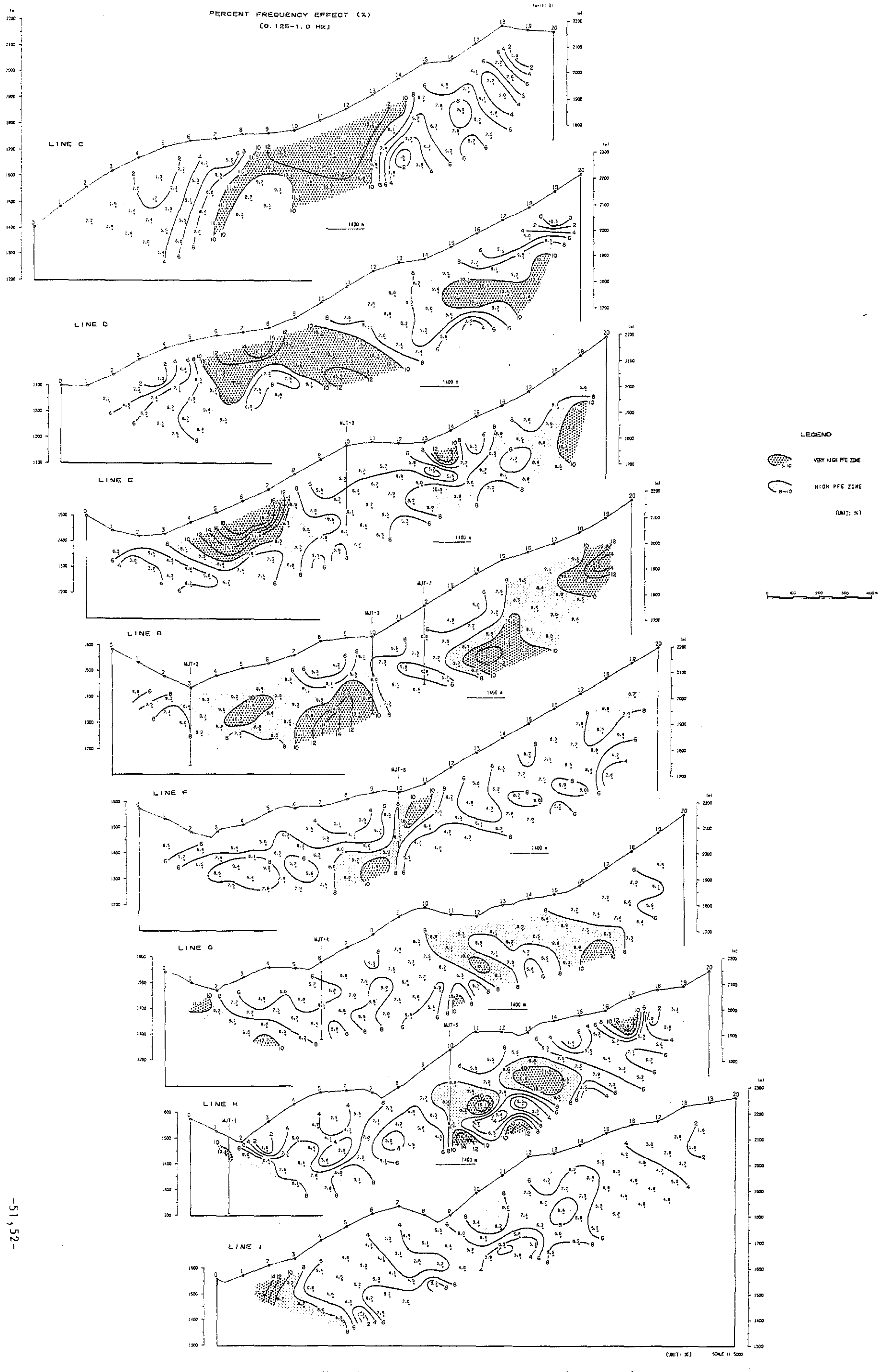


Fig. 24 Panel Diagram of PFE (Line B-I)

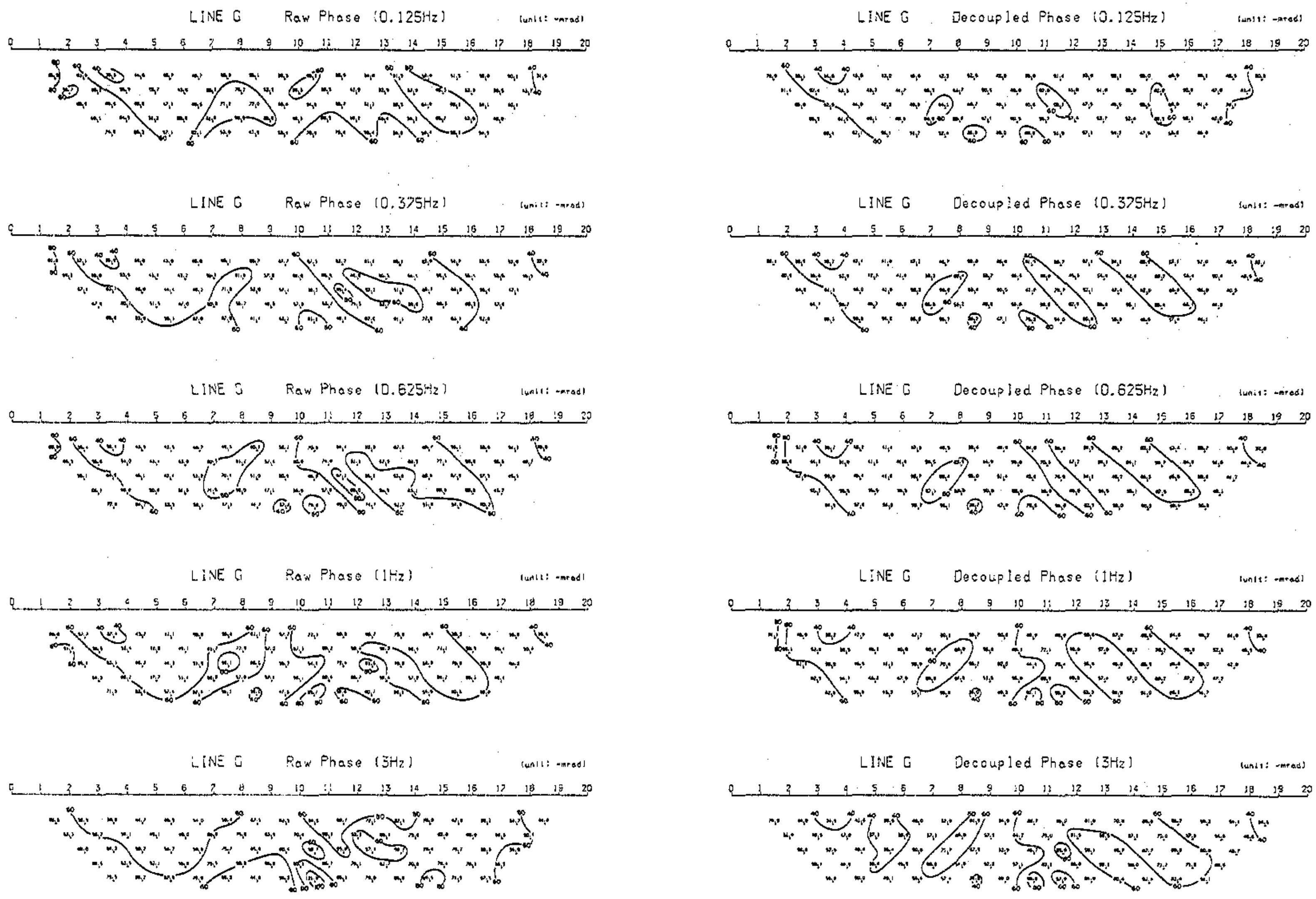


Fig. 26 Phase Difference at Five Frequencies (Line G)

In accordance with an increase of frequency, an area of 60 mrad becomes larger in the lower parts between No.6 and No.9 and between No.17 and No.19, showing a small effect of electromagnetic coupling at a frequency over 1 Hz. Phase sections on five frequencies after decoupling gave similar patterns with a section of fundamental frequecy (0.125 Hz) showing an effect of decoupling procedure.

Line I(Fig.27):

Sections of five frequencies gave intimate contour patterns, as with the previous two lines, but a weak effect of electromagnetic coupling was noticed in accordance with an increase of frequency. Five sections after decoupling showed similar patterns as the one for the frequecy frequency (0.125 Hz), suggesting an effect of decoupling.

(4) Phase, Magnitude and Cole-Cole Spectrum

Pseudosections of phase spectrum, magnitude spectrum and Cole-Cole diagram are provided. Various spectrum sections after decoupling are also presented.

Line D (Fig.28):

(A) Phase spectrum

The predominant spectra have a form which is flat in the field up to 10 Hz and has a rising tendency beyond this frequency. In the lower part between No.5 and No.9, a flat spectrum was obtained over a whole area of frequencies. This feature also appears in the spectrum after decoupling, being convex between No.5 and No.9, or of a spectrum slanting down to the right-hand side (X-, Y-type). Unaccountable spectra were observed at depth of No.3 and No.18, where PFE stoppd at 1.2% and -1.3% respectively, being extremely low. Many spectra after decoupling are generally flat or of a dropping type.

(B) Magnitude spectrum

Generally, spectra are of a dropping type with a small inclination. Larger inclination has been detected at depth between No.5 and No.9, as seen in the case of phase spectrum. Spectra after decoupling show larger inclinations at the same place. Similar spectra are observed between No.14 and No.15 at the level of N=1

(C) Cole-Cole diagram

Many are C-type spectra slanting down. A B-type flat spectrum is detected in the same position where anomalous spectra of phase and magnitude have been located. Decoupling of Cole-Cole diagram generally gives upturn A-type spectra.

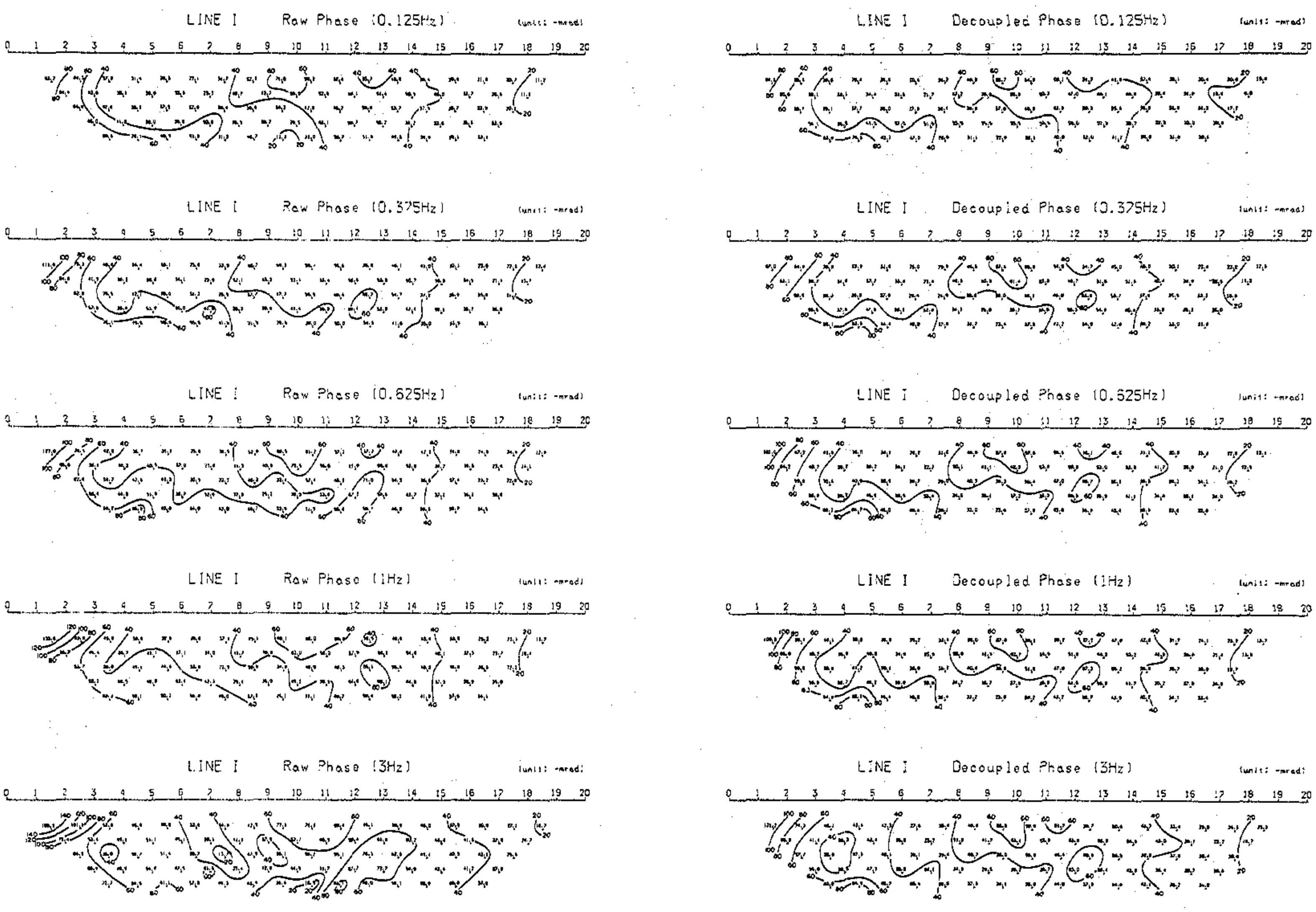


Fig. 27 Phase Difference at Five Frequencies (Line I)

Spectrum anomalies are noticed between No.5 and No.9, and between No.14 and No.15, where PFE values stand at more than 12% and 8% respectively.

Line G (Fig.29):

(A) Phase spectrum

Many spectra are of a monotonously ascending type, although noise increases beyond the depth of N=3. Three spectra which decline at a frequency beyond 8 Hz have been detected at the western end of the line. Many spectra are horizontal after decoupling, but downturn spectra are found at depth between No.2 and No.3, and upturn spectra are observed at depths at No.10 and No.15 and at moderate depth at No.11. An area where high values of PFE and phase have been detected between No.10 and No.16 shows an X-type spectrum in which the central part is convex.

(B) Magnitude spectrum

Spectra of downturn tendency with a uniform inclination are common. Different spectra have been detected after decoupling at the western end and at depth at No.10, where different spectra of up-and downturn spectra have been detected in the phase spectra.

(C) Cole-Cole diagram

All spectra are of the downturn type, except at the western end where an upturn spectrum is found. After decoupling, many spectra are flat, but several spectra of upturn tendency are seen at the western end of the line.

From the above, anomalies of spectra are pointed out at the western end of the line, at depths at Nos.10 and 15, and at moderate depth at No.11 where more than 10% PFE has been detected.

Line I (Fig.30):

(A) Phase spectrum

A negative phase has been detected at depth between No.6 and No.11. A high phase contrast was recorded at the western end of the line. Hasan River is situated between Nos.8 and 9 where a mineralization and alteration zone exists. Although a value of PFE is a little bit higher at around 6%, a zone of less than 50 ohm-m is distributed to give a large contrast against the AR of surrounding areas. After decoupling, upturn spectra are observed at both ends of the line, and convex or flat-lying spectra are observed in the middle of the line. The area of negative phase shows flat-lying spectra and a large contrast of phases.

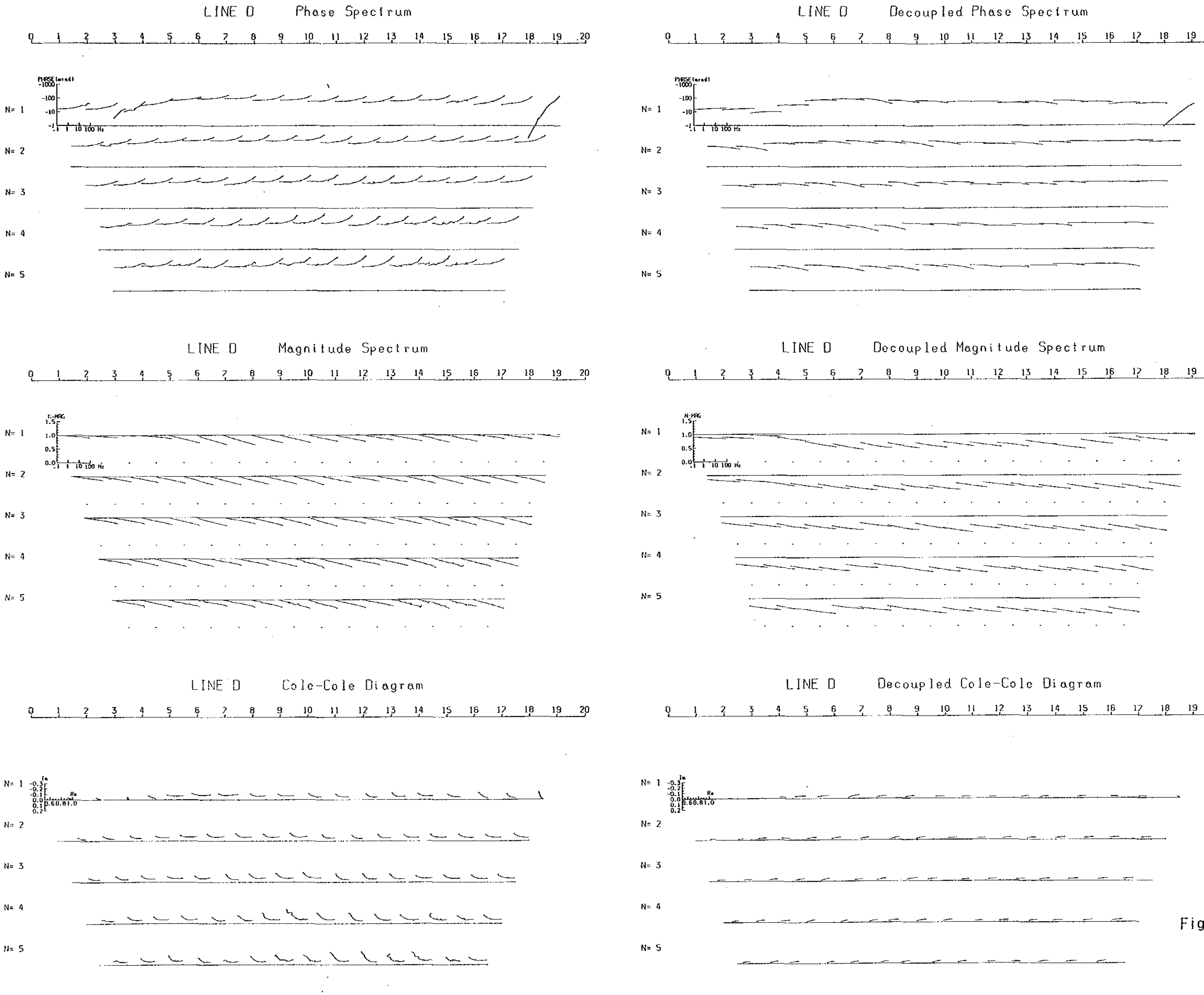
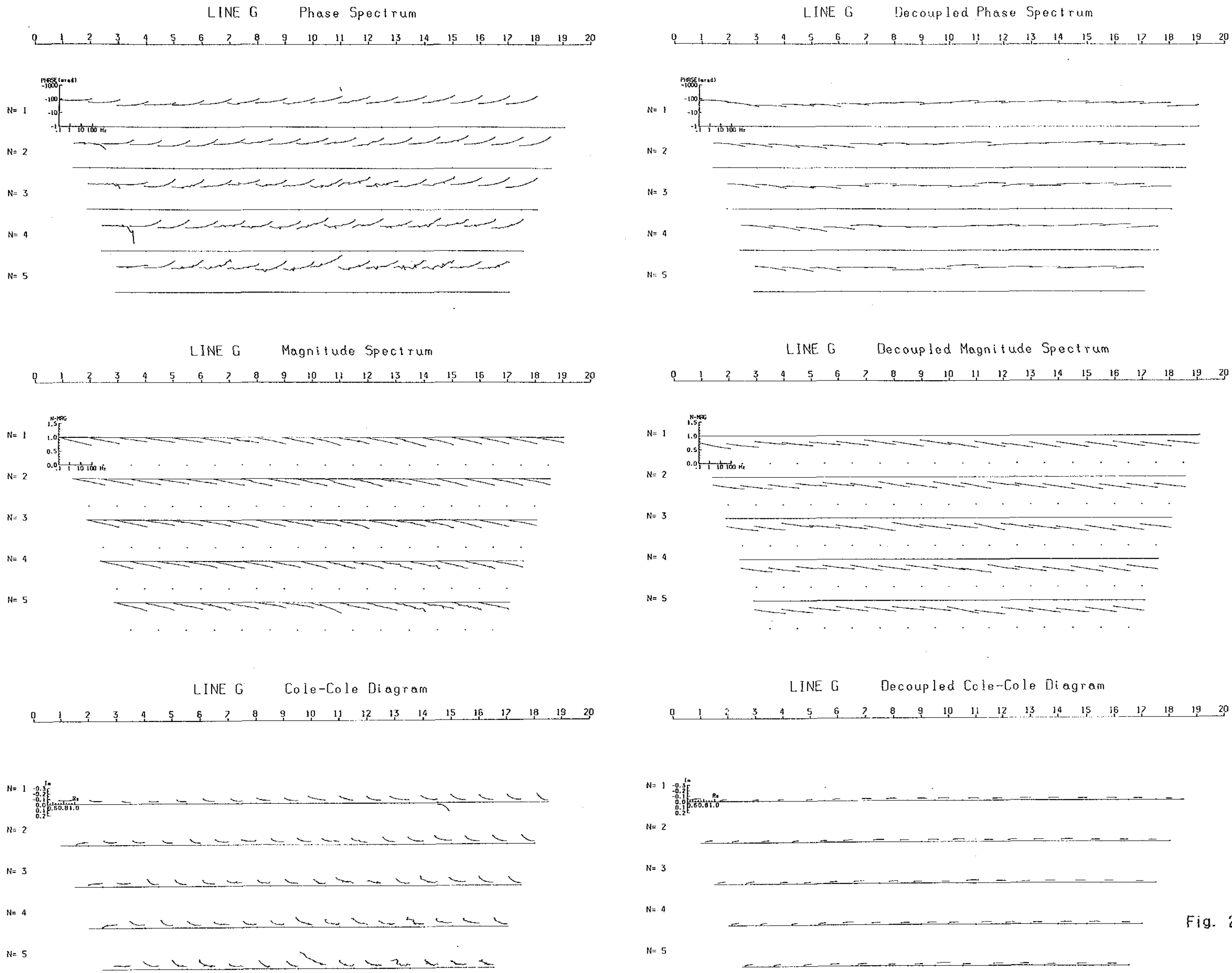


Fig. 28 Phase, Magnitude and Cole-Cole Spectrums (Line D)



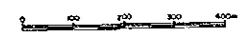
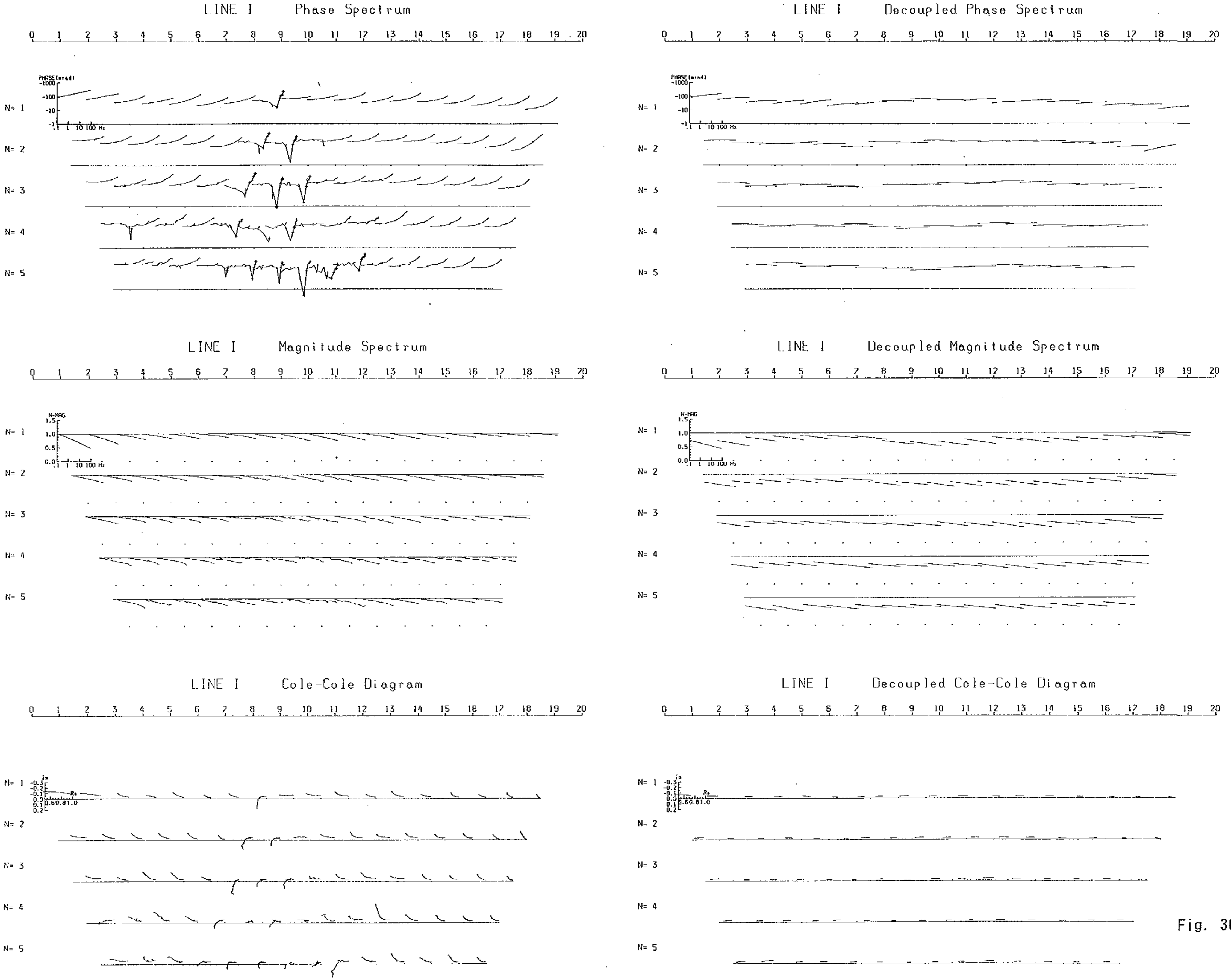


Fig. 29 Phase, Magnitude and Cole-Cole Spectrums (Line G)



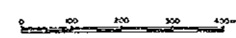


Fig. 30 Phase, Magnitude and Cole-Cole Spectrums (Line I)

(B) Magnitude spectrum

No conspicuous characteristics have been recorded except downturn spectra with steep inclinations at the western end of the line. Magnitude after decoupling gives steep spectra west of the line and at shallow depth between No.8 and No.11.

(C) Cole-Cole diagram

Spectra are generally of a downturn trend except a central part of the line where a peculiar L-shape spectrum has been obtained in the section of negative phase. After decoupling, many spectra are of flat-lying B-type with a small number of C-type of downturn tendency in the vicinity of Nos.4 and 5. At the western end of the line, an upturn spectrum, which indicates mineralization, has been detected and is assumed to be related to a zone of pyrite impregnation in andesites of Maden river.

From the above, anomalies of spectra are pointed out at the western end of the line and at shallow depth between No.8 and No.11. The PFE of these areas exceed 8%.

(5) Decoupled Percent Frequency Effect

Phase spectrum, magnitude spectrum and Cole-Cole diagram after decoupling have been discussed above. The PFE of D,G and I is explained in this section.

Line D (Fig.31,the top)

A contour pattern of PFE is similar with that of Fig.24, but a zone of 10% becomes larger between No.14 and No.18.

Line G (Fig.31, the middle)

The section has a similar pattern with that of Fig.24 but zones of more than 10% PFE at depths at No.3 and between No.15 and No.16 have disapperared.

Line I (Fig.31, the bottom)

Not much difference has been observed from before and after decoupling. A zone of high PFE at 10% occurs at the lower part of No.4.

Contour patterns of these three sections did not show apparent changes due to decoupling, indicating that the electromagnetic coupling did not give much influence. This phenomenon probably comes from high resistivities of rocks in the area.

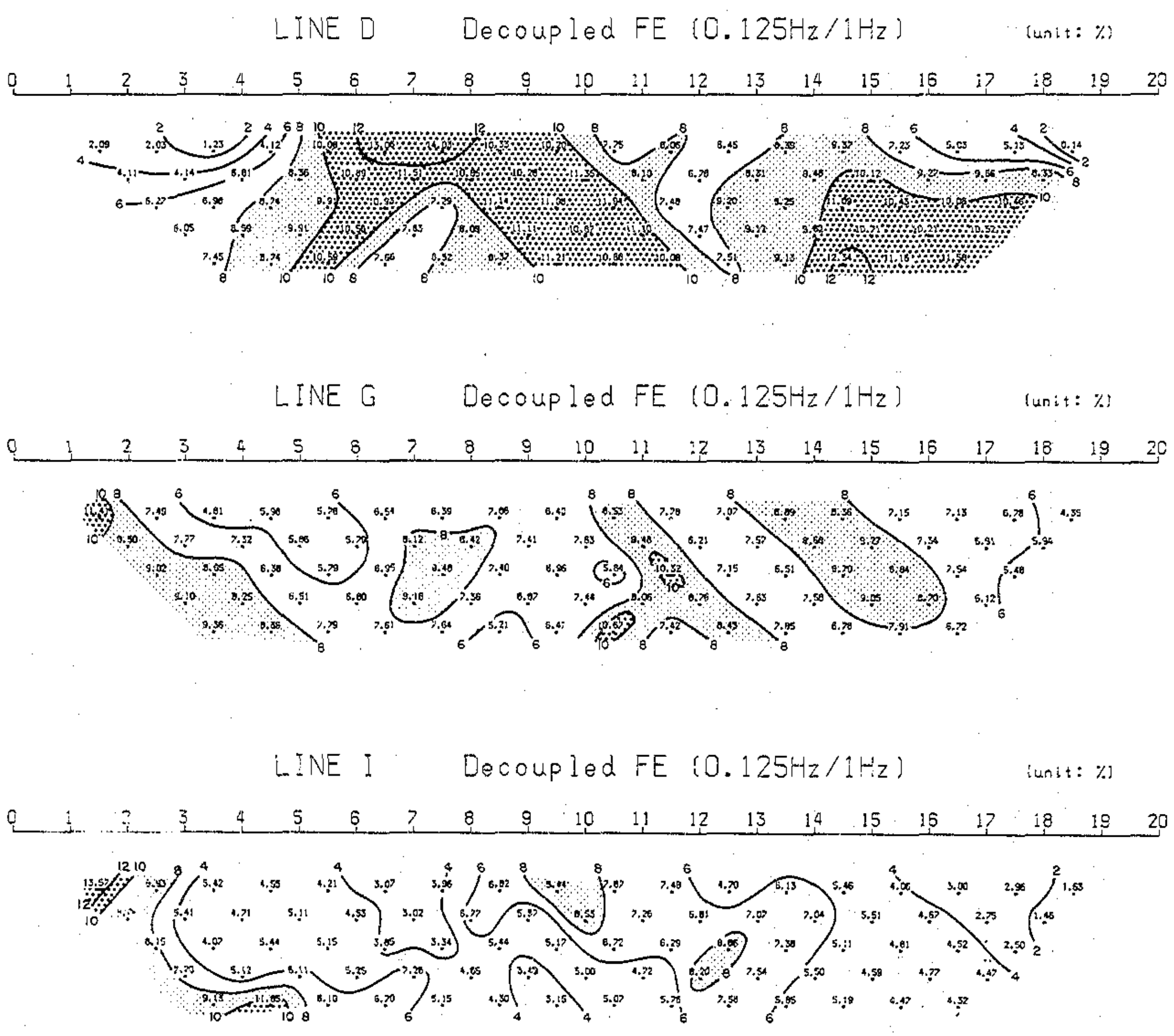


Fig. 31 Decoupled PFE (Line D, G and I)

(6) Model Simulation for IP Anomaiy

For a quantitative analysis, localities of anomaly sources and values of PFE and AR were investigated by model simulation. Centered at the drilling sites, the simulation was conducted on Lines B, E, F and J.

Line B (Fig.32-1):

High anomalies of PFE were delineated west of MJT-7 on the line. The area is mainly underlain by porphyritic granite (Pg1) except to the east where andesites occur. In the simulation, the porphyritic granite was coded as 8, the mineralized part as 3 and a leached zone near the surface as 1. The andesites were allocated Code 6. Simulation gave a distribution of AR and a pattern of PFE which is in accord with the field measurements, indicating that the given model is adequate. The mineralized zone (Code 3) is assumed to be the origin of the anomaly detected in the lower section between No.7 and No.10.

Line E (Fig.32-2):

The most prominent anomaly has been delineated at depth between No.4 and No.8. The western half is overlain by andesites Coded 5, and the eastern half is underlain by the porphyritic granite (Pg1) Coded 5. A source of anomaly is considered to be at shallow depth and is given Code 1 and 2, and a leached zone is assigned Code 3.

Patterns of AR and PFE are generally similar with field measurements. A pantleg pattern is common, but the delineated pattern is hardly obtained by the simulation. Similar patterns obtained in the field are considered to be a result of the three dimensional aspect.

Line F (Fig.32-3):

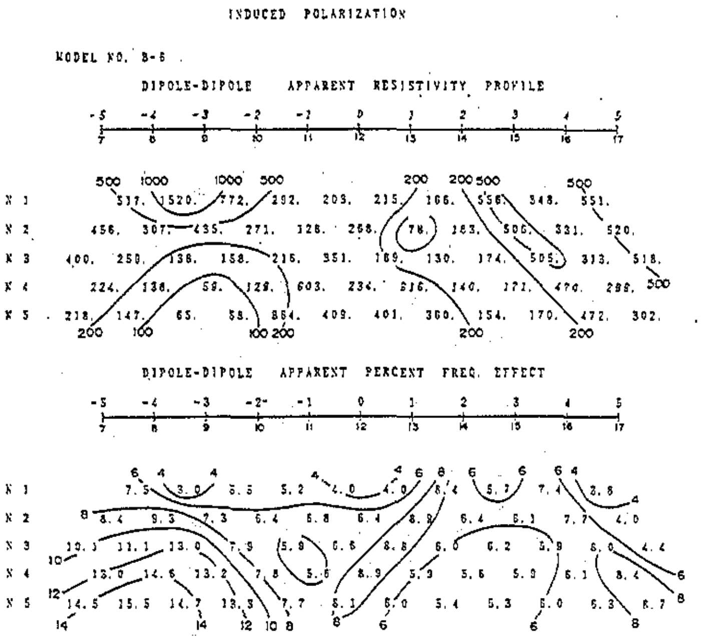
An anomaly at a shallow depth is located east of MJT-6, and an anomaly at depth is in the west. The porphyritic granite (Pg1) (Codes 4 and 5) is distributed along the line. An intrusive rock of porphyritic granite (Pg2) was penetrated by drilling. Highly resistive areas were given Codes 7 and 9, and strongly pyritized sections were allotted with Codes 3 and 8. The penetrated intrusive of Code 2 is considered to have a similar AR as the porphyritic granite (Pg1), and a value of PFE was estimated at a level of 2% due to a lack of mineralization.

After the simulation, AR and PFE were in accordance with the field measurements. Areas Coded 3 and 8 of with high PFE probably correspond to sections of strong pyritization. A zone of high AR with low PFE (Codes 7 and 9) at shallow depth may be the leached zone.

	7	8	9	10	11	12	13	14	15	16
1	855	555	551	111	111	111	111	888	666	666
2	885	555	588	888	444	444	888	888	666	660
3	888	555	888	888	444	444	888	888	888	666
100m 4	888	858	888	777	777	777	777	888	888	666
5	888	888	888	777	777	777	777	888	888	666
6	338	888	888	777	777	777	777	888	888	666
200m 7	338	888	888	777	222	777	777	888	888	888
8	338	888	888	777	222	777	777	888	888	888
9	338	888	888	777	222	777	777	888	888	888
300m 10	888	888	888	777	222	777	777	888	888	888
11	888	888	888	777	222	777	777	888	888	888
12	888	888	888	777	222	777	777	888	888	888
13	888	888	888	777	222	777	777	888	888	888
14	888	888	888	777	222	777	777	888	888	888
15	888	888	888	777	222	777	777	888	888	888
16	888	888	888	777	222	777	777	888	888	888

MODEL NO. B-6

CODE	RESISTIVITY OHM M	F. E. %
1	1000.	2.0
2	1000.	2.0
3	50.	25.0
4	50.	7.0
5	2000.	2.0
6	500.	4.0
7	200.	7.0
8	300.	8.0
9	0.	.0



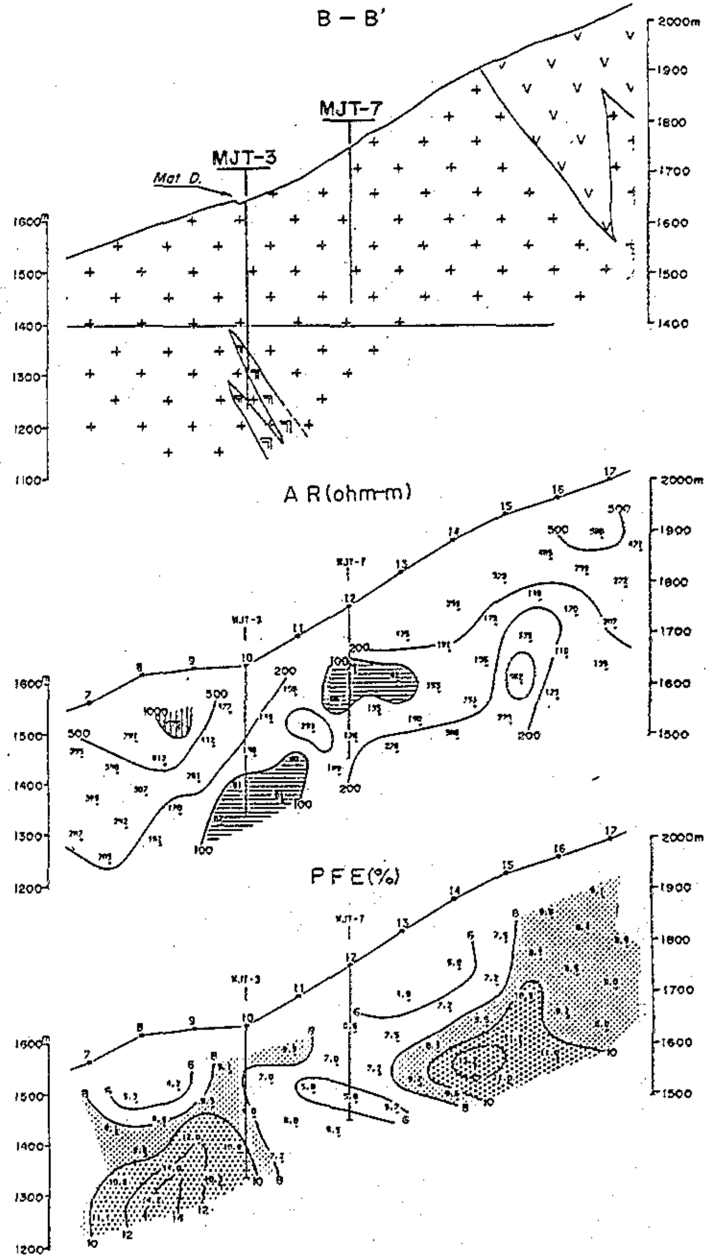
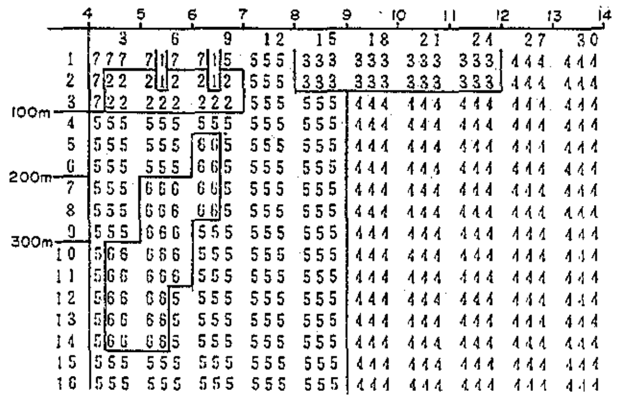
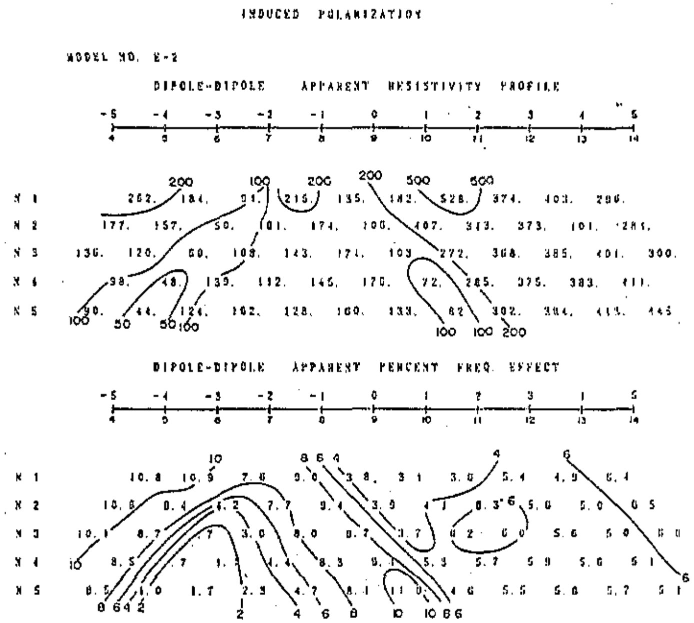


Fig. 32-1 Result of Model Simulation (Line B)



MODEL NO. E-2

CODE	RESISTIVITY OHM M	F. E. %
1	500.	20. 0
2	100.	15. 0
3	500.	3. 0
4	300.	6. 0
5	100.	5. 0
6	50.	5. 0
7	500.	5. 0
8	0.	. 0
9	0.	. 0



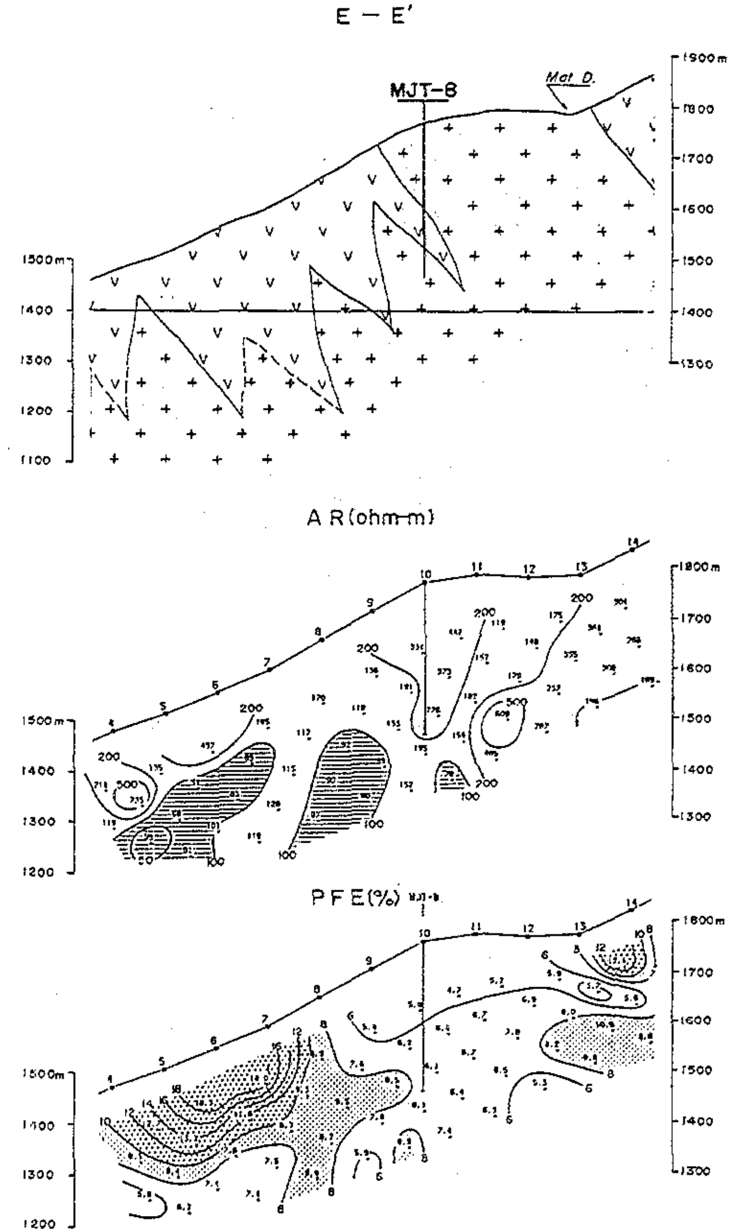
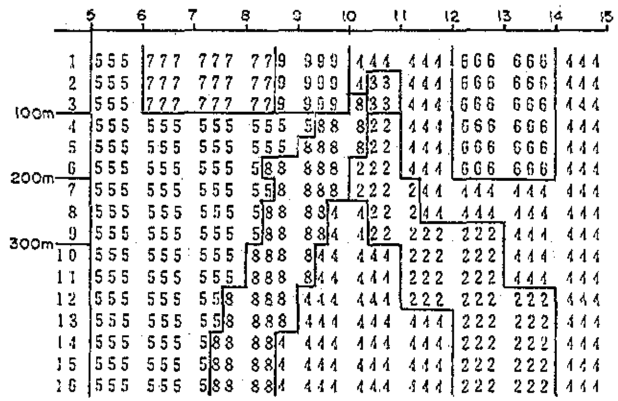
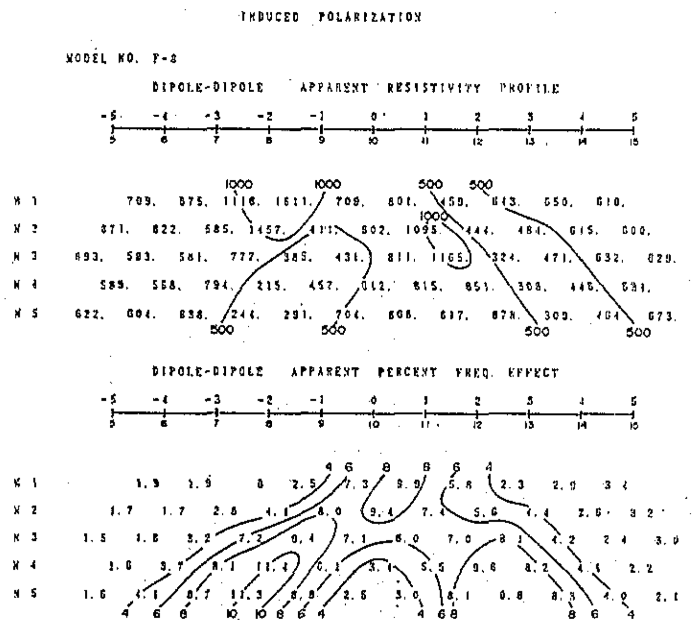


Fig. 32-2 Result of Model Simulation (Line E)



MODEL NO. F-8

CODE	RESISTIVITY OHM M	F. E. %
1	0.	.0
2	500.	2.0
3	300.	15.0
4	500.	5.0
5	500.	3.0
6	700.	2.0
7	1000.	1.0
8	500.	20.0
9	2000.	4.0



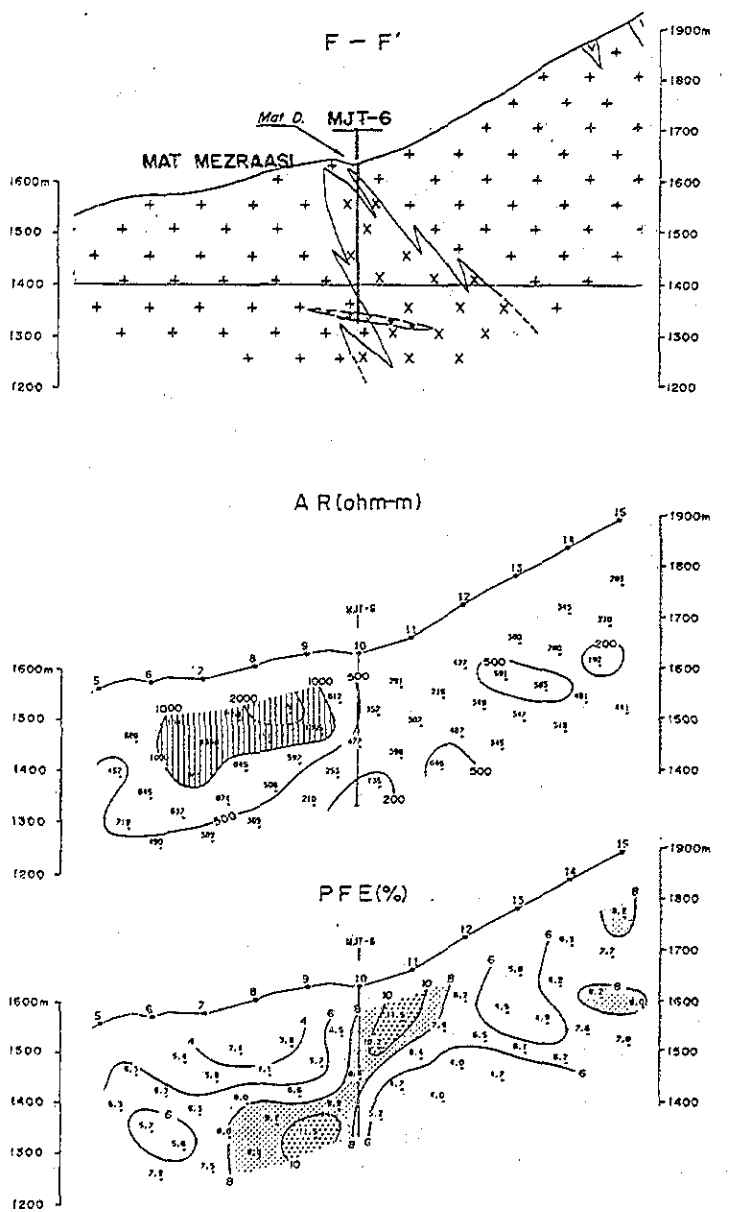


Fig. 32-3 Result of Model Simulation (Line F)

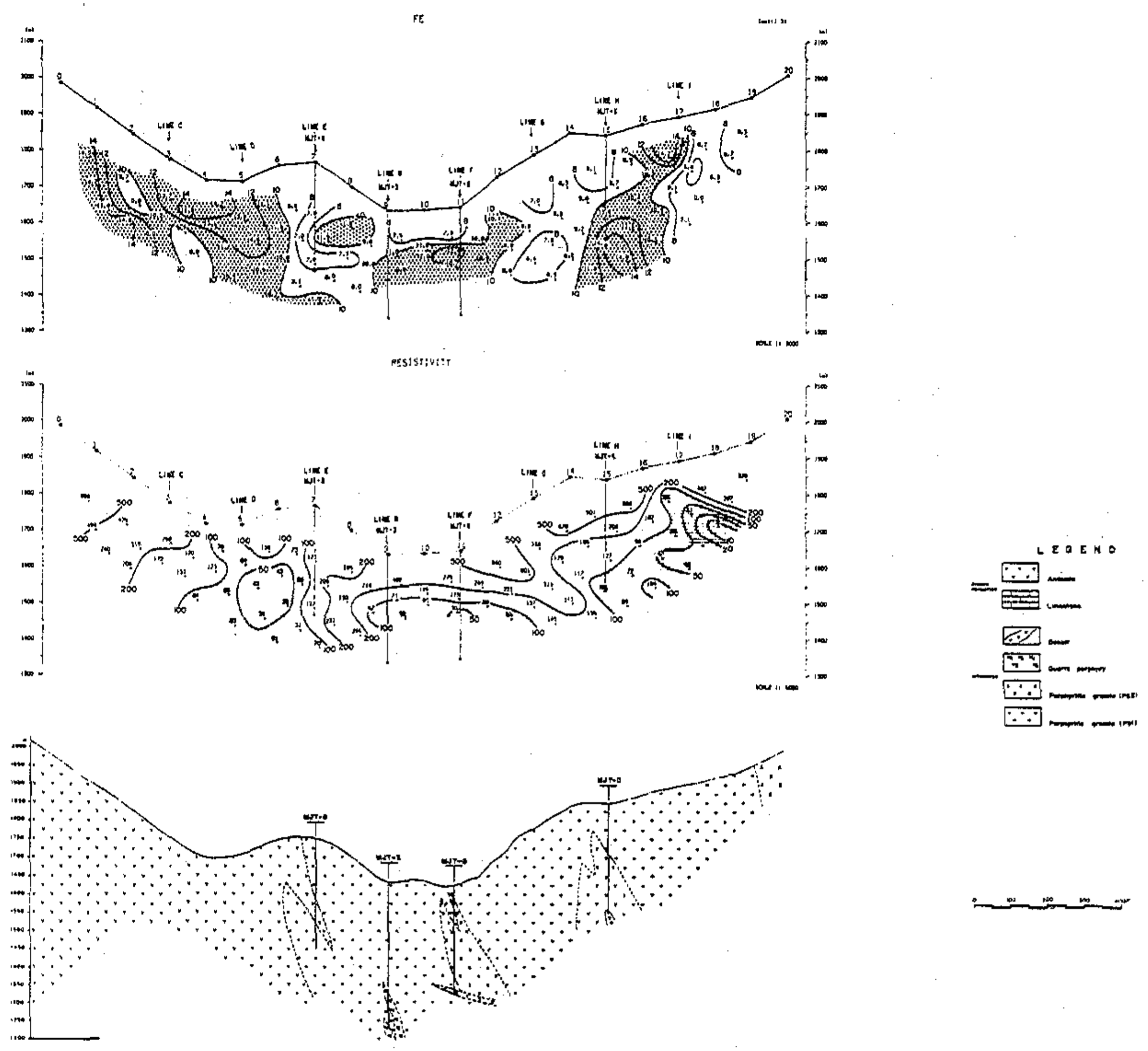


Fig. 33 Pseudo-Section of Apparent Resistivity and PFE (Line J)

Line J (Fig.33):

The line traverses the central part in a N-S direction. After consultation with MTA, the standard IP method was conducted to delineate a distribution of high anomalies of PFE.

A zone of high AR (over 1,000 ohm-m) has not been observed; zones of AR less than 100 ohm-m were detected in the following three places:

① between No.4 and No.7 on andesites

② between No.9 and No.11 on the porphyritic granite (Pg1)

③ between No.14 and No.18 on the same Pg1

These zones of low AR are situated in the lower parts of topographic depressions. Topographic effects have been eliminated by the terrain correction and these are related with groundwater and alteration zones. The zone of ③ corresponds with a zone of mineralization and alteration detected at Hasan River.

The values of PFE exceeded 6% over the whole area and areas of more than 10% have been detected in four places:

① northern part of No.1 in andesites

② between No.2 and No.6 in andesites

③ between No.7 and No.12 in an area of andesite and porphyritic granite(Pg1)

④ between No.14 and No.17 in the porphyritic granite (Pg1)

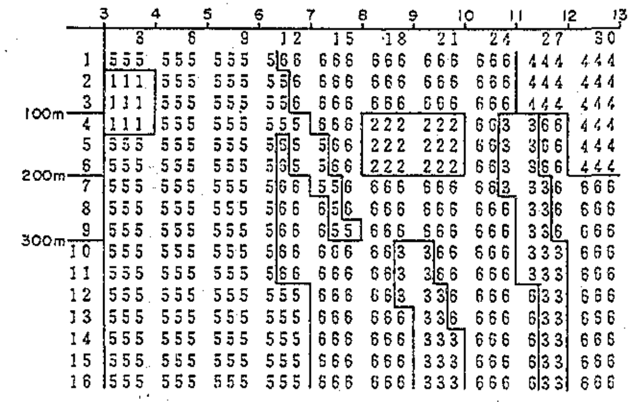
From patterns of PFE, ①, ② and ④ are of origins continuous from near surface to depth, and ③ may be related to an origin at shallow depth.

The simulation was conducted over an area between No.3 and No.13 (See Fig.34). Andesites at the northern part of MJT-8 (Code 5) and the porphyritic granites (Pg1) (Code 6) in the southern part have been taken into consideration. Strong mineralization is assumed in the lower part of No.3 (Code 1) and between No.8 and No.10 (Code 2). Dacites intersected by MJT-6 were given Code 3. The result of the simulation is harmonic with PFE in the field, but some differences in AR have been noticed between calculated values and field measurements. Calculated resistivities are higher than the field measurements for areas detected at depths between No.4 and No.7 and between No.9 and No.12. However, delineated anomalies give enough of a basis to estimate a model of PFE distribution.

(7) Discussion and Interpretation Map

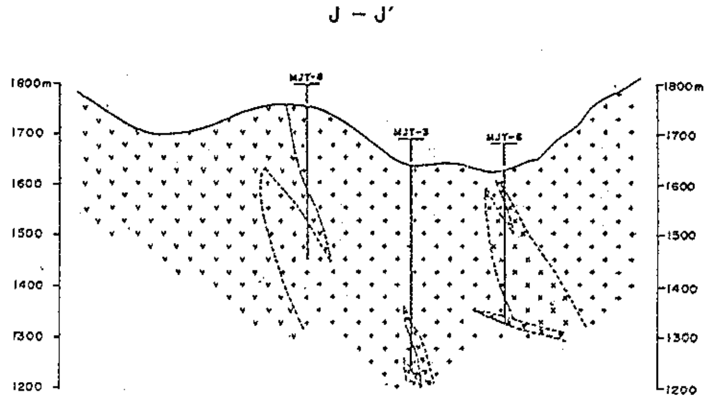
The survey is comprised of the measurements of SIP over three lines totalling 6 km and IP over six lines totalling 12 km with a line interval of 200 m to delineate the extension of the mineralized zone.

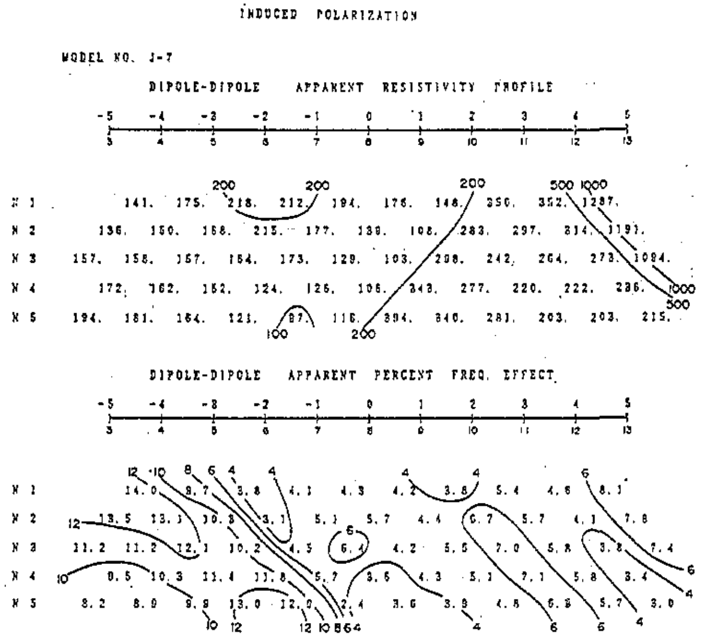
The results are summarized as follows.



MODEL NO. J-7

CODE	RESISTIVITY OHM M	P.F.E. %
1	100.	20.0
2	50.	15.0
3	500.	2.0
4	1000.	8.0
5	200.	5.0
6	200.	4.0
7	0.	.0
8	0.	.0
9	0.	.0





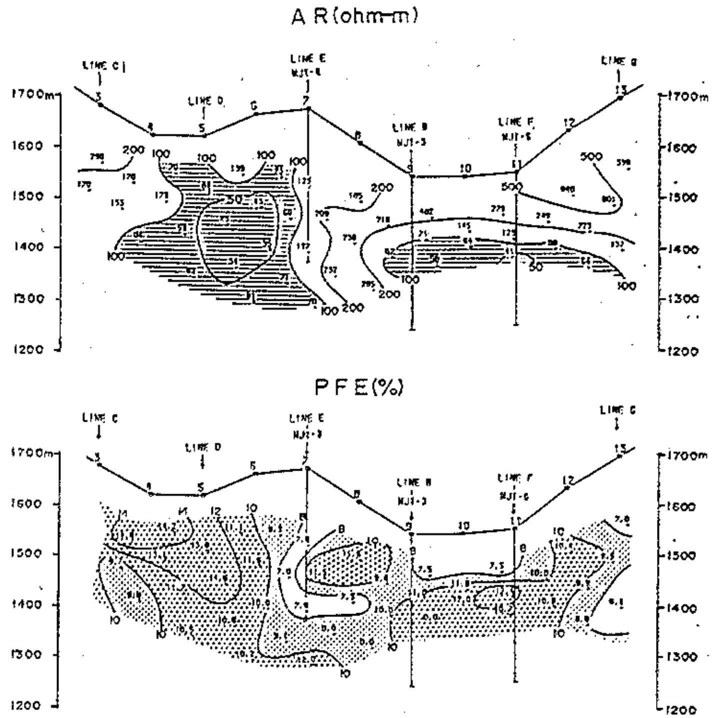


Fig. 34 Result of Model Simulation (Line J)

1) AR

Prevailing AR are of the order of 500 ohm-m and zones of AR less than 100 ohm-m have been detected mainly in the vicinities of Maden River in the west and Hasan River in the south. These zones are situated in areas of andesites and the porphyritic granite (Pg1), and are probably related with alteration zones and ground-water. Zones of high AR are located between No.6 and No.9 and between No.13 and No.17 of Line C in the north and east of Lines H and I in the south-eastern part of the area where andesites and porphyritic granites underlie.

2) PFE

The PFE stands as an indicator of the extension of the mineralized zone and more than 90 % of the PFEs exceeded a level of 4 %. The laboratory investigation of surface rock samples and cores conducted in the previous year showed that the PFE of fresh rocks or weakly mineralized samples did not exceed 1.5 %. A zone of 4 % PFE can be deemed anomalous, suggesting that the whole area belongs to a mineralized zone. A zone of more than 8 % PFE gives a horseshoe shape distribution in the northern half of the area, and another zone of high PFE has been detected in the central part of the area extending southward (Figs. 21 and 24).

In general, ore deposits of porphyry copper type have a zonal distribution of alteration zones consisting of, from outside to inside, propylitic, phyllic and potassic zones. A pyrite shell is found on the outer side of the phyllic alteration zone and a bonanza of copper and molybdenum is located inside the pyrite shell. The horseshoe shape zone of more than 8 % PFE at N=1 can be correlated with the pyrite shell and roughly coincides with a phyllic zone delineated by the geological survey of last year, and is assumed to extend to the poximity of Line D in the north-eastern area as indicated by this investigation. A geochemical anomaly of more than 200 ppm Cu lies in the zone of high PFE and the anomaly of more than 75 ppm of Mo is situated inside this anomalous zone.

3) Rock properties

Rock properties of 25 drilling cores from this year are given in Table 4-1 with the results of 19 samples of the previous year. The relation between phase and metal content of Cu and Mo is shown in Table 4-2. Rock properties of each phase type are given in Table 4-3 with the minimum (Min.), the maximum (Max.) and the average (Ave.) values of metal content.

According to Table 4-2, a specific type of phase spectrum does not correspond

Table 4-1 Relationship between SIP Response and Mineralized Zone

Sample No.	Depth (m)	Rock	Phase (-mrad)	PFE (%)	Resist. (ohm-m)	Spectrum type	Cu (%)	Mo (%)	Remarks
Drilling No. MJT - 1									
21	52.10	Alternated andesite	-2.2	0.50	162	D	0.06	0.001	Sericite-chlorite,diss.pyrite
22	99.80	Alternated andesite	-4.3	-0.19	126	D	0.09	0.009	Diss.pyrite
23	139.90	Porphyrtic granite(pg1)	21.8	4.56	219	D	0.08	0.004	Pyrite-quartz vein
24	150.80	Alternated andesite	561.6	134.17	449	Y	0.10	0.001	Epidote, pyrite along fissures
25	184.50	Porphyrtic granite(pg1)	208.2	38.71	1,795	X	0.09	0.019	Diss.pyrite
26	200.10	Basaltic andesite	3.5	0.45	4,757	A	0.06	0.001	Propyliza.
27	250.90	Andesite	8.8	1.43	1,299	A	0.03	0.00	Filmy pyrite
28	274.30	Basaltic andesite	117.8	18.20	547	X	0.04		Propyliza.,diss.pyrite
29	297.90	Basaltic andesite	376.2	88.31	1,361	X	0.01		Propyliza.,diss.pyrite
Drilling No. MJT - 2									
31	44.70	Porphyrtic granite(pg1)	7.8	1.60	294	D	0.15	0.003	Diss.pyrite,sericite-chlorite
32	51.70	Alternated andesite	6.7	1.49	824	D	0.40	0.010	Propyliza.,diss.pyrite
33	154.30	Alternated andesite	541.2	144.57	550	X	0.12	0.003	Diss.pyrite along fissures
34	200.00	Alternated andesite	221.2	37.22	2,035	Y	0.12	0.004	Diss.pyrite along fissures
35	250.10	Alternated andesite	21.2	3.30	10,068	A	0.19	0.008	Diss.pyrite along fissures
36	299.30	Basaltic andesite	32.1	4.91	4,303	B	0.13	0.004	Diss.pyrite along fissures
Drilling No. MJT - 3									
41	151.05	Porphyrtic granite(pg1)	36.7	5.53	849	A	0.21	0.006	Sil.,sericite,molybdenite-qz
42	199.20	Porphyrtic granite(pg1)	32.4	4.69	3,754	B	0.15	0.011	Sil.,sericite,diss.pyrite
43	250.00	Porphyrtic granite(pg1)	19.4	3.08	6,253	B	0.13	0.007	Sil.,molybdenite,diss.pyrite
44	301.20	Porphyrtic granite(pg1)	38.6	0.83	1,694	X	0.07	0.004	Sil.,sericite,diss.pyrite
Drilling No. MJT - 4									
1	16.5	Porphyrtic granite(pg1)	31.1	4.3	797	B	0.21	0.001	Diss.pyrite, sericite-biotite
2	52.0	Porphyrtic granite(pg1)	83.1	13.3	990	D	0.06	0.002	Chalcopyrite, diss.pyrite, biotite-chlorite
3	100.0	Porphyrtic granite(pg1)	8.5	0.4	360	E	0.02	0.000	Sericite-biotite-chlorite
4	500.0	Porphyrtic granite(pg1)	41.8	6.3	1,390	D	0.05	0.000	Diss.pyrite, biotite-sericite
5	200.0	Porphyrtic granite(pg1)	17.7	2.3	258	D	0.05	0.002	Sericite-chlorite-biotite
6	250.0	Porphyrtic granite(pg1)	28.7	3.7	852	Y	0.04	0.005	Biotite-sericite
7	300.0	Porphyrtic granite(pg1)	19.5	2.4	1,100	Y,(E)	0.04	0.010	Sericite-biotite-chlorite
Drilling No. MJT - 5									
8	49.0	Porphyrtic granite(pg1)	63.0	9.3	3,560	A	0.05	0.000	Chalcocite, Chalcopyrite, sericite
9	99.0	Porphyrtic granite(pg1)	41.2	6.6	2,160	D	0.03	0.000	Sericite
10	195.0	Basaltic andesite	114.0	20.2	5,690	D,(B)	0.06	0.000	
Drilling No. MJT - 6									
11	13.3	Porphyrtic granite(pg1)	27.9	3.8	1,440	B	0.35	0.024	Sericite
12	49.8	Porphyrtic granite(pg2)	24.7	3.6	1,630	B	0.04	0.000	Diss.pyrite
13	100.05	Porphyrtic granite(pg1)	18.7	2.5	892	D,(E)	0.31	0.010	Sericite-chlorite
14	150.0	Porphyrtic granite(pg2)	17.5	2.6	3,720	B	0.01	0.000	
15	198.8	Porphyrtic granite(pg2)	40.1	6.0	1,580	B	0.06	0.000	
16	250.0	Porphyrtic granite(pg1)	27.6	5.2	889	D	0.19	0.014	
17	301.0	Porphyrtic granite(pg2)	20.5	2.4	405	E	0.09	0.002	Silicified
Drilling No. MJT - 7									
18	16.0	Porphyrtic granite(pg1)	16.4	2.7	7,300	D	0.16	0.013	Sericite, qurtz vein
19	55.0	Porphyrtic granite(pg1)	54.5	10.2	2,530	D	0.05	0.020	Sericite
20	255.0	Porphyrtic granite(pg1)	47.9	8.3	1,600	D	0.15	0.018	Sericite, qurtz vein
21	300.0	Porphyrtic granite(pg1)	62.7	8.7	4,200	Y	0.10	0.006	Sericite-anhydrite
Drilling No. MJT - 8									
22	36.5	Porphyrtic granite(pg1)	24.0	3.7	6,700	A	0.03	0.001	Sericite
23	46.6	Qurtz vein	13.8	2.2	3,120	A	0.04	0.000	
24	146.35	Porphyrtic granite(pg1)	20.3	2.7	911	E	0.08	0.015	Sericite, qurtz vein
25	190.1	Porphyrtic granite(pg1)	31.2	3.9	195	E	0.14	0.006	Sericite, qurtz vein

１９８５：ＭＪＴ−１,−２,−３
１９８６：ＭＪＴ−４,−５,−６,−７,−８

Table 4-2 Relationship between Cu, Mo% and Phase Spectrum

Cu (%)	SPECTRUM TYPE A	B	C	D	E	X	Y
≦ 0.02		1				1	
≦ 0.04	3	1		1	1	1	2
≦ 0.06	2	1		6			
≦ 0.08				1	1	1	
≦ 0.10				1	1	1	2
≦ 0.12						1	1
≦ 0.14		2			1		
≦ 0.16		1		3			
≦ 0.18							
≦ 0.20	1			1			
≦ 0.22	1	1					
≦ 0.24							
≦ 0.26							
≦ 0.28							
≦ 0.30							
≦ 0.40		1		2			
Total No.	7	8		15	4	5	5

Mo (%)	SPECTRUM TYPE A	B	C	D	E	X	Y
≦ 0.002	5	4		6	2	2	1
≦ 0.004		1		2		2	1
≦ 0.006	1				1		2
≦ 0.008	1	1					
≦ 0.010				3		1	
≦ 0.012		1					
≦ 0.014				2			
≦ 0.016					1		
≦ 0.018				1			
≦ 0.020				1		1	
≦ 0.022							
≦ 0.024		1					
≦ 0.026							
≦ 0.028							
≦ 0.030							
≦ 0.040							
Total No.	7	8		15	4	5	5

Table 4-3 SIP Response and Cu, Mo%
in the Classification of Phase Spectrum

Type	Sample No.		Phase -mrad	PFE %	Resistivity ohm-m	Cu %	Mo %
A	7	Min.	3.5	0.45	849	0.03	0.000
		Max.	63.0	9.30	10,068	0.21	0.008
		Ave.	24.3	3.70	4,336	0.09	0.002
B	8	Min.	17.5	2.60	797	0.01	0.000
		Max.	40.1	6.00	6,253	0.35	0.024
		Ave.	28.2	4.12	2,934	0.14	0.006
D	15	Min.	-4.3	-0.19	126	0.03	0.000
		Max.	114.0	20.20	7,300	0.40	0.020
		Ave.	32.8	5.70	1,688	0.13	0.007
E	4	Min.	8.5	0.40	195	0.02	0.000
		Max.	31.5	3.90	911	0.14	0.015
		Ave.	20.1	2.40	468	0.08	0.006
X	6	Min.	38.6	0.83	449	0.01	0.001
		Max.	541.2	144.57	1,795	0.12	0.019
		Ave.	307.3	70.80	1,066	0.07	0.005
Y	4	Min.	19.5	2.40	852	0.04	0.004
		Max.	221.2	37.22	4,200	0.12	0.010
		Ave.	83.0	13.00	2,047	0.08	0.006

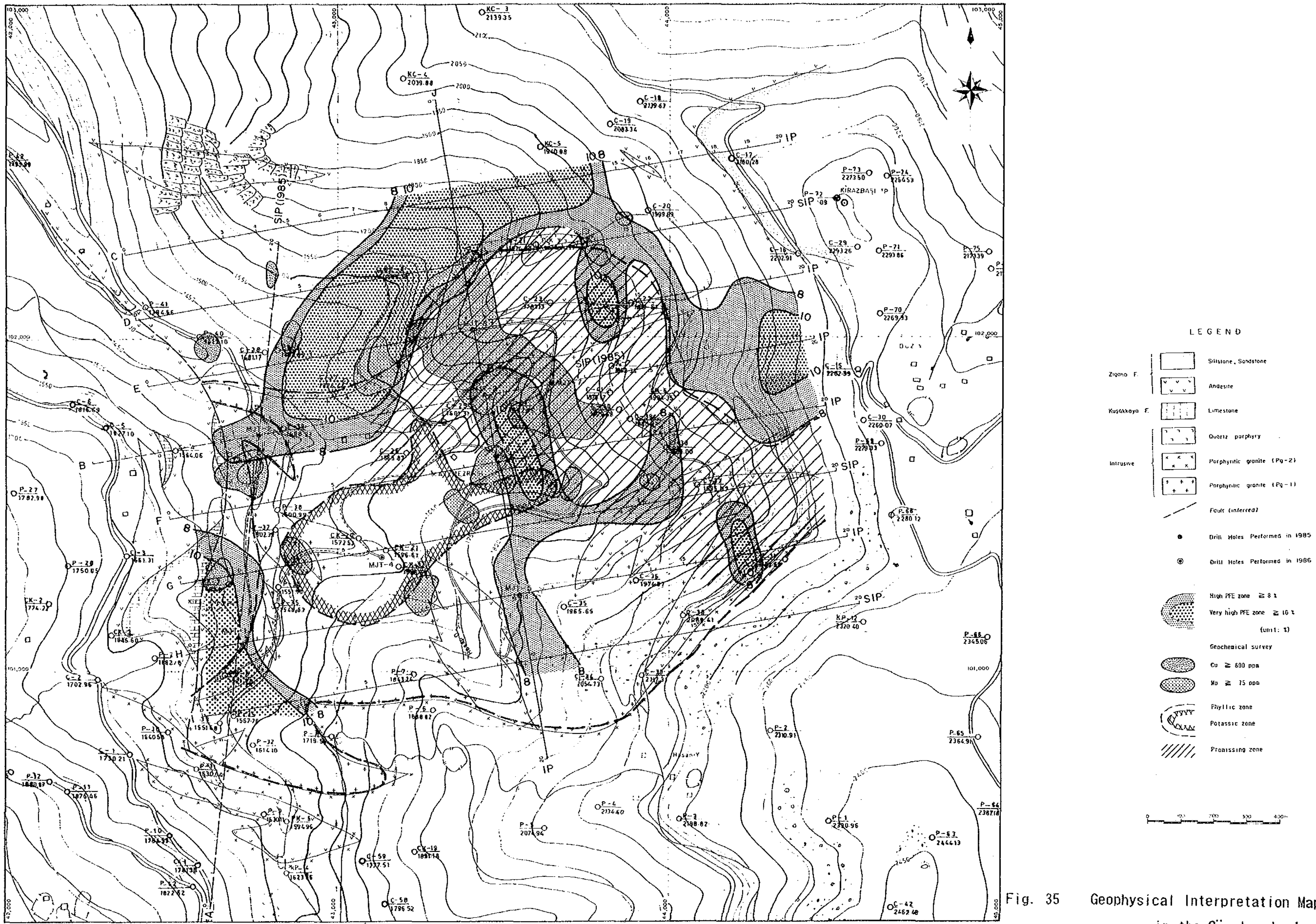


Fig. 35 Geophysical Interpretation Map in the Güzelyayla Area

with specific metal contents of copper or molybdenum, but copper rich samples have a tendency to show a spectrum of A-, B- or D-type. Samples rich in molybdenum often show a spectrum of B-, D- or E-type. But, types of A, B, D and E are also common in samples of poor Cu and Mo content, making it difficult to presume a metal content by one of these types. X- or Y-type, which are popular in massive ores, has been observed in samples of low Cu or Mo content, but it is noticed that samples of these types have not been detected in samples with high Cu or Mo content. Samples of X- or Y-types in this area are megascopically rich in pyrite. Spectra of these types can be related with pyrite mineralization.

According to Table 4-3, phase spectra of high copper content are of B- and D-types and these are followed by A-, E- or Y-, and X-types in descending order. The copper content of B- and D-types are some 1.7 times larger than that of others. The phase stands at about 30 mrad with a value of 4 to 6% PFE. Molybdenum contents are highest with D-type, moderate with B-, E- and Y-type spectra and the lowest with A-type. Samples of X-type spectra are rather poor in Cu and Mo contents.

Consequently, samples with high copper content often show a B- or D-type spectrum with moderate values of phase, PFE and AR. Samples associated with X- or Y-type are related with pyrite mineralization with a low value of Cu or Mo.

Due to low values of metal content, copper and molybdenum did not give a specific spectrum. It is possible that the specific spectrum is obtained if samples have more metal content.

4) Conclusive remarks

As discussed above, the horseshoe shape zone of PFE higher than 10% is correlative with the pyrite shell in the phyllic zone and a target area for exploration is assumed to exist in this shell through to the zone of potassic alteration.

Interpretation Map (Fig. 35)

The survey result is summarized in the interpretation map. PFE anomalies areas with over 8 % and 10 % with respect to the plan map of PFE (N=1) and the promising area for copper and molybdenum mineralization, as is determined by simulation analysis and from the results of the laboratory test. The phyllic zone and potassic zone from the 1985 geologic survey and the geochemical anomalous zones of over 600 ppm for Cu and over 75 ppm for Mo are also marked on the same map.

Chapter 5 Drilling Survey

5-1 Outline of the Diamond Drilling

(1) Purpose of the Diamond Drilling

As a result of geological and geochemical surveys carried out in the initial and second phases of the project, a porphyry copper type ore deposit was found as a promising target for future exploration in the Güzelyayla Area. In the third phase, a drilling survey consisting of five holes (total hole length 1,505m) was planned and subsequetly 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 and the ore deposit and the results of geological, geochemical and geophysical surveys.

The Purpose of these cores are as follows ;

MJT-4 : Exploration in the center of the potassic zone

MJT-5 : Exploration of the phyllic zone in the south-eastern Güzelyayla

MJT-6 : Exploration of the molybdenum anomalous area found by soil geochemical survey

MJT-7 : Exploration of the IP anomaly area

MJT-8 : Exploration of the SIP anomaly area

(2) Outline of Drilling Operation

① Location of drill holes

	Y	X	Z [m sea level]
MJT-4	43 131	01 338	1,578
MJT-5	43 550	01 227	1,857
MJT-6	43 482	01 640	1,635
MJT-7	43 639	01 860	1,752
MJT-8	43 409	02 023	1,761

② Drilling operation method

The wire line drilling method using an NQ type diamond bit as far as possible was applied. Drill inclination was vertical.

③ Core survey

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

④ Chemical assay of drilling cores

Whole cores collected were split along the core extention, and half

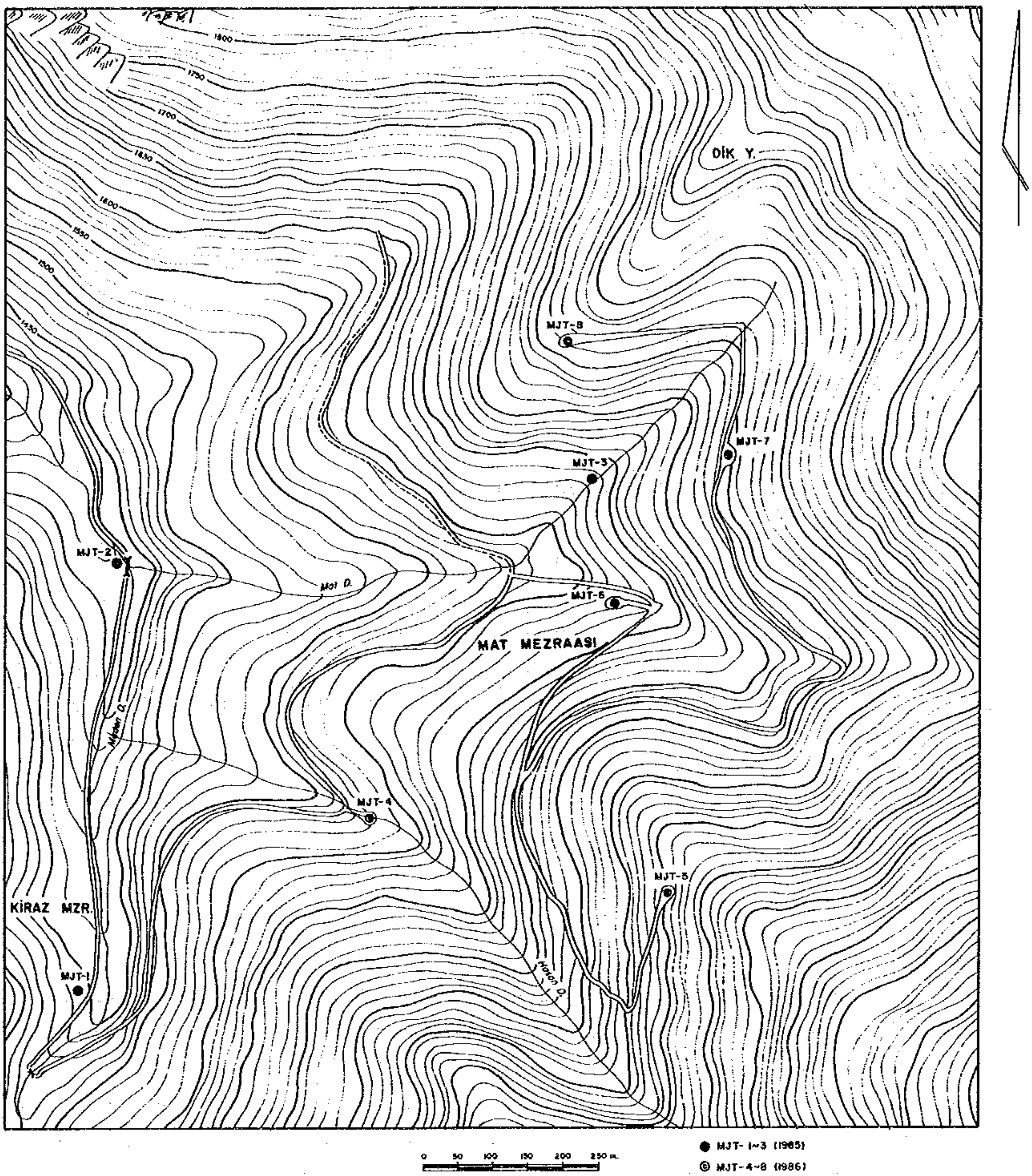


Fig. 36 Location Map of Drilling Holes in the Güzelyayla Area

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, silver, tungsten, and tin content.

⑤ Laboratory works on 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 No.	Drill length planned	Drill length performed	Dip (°)	Surface soil	Core length	Core recovery	Period
MJT-4	300m	301.00m	-90	0.00m	300.70m	99%	June 24- July 10
MJI-5	300m	301.00m	-90	0.00m	297.20m	99%	Sep.10 - Sep.23
MJT-6	300m	301.00m	-90	0.00m	301.00m	100%	June 24- July 12
MJI-7	300m	301.00m	-90	0.00m	300.80m	99%	July 25- Aug.10
MJT-8	300m	301.00m	-90	0.00m	298.90m	99%	July 25- Aug.12
Total	1,500m	1,505.00m		0.00m	1,498.60m	99%	

5-2 Drilling Operation

(1) Drilling Method

The drilling operation was performed by means of the wire line method using a diamond drilling bit of NQ size (75m/m diameter). All drill sites had exposed bedrock at the 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 Güzelyayla area consists of andesite, porphyritic granite(Pg1 and Pg2), basalt and quartz porphyry. At the predominantly alterated sections of rocks in the hole, the rocks are soft and brittle, and have many well-developed fractures (includes cracks, joints, and faults). This often caused loss of circulating mud water and much flash water through fissures. Meanwhile, strong silicified rock was very hard to drill.

(2) Drilling Machine, Equipment and Consumables

The Longyear L-38 was used for the drilling operation. Types and specifications of the machine, engine, pump and equipment, and amount of consumables are shown in Tables 5 and 7.

(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 consisted of five members, a Japanese drilling engineer, a Turkish assistant driller (MTA) and three Turkish workers.

(4) Transportation and Road Construction

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 individual drilling sites, a new 1.5 km road was constructed by bulldozer.

Drill (Period)	Length km	Dozer set	Compressor set	Worker	Explosives kg	Light oil ℓ	Gasoline ℓ
MJT-4 MJT-6 (20 May~ 19 June)	$0.3+\alpha$	1	1	300	80	2,629	1,199
MJT-7 MJT-8 (20 June~ 18 July)	1.7	1	1	290	180	3,960	1,002
MJT-5 (19 July~ 6 Sep.)	0.8	1	2	570	510	6,416	2,516
Total (20 May~ 6 Sep.)	$2.8+\alpha$	1	2	1,160	770	13,005	4,717

Dozer : Hanomag K-18 CE (Weight; 22 Ton)

Compressor: Maksam 4.5 m^3/m (Weight; 1,750 kg)

(5) Water Supply

The water necessary for the drilling operation was run through a polyethylene pipe line from a neighbouring stream, but it was nessecary to pump up at the drilling sites of MJT-5 and MJT-8.

(6) Withdrawal

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

5-3 Results of the Diamond Drilling

(1) MJT-4

The hole reached massive bed rock at 6.10m after cutting through the surface with an NQ size diamond bit, circulating dense bentonite mud water. After reaming by the NW casing shoe bit, NX casing pipes were inserted at 6.10m

Below 6.10m, NQ wire line method, bentonite mud water and cutting oil were used for the operation. The whole rock was altered porphyritic granite (Pg1). The rock has undergone strong biotitization and sericitization from surface to 301m. Mineralization was weak between 85m and 150m. Below 150m, the rock gradually become more strongly silicified and mineralization became strong toward the deeper part. The drilling was completed at 301.00 m.

Depth (m)	0~ 301.00
Mud Water	Bentonite mud water Cutting oil
Bit Exchange (pcs)	NQWL bit(10)
Pump Pre. (kg/cm^2) Pump Feed (ℓ/min) Pump deri (ℓ/min)	5~ 15 50 50
Bit Pre. (kg/cm^2) Bit Rot. (rpm)	500~ 2,000 300
Core Recovery (%)	99.9

(2) MJT-5

The hole reached massive bed rock at 6.10m, after cutting through surface with an NQ size diamond bit, circulating dense bentonite mud water. NW casing pipe was inserted at 6.10m after reaming with the NX casing shoe bit.

Below 6.10m, the drilling operation was carried out by wire line method, circulating mud water mixed with bentonite and cutting oil. The rock between surface and 133.90m in depth was strongly sericitized pophyritic granite (Pg1). Below 133.90m, severely fractured chloritized basaltic andesite continued to 300m, and the last one meter (300~301m) intersected with sericitized Pg1 again. It was very difficult to drill because of the loss of mud water circulation along fractures at 37.5m, 64.5m, and 170m. The hole was completed at 301.00m.

Depth (m)	0~6.10	6.10~133.90	133.9000~301.00
Mud Water	Bentonite mud water Cutting oil		
Bit Exchange (pcs)	NQWL bit(1)	NQWL bit(4)	NQWL bit(7)
Pump Pre. (kg/cm²)	5	5	10
Pump Feed (ℓ/min)	50	50	50
Pump deri (ℓ/min)	50	20~30	20~30
Bit Pre. (kg/cm²)	2,000	2,000	2,000
Bit Rot. (rpm)	300	300	300
Core Recovery (%)	100	100	100

(3) MJT-6

As porphyritic granite (Pg1) was exposed at the surface of the site, the hole was drilled using an NQ diamond bit, circulating bentonite mud water, and was reamed with an NW casing shoe bit. NW casing pipes were inserted through porphyritic granite to 9.10m.

Below 9.10m, NQ wire line method, mixed mud water of bentonite and cutting oil were used for the drilling operation. The loss of water circulation was caused at 194m. The lithology of this drill hole consists of porphyritic granite of Pg1 and Pg2. The major rock was Pg1 with well-developed fissures and strong sericitization to 112.5m and from 244 to 289m, but Pg2 was weakly altered between 112.5 and 244m. Mineralization accompanied by copper and molybdenum mineralization occurred in Pg1. The drilling was completed at 301.00m.

Depth (m)	0~9.10	9.10~63.00	63.00~93.00	93.00~301.00
Mud Water	Bentonite mud water Cutting oil			
Bit Exchange (pcs)	NQWL bit(1)	NQWL bit(2)	NQWL bit(4)	BQWL bit(3)
Pump Pre. (kg/cm²)	5	5	10	15
Pump Feed (ℓ/min)	50	50	50	50
Pump deri (ℓ/min)	50	50	0	0
Bit Pre. (kg/cm²)	500~1,000	2,000	2,000	2,000
Bit Rot. (rpm)	300	300	300	300
Core Recovery (%)	100	100	100	100

(4) MJT-7

The hole reached massive bed rock at 6.10m after cutting through surface with an NQ size diamond bit, circulating dense bentonite mud water. After reaming with the NW casing shoe bit, NX casing pipes were inserted at 6.10m

Below 6.10m, NQ wire line method, bentonite mud water and cutting oil were used for the operation. The whole rock was altered porphyritic granite (Pgl).

The rock has undergone strong sericitization from surface to 301m, and ribbon structure was predominant from 25 to 254m. Below 254m, it gradually become more strongly silicified and mineralization became poorest toward the deeper part. The drilling was completed at 301.00m.

Depth (m)	0~301.00
Mud Water	Bentonite mud water
Bit Exchange (pcs)	NQWL bit(10)
Pump Pre. (kg/cm²)	5~15
Pump Feed (ℓ/min)	50
Pump deri (ℓ/min)	50
Bit Pre. (kg/cm²)	500~2,000
Bit Rot. (rpm)	300
Core Recovery (%)	99.9

(5) MJT-8

As porphyritic granite (Pgl) was exposed at the surface of the site, the hole was drilled using an NQ diamond bit, circulating bentonite mud water,and

Table 5 Drilling Machine and Equipment Used (Güzelyayla Area)

Drilling Machine Model " L - 38 "	2 set
Specifications :	
Capacity	700 m (BQ - WL)
Dimensions L × W × H	2,150mm × 1,170mm × 1,450
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 " 535 RQ "	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 pcs
	NX 3 m 21 pcs

Table 6 Drilling Meterage of Diamond Bit Used (Güzelyayla Area)

Item	Size	Drilling Meterage by Unit														
		MJT-4			MJT-5			MJT-6			MJT-7			MJT-8		
		Bit No	m	m/pc	Bit No	m	m/pc	Bit No	m	m/pc	Bit No	m	m/pc	Bit No	m	m/pc
Bit	NQ	NN- 1	32.00		NN-39	30.50		NN- 2	30.50		NN-19	31.65		NN-20	30.15	
		NN- 3	30.50		NN-40	30.40		NN- 4	32.10		NN-21	36.65		NN-22	34.30	
		NN- 5	24.40		NN-41	26.60		NN- 6	36.40		NN-23	30.95		NN-24	33.30	
		NN- 7	36.60		NN-42	35.40		NN- 8	38.35		NN-25	27.30		NN-26	30.70	
		NN- 9	33.55		NN-43	24.20		NN-10	26.75		NN-27	31.05		NN-28	28.50	
		NN-11	39.20		NN-44	16.80		NN-12	26.75		NN-29	30.50		NN-30	31.90	
		NN-13	30.95		NN-45	17.00		NN-14	36.35		NN-31	30.15		NN-32	22.90	
		NN-15	42.70		NN-46	12.20		NN-16	35.60		NN-33	31.00		NN-34	30.20	
		NN-17	31.10		NN-47	22.10		NN-18	38.20		NN-35	30.00		NN-37	35.80	
					NN-48	26.30					NN-36	21.75		NN-38	23.25	
					NN-49	30.10										
					NN-50	29.40										
				33.44			25.08			33.44			30.10			30.10
Reamer	NQ	NR-11	62.50		NR-31	60.90		NR-12	62.60		NR-21	68.30		NR-22	64.45	
		NR-13	61.00		NR-32	62.00		NR-14	74.75		NR-23	58.25		NR-24	64.00	
		NR-15	72.75		NR-33	41.00		NR-16	53.50		NR-25	61.55		NR-26	60.40	
		NR-17	73.35		NR-34	29.20		NR-18	71.95		NR-27	61.90		NR-28	53.10	
		NR-19	31.40		NR-35	48.40		NR-20	38.20		NR-29	51.00		NR-30	59.05	
					NR-36	59.50										
				60.20			50.16			60.20			60.20			60.20
Casing shoe bit		A-12138	6.10		A-12163	6.10		A-12143	9.00		A-12153	6.10		A-12157	6.10	

Table 7 List of Consumables Used(Güzelyayla Area)

Discription	Specifi -cation	Unit	Quantity					
			MJT-4	MJT-5	MJT-6	MJT-7	MJT-8	Total
Light oil		ℓ	2,100	4,300	2,820	3,000	3,360	15,580
Petrol		ℓ	870	1,080	930	500	520	3,900
Engine oil		ℓ	40	100	40	50	80	310
Hydraulic oil		ℓ		40		40	20	100
Grease		Kg	20	30	20	20	20	110
Cement		Kg	30	30	30	30	30	150
Bentonite		Kg	2,000	11,200	6,000	2,950	9,425	31,575
C.M.C		Kg	55	90	80	40	180	445
Cutting oil		ℓ	40	140	100	80	240	600
Telstop		Kg	20	60	60	20	120	280
Diamond bit	NQ	pcs	9	12	9	10	10	50
Diamond reamer	NQ	pcs	5	6	5	5	5	26
Casing diamond shoe	NX	pcs	1	1	1	1	1	5
Core barrel Ass′ y	NQ-WL	set	1	2	1	1	2	7
Inner tube	NQ-WL	pcs	2	4	3	2	3	14
Core lifter case	NQ-WL	pcs	10	12	12	8	10	52
Core lifter	NQ-WL	pcs	10	16	16	10	10	62
Thrust ball bearing	NQ-WL	pcs	10	10	10	8	8	46
Chack piece	NQ-WL	set	1	1	1	1	1	5
Cylinder liner	535-RQ	pcs	3	3	3	3	3	15
Valve seat	535-RQ	pcs	6	6	6	6	6	30
Steel ball	535-RQ	pcs	6	6	6	6	6	30
Piston rubber	535-RQ	pcs	6	6	6	6	6	30
Core box	NQ	pcs	59	59	59	60	63	300

Table 8 Working Time Table of the Drilling Operation(Güzelyayla Area)

Hole-No	Drilling			Shift		Working man		Working Time							
	Bit size	Drilling length	Core	Drilling	Total	Engineer	Worker	Drilling	Other working	Recovering	Total	Removing	Water trasportation	Road construction and others	G.Total
		m	m	shift	shift	man	man	h	h	h	h	h	h	h	
MJT-4	NQ	301.00	300.70	49	58	78	300	236.00	156.00		392.00	50.00		32.00	474.00
MJT-5	NQ	301.00	297.20	42	80	126	588	205.00	131.00		336.00	48.00		32.00 200.00	616.00
MJT-6	NQ	301.00	301.00	55	64	84	306	248.00	192.00		440.00	50.00		32.00	522.00
MJT-7	NQ	301.00	300.80	49	63	93	372	244.00	148.00		392.00	48.00		64.00	504.00
MJT-8	NQ	301.00	298.90	55	67	93	372	244.00	196.00		440.00	48.00		48.00	536.00
Total	NQ	1,505	1,498.6	250	332	474	1,938	1,177.00	823.00		2,000.00	244.00		408.00	2,652.00

Table 9 Record of the Drilling Operation of MJT-4

	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
19 June	Pds						1	3	8
20 June	Pds						2	3	8
21 June	Pds						3	3	8
22 June	Pds						4	3	12
23 June	Pds						5	3	12
24 June	1.50			1.50	1.20	1	6	3	12
25 June	3.05	6.10	Ins-C.P	10.65	10.35	3	9	3	12
26 June	6.10	3.55	5.60	25.90	25.60	3	12	3	12
27 June	6.10	6.10	6.10	44.20	43.90	3	15	3	12
28 June	4.30	6.10	6.10	60.70	60.40	3	18	3	12
29 June	6.80	6.60	6.70	80.80	80.50	3	21	3	12
30 June	6.10	8.30	6.95	102.15	101.85	3	24	3	12
1 July	6.10	8.25	7.00	122.50	123.20	3	27	3	12
2 July	6.10	6.80	8.45	144.85	144.55	3	30	3	12
3 July	6.10	9.15	6.10	166.20	165.90	3	33	3	12
4 July	6.10	6.10	6.80	185.20	184.90	3	36	3	12
5 July	8.45	8.05	7.20	208.90	208.60	3	39	3	12
6 July	6.85	7.00	6.40	229.15	228.85	3	42	3	12
7 July	8.20	7.15	7.10	251.60	251.30	3	45	3	12
8 July	6.10	6.10	6.10	269.90	269.60	3	48	3	12
9 July	5.10	6.10	4.05	285.15	284.85	3	51	3	12
10 July	4.10	5.60	6.15	301.00	300.70	3	54	3	12
11 July	Dismant						55	3	12
12 July	Dismant						56	3	12
13 July	Dismant						57	3	12
14 July	Dismant						58	3	12
Total	97.15	107.05	96.80	301.00	300.70	49	58	78	300

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

Table 10 Record of the Drilling Operation of MJT-5

	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
17 Aug.	NH								
18 Aug.	NH								
19 Aug.	NH								
20 Aug.	Raod-con						1	3	12
∫							∫	∫	∫
30 Aug.	Road-con						11	3	12
31 Aug.	Road-con	Road-con					13	3	24
∫							∫	∫	∫
6 Sep.	Road-con	Road-con					25	3	24
7 Sep.	Pds	Pds					27	3	24
8 Sep.	Pds	Pds					29	3	24
9 Sep.	Pds	Pds					31	3	24
10 Sep.	7.30	6.20	7.40	20.90	20.90	3	34	3	12
11 Sep.	8.00	7.00	7.60	43.50	43.50	3	37	3	12
12 Sep.	8.40	7.10	5.50	64.50	64.50	3	40	3	12
13 Sep.	9.00	7.70	6.30	87.50	87.50	3	43	3	12
14 Sep.	6.70	9.30	8.50	112.00	112.00	3	46	3	12
15 Sep.	8.10	7.50	7.70	135.30	135.30	3	49	3	12
16 Sep.	8.20	6.00	8.00	157.50	157.50	3	52	3	12
17 Sep.	6.90	5.60	8.10	178.10	175.00	3	55	3	12
18 Sep	6.90	8.10	7.10	200.20	196.90	3	58	3	12
19 Sep	7.70	7.30	7.30	222.50	219.20	3	61	3	12
20 Sep.	6.40	6.80	5.80	241.50	238.20	3	64	3	12
21 Sep.	5.80	6.20	6.50	260.00	256.20	3	67	3	12
22 Sep.	6.40	7.10	7.20	280.70	276.90	3	70	3	12
23 Sep.	7.70	6.50	6.10	301.00	297.20	3	73	3	12
24 Sep.	Dismant						74	3	12
25 Sep.	Dismant						75	3	12
26 Sep.	Dismant						76	3	12
27 Sep.	Dismant						77	3	12
Total	103.50	98.40	99.10	301.00	297.20	42	77	117	588

Abbreviation

Road-con ; Road-construction

Pds ; Preparation for drilling site

Transpor ; Transportation

NH ; National holiday

Dismant ; Dismantlement

Recoveri; Recovering work

Tra-Ress ; Transportation and Reassemblage

Table 11 Record of the Drilling Operation of MJT-6

	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
19 June	Pds						1	3	6
20 June	Pds						2	3	6
21 June	Pds						3	3	6
22 June	Pds						4	3	6
23 June	Pds						5	3	6
24 June	1.00			1.00	1.00	1	6	3	12
25 June	3.30	4.50	Ins-C.P	8.80	8.80	3	9	3	12
26 June	3.90	4.90	6.40	24.00	24.00	3	12	3	12
27 June	6.50	4.80	6.10	41.40	41.40	3	15	3	12
28 June	5.95	6.10	6.10	59.55	59.55	3	18	3	12
29 June	7.25	6.30	7.50	80.60	80.60	3	21	3	12
30 June	6.30	6.65	5.45	99.00	99.00	3	24	3	12
1 July	6.30	5.35	6.35	117.00	117.00	3	27	3	12
2 July	6.60	6.45	4.75	134.80	134.80	3	30	3	12
3 July	6.90	5.80	5.75	153.25	153.25	3	33	3	12
4 July	4.65	4.45	6.60	168.95	168.95	3	36	3	12
5 July	6.30	6.55	6.90	188.70	188.70	3	39	3	12
6 July	5.05	5.65	6.50	205.90	205.90	3	42	3	12
7 July	5.05	6.20	5.10	222.25	222.25	3	45	3	12
8 July	4.95	6.20	5.00	238.40	238.40	3	48	3	12
9 July	5.90	6.20	6.20	256.70	256.70	3	51	3	12
10 July	6.10	4.80	4.60	272.20	272.20	3	54	3	12
11 July	3.70	4.30	5.10	285.30	285.30	3	57	3	12
12 July	5.25	6.00	4.45	301.00	301.00	3	60	3	12
13 July	Dismant						61	3	12
14 July	Dismant						62	3	12
15 July	Dismant						63	3	12
16 July	Dismant						64	3	12
Total	100.95	101.20	98.85	301.00	301.00	55	64	84	306

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

Table 12 Record of the Drilling Operation of MJT-7

	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
15 July	Road-con						1	3	12
16 July	Road-con						2	3	12
17 July	Road-con						3	3	12
18 July	Road-con						4	3	12
19 July	Pds						5	3	12
20 July	Transpor						6	3	12
21 July	Transpor						7	3	12
22 July	Tra-Ress						8	3	12
23 July	Tra-Ress						9	3	12
24 July	Tra-Ress						10	3	12
25 July	1.60			1.60	1.60	1	12	3	12
26 July	4.70	2.60	5.55	14.45	14.45	3	15	3	12
27 July	5.15	6.05	6.00	31.65	31.65	3	18	3	12
28 July	9.00	6.00	8.70	55.35	55.35	3	21	3	12
29 July	6.00	6.95	7.50	75.80	75.80	3	24	3	12
30 July	9.10	8.35	6.00	99.25	99.25	3	27	3	12
31 July	6.00	8.10	8.45	121.80	121.80	3	30	3	12
1 Aug	4.75	9.00	7.05	142.60	142.60	3	33	3	12
2 Aug	7.95	7.05	6.00	163.60	163.60	3	36	3	12
3 Aug	6.00	7.15	7.45	184.20	184.20	3	39	3	12
4 Aug	3.90	8.00	7.70	203.80	203.80	3	42	3	12
5 Aug	6.20	6.00	6.35	222.35	222.15	3	45	3	12
6 Aug	6.05	5.60	5.50	239.50	239.30	3	48	3	12
7 Aug	5.10	5.40	5.60	255.60	255.40	3	51	3	12
8 Aug	6.00	6.00	6.30	273.90	273.70	3	54	3	12
9 Aug	6.10	6.00	6.00	292.00	291.80	3	57	3	12
10 Aug	3.60	5.40		301.00	300.80	2	59	3	12
11 Aug	Dismant						60	3	12
12 Aug	Dismant						61	3	12
13 Aug	Dismant						62	3	12
14 Aug	Dismant						63	3	12
Total	97.20	103.65	100.15	301.00	300.80	50	63	93	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

Table 13 Record of the Drilling Operation of MJT-8

	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
17 July	Road-con						1	3	12
18 July	Road-con						2	3	12
19 July	Pds						3	3	12
20 July	Transpor						4	3	12
21 July	Transpor						5	3	12
22 July	Transpor						6	3	12
23 July	Tra-Ress						7	3	12
24 July	Tra-Ress						8	3	12
25 July	1.00			1.00	1.00	1	9	3	12
26 July	5.45	2.95	4.35	13.75	13.75	3	12	3	12
27 July	6.00	5.50	4.90	30.15	30.15	3	15	3	12
28 July	5.10	7.15	7.35	49.75	49.75	3	18	3	12
29 July	4.60	6.40	3.70	64.45	64.45	3	21	3	12
30 July	6.30	6.00	9.00	85.75	85.75	3	24	3	12
31 July	7.50	4.50	7.80	105.55	105.55	3	27	3	12
1 Aug	6.00	4.20	5.50	121.25	121.25	3	30	3	12
2 Aug	5.70	6.20	6.80	139.95	139.95	3	33	3	12
3 Aug	6.30	6.30	4.40	156.95	156.95	3	36	3	12
4 Aug	5.60	5.80	6.20	174.55	174.55	3	39	3	12
5 Aug	4.80	6.60	5.90	191.85	191.85	3	42	3	12
6 Aug	4.90	4.90	5.40	207.05	206.05	3	45	3	12
7 Aug	4.70	5.50	4.50	221.75	219.65	3	48	3	12
8 Aug	5.30	5.20	4.30	236.55	234.45	3	51	3	12
9 Aug	5.40	6.00	6.60	254.55	252.45	3	54	3	12
10 Aug	5.70	5.50	5.50	271.25	269.15	3	57	3	12
11 Aug	4.90	6.30	5.60	288.05	285.95	3	60	3	12
12 Aug	6.30	4.20	2.45	301.00	298.90	3	63	3	12
13 Aug	Dismant						64	3	12
14 Aug	Dismant						65	3	12
15 Aug	Dismant						66	3	12
16 Aug	Dismant						67	3	12
Total	101.55	99.2	100.25	301.00	298.90	55	67	93	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

Table 14 Summary of the Drilling Operation of MJT-4

	Survey Period				Total man day	
	Period	Days	Work day	Off day	Engineer	Worker
Operation			days	days	man	man
Preparation	19 June～23 June	5	5	-	15	48
Drilling	24 June～10 July	17	Drilling 17	-	51	204
			Recovering			
Removing	11 July～14 July	4	4	-	12	48
Total	19 June～14 July	26	26	-	78	300

Drilling length			
Length planed	300.00m	Overburden	m
Increase or Decrease in length	301.00m	Core length	300.70m
Length drilled	301.00m	Core recovery	% 99.9

Core recovery of 100 m hole		
Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0 ～ 100	99.8	99.8
100 ～ 200	100	99.9
200 ～ 301	100	99.9

Working hours	h	%	%
Drilling	236.00	60	49.8
Other working	156.00	40	32.9
Recovering			
Total	392.00	100	
Reassemblage	50.00		10.5
Dismantlement	32.00		6.8
Water transportation			
Road construction and others			
G.Total	474.00		100

Efficiency of Drilling	
Total m/work period(m/day)	301.00m/17 days (17.7m/day)
Total m/total shift (m/shift)	301.00m/58 shifts (5.18m/shift)

Drilling length/bit(each sized bit)			
Bit size	HX	NQ	BQ
Drilled length		301.00m	
Core length		300.70m	

Casing pipe inserted			
Size	Meterage (m)	Meterage / drilling length × 100 (%)	Recovery (%)
HX			
NW	6.1	2.0	100
NW			

Table 15 Summary of the Drilling Operation of MJT-5

	Survey Period				Total man day	
	Period	Days	Work day	Off day	Engineer	Worker
Operation			days	days	man	man
Preparation	17 Aug.～ 9 Sep.	24	21	3	63	372
Drilling	10 Sep.～23 Sep.	14	Drilling 14	-	42	168
			Recovering			
Removing	24 Sep.～27 Sep.	4	4	-	12	48
Total	17 Sep.～27 Sep.	42	39	3	117	588

Drilling length			
Length planed	300.00m	Overburden	m
Increase or Decrease in length	301.00m	Core length	297.20m
Length drilled	301.00m	Core recovery	% 99.0

Core recovery of 100 m hole

Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0 ～ 100	100.0	100.0
100 ～ 200	96.7	98.4
200 ～ 301	99.5	99.0

Working hours	h	%	%
Drilling	205.00	61	33.2
Other working	131.00	39	21.3
Recovering			
Total	336.00	100	54.5
Reassemblage	48.00		7.8
Dismantlement	32.00		5.2
Water transportation			
Road construction and others	200.00		32.5
G.Total	616.00		100

Efficiency of Drilling

Total m/work period(m/day)	301.00m/14 days (21.5m/day)
Total m/total shift (m/shift)	301.00m/42 shifts (7.16m/shift)

Drilling length/bit(each sized bit)

Bit size	HX	NQ	BQ
Drilled length		301.00m	
Core length		297.20m	

Casing pipe inserted

Size	Meterage (m)	Meterage / drilling length × 100 (%)	Recovery (%)
HX			
NW	6.1	2.0	100

Table 16 Summary of the Drilling Operation of MJT-6

		Survey Period				Total man day	
		Period	Days	Work day	Off day	Engineer	Worker
Operation				days	days	man	man
	Preparation	19 June～23 June	5	5	-	15	30
	Drilling	24 June～12 July	19	Drilling 19	-	57	228
				Recovering			
	Removing	13 July～16 July	4	4	-	12	48
	Total	19 June～16 July	28	28	-	84	306

Drilling length				
Length planed	300.00m	Overburden	m	
Increase or Decrease in length	301.00m	Core length	301.00m	
Length drilled	301.00m	Core recovery	100	%

Core recovery of 100 m hole		
Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0 ～ 100	100	100
100 ～ 200	100	100
200 ～ 301	100	100

Working hours	h	%	%
Drilling	248.00	56.4	47.5
Other working	192.00	43.6	36.8
Recovering			
Total	440.00	100	84.3
Reassemblage	50.00		9.6
Dismantlement	32.00		6.1
Water transportation			
Road construction and others			
G.Total	522.00		100

Efficiency of Drilling	
Total m/work period(m/day)	301.00m/19 days (15.8m/day)
Total m/total shift (m/shift)	301.00m/64 shifts (4.70m/shift)

Drilling length/bit(each sized bit)			
Bit size	HX	NQ	BQ
Drilled length		301.00m	
Core length		301.00m	

Casing pipe inserted			
Size	Meterage (m)	Meterage / drilling length × 100 (%)	Recovery (%)
HX			100
NW	9.1	2.9	100

Table 17 Summary of the Drilling Operation of MJT-7

Operation	Period	Days	Work day (days)	Off day (days)	Engineer (man)	Worker (man)
Preparation	15 July～24 July	10	10	-	30	120
Drilling	25 July～10 August	17	Drilling 17 / Recovering	-	51	204
Removing	11 August～14 August	4	4	-	12	48
Total	15 July～14 August	31	31	-	93	372

Survey Period: Period, Days, Work day, Off day; Total man day: Engineer, Worker

Drilling length			
Length planed	300.00m	Overburden	m
Increase or Decrease in length	301.00m	Core length	300.80m
Length drilled	301.00m	Core recovery	99.9 %

Core recovery of 100 m hole

Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0 ～ 100	100	100
100 ～ 200	100	100
200 ～ 301	98.8	99.9

Working hours	h	%	%
Drilling	244.00	62.0	48.4
Other working	148.00	38.0	29.3
Recovering			
Total	392.00	100	77.8
Reassemblage	48.00		9.6
Dismantlement	32.00		6.3
Water transportation			
Road construction and others	32.00		6.3
G.Total	504.00		100

Efficiency of Drilling

Total m/work period(m/day)	301.00m/17 days (17.7m/day)
Total m/total shift (m/shift)	301.00m/63 shifts (4.80m/shift)

Drilling length/bit(each sized bit)

Bit size	HX	NQ	BQ
Drilled length		301.00m	
Core length		300.80m	

Casing pipe inserted

Size	Meterage (m)	Meterage drilling length × 100 (%)	Recovery (%)
HX			100
NW	6.1	2.0	100

Table 18 Summary of the Drilling Operation of MJT-8

	Survey Period				Total man day	
	Period	Days	Work day	Off day	Engineer	Worker
Operation			days	days	man	man
Preparation	17 July～24 July	8	8	-	24	96
Drilling	25 July～12 August	19	Drilling 19	-	57	228
			Recovering			
Removing	13 August～16 August	4	4	-	12	48
Total	17 July～16 August	31	31	-	93	372

Drilling length			
Length planed	300.00m	Overburden	m
Increase or Decrease in length	301.00m	Core length	298.90m
Length drilled	301.00m	Core recovery	% 99.3

Core recovery of 100 m hole		
Depth of hole (m)	Core recovery (%)	Core recovery cumulated (%)
0 ～ 100	100	100
100 ～ 200	100	100
200 ～ 301	97.9	99.3

Working hours	h	%	%
Drilling	244.00	55.5	45.5
Other working	196.00	44.5	36.6
Recovering			
Total	440.00	100	82.1
Reassemblage	48.00		9.0
Dismantlement	32.00		6.0
Water transportation			
Road construction and others	16.00		2.9
G.Total	536.00		100

Efficiency of Drilling

Total m/work period(m/day)	301.00m/19 days (15.8m/day)
Total m/total shift (m/shift)	301.00m/67 shifts (4.50m/shift)

Drilling length/bit(each sized bit)

Bit size	HX	NQ	BQ
Drilled length		301.00m	
Core length		298.90m	

Casing pipe inserted

Size	Meterage (m)	Meterage / drilling length × 100 (%)	Recovery (%)
HX			100
NW	6.1	2.0	100

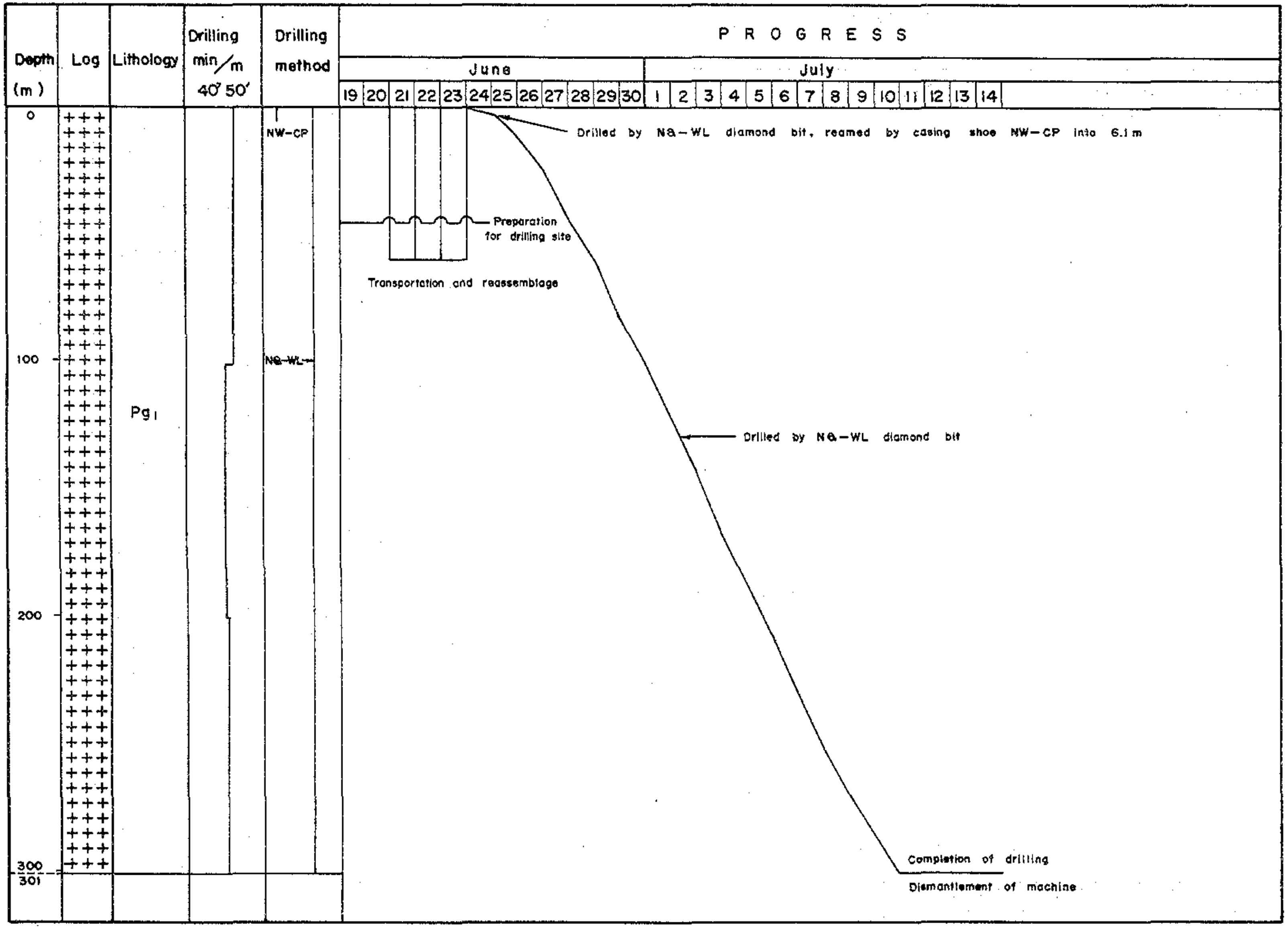


Fig. 37 Drilling Progress of MJT-4

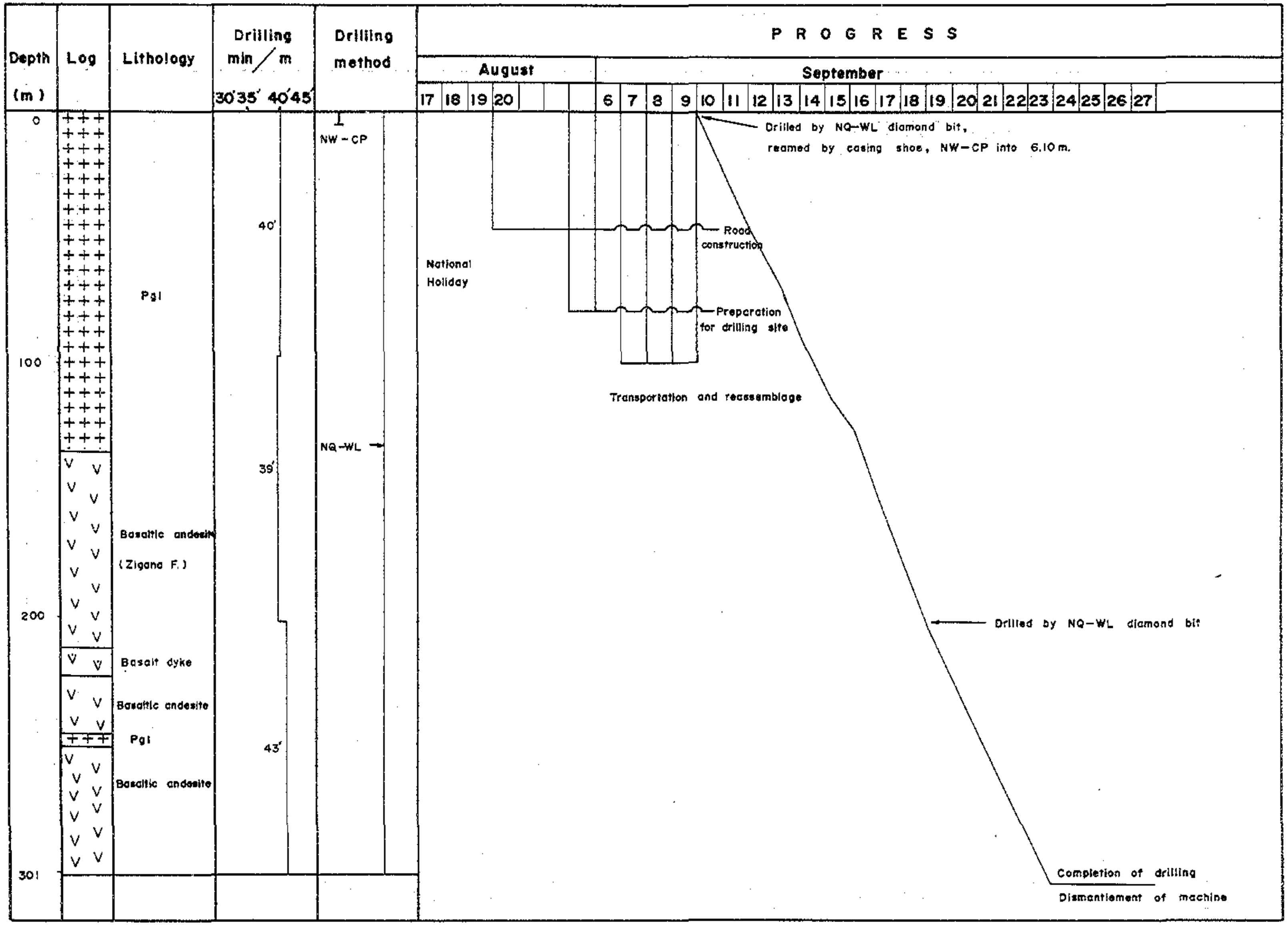


Fig. 38 Drilling Progress of MJT-5

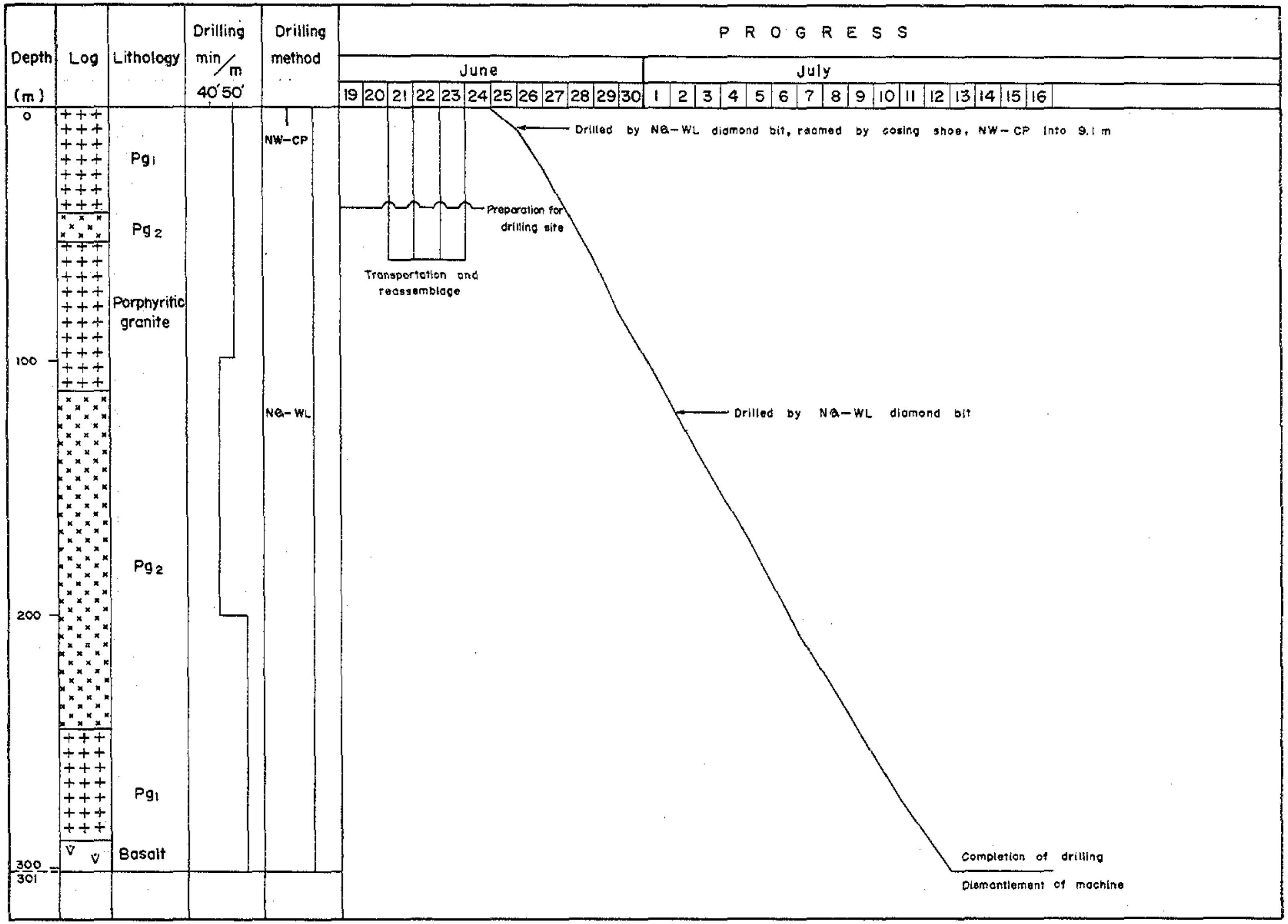


Fig. 39 Drilling Progress of MJT-6

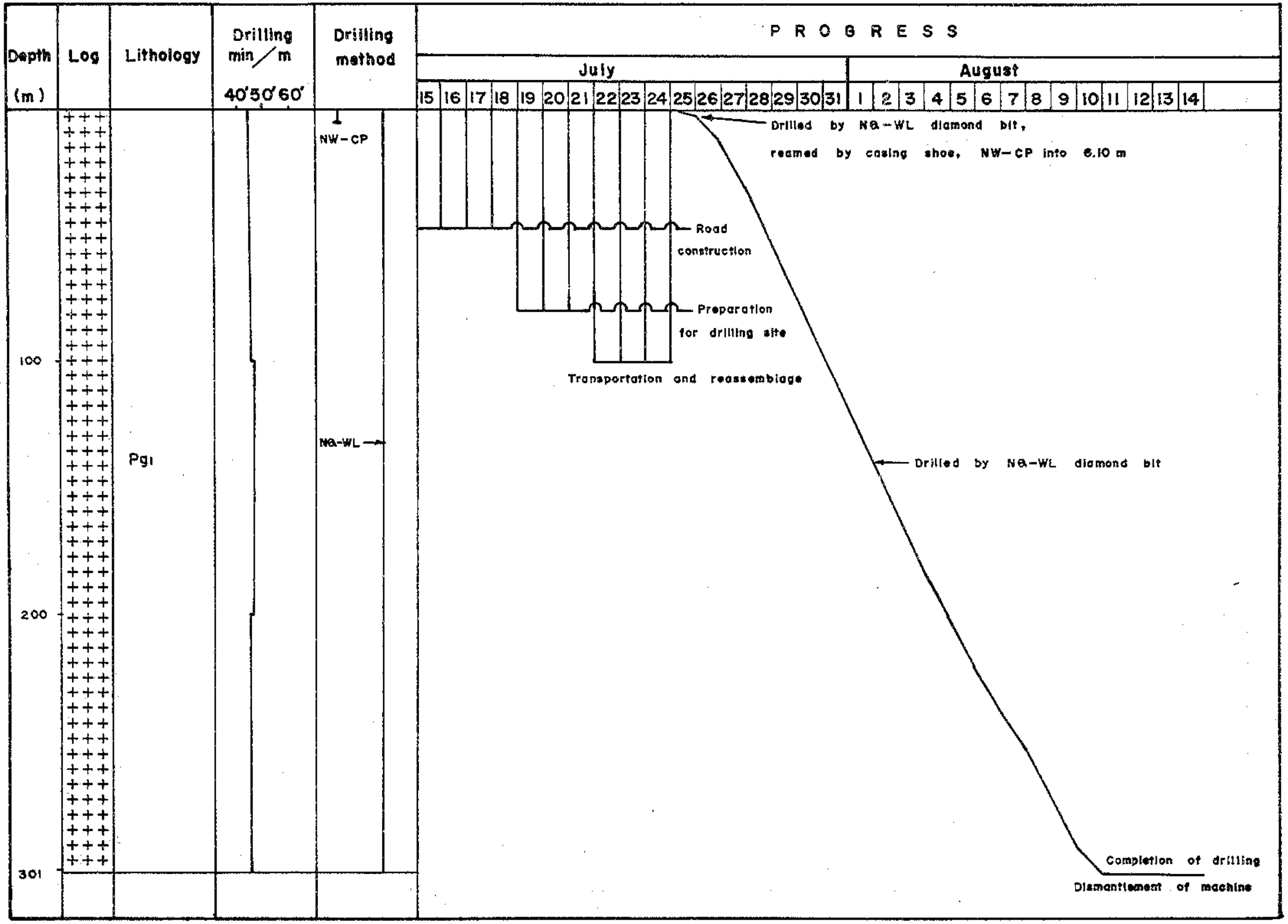


Fig. 40 Drilling Progress of MJT-7

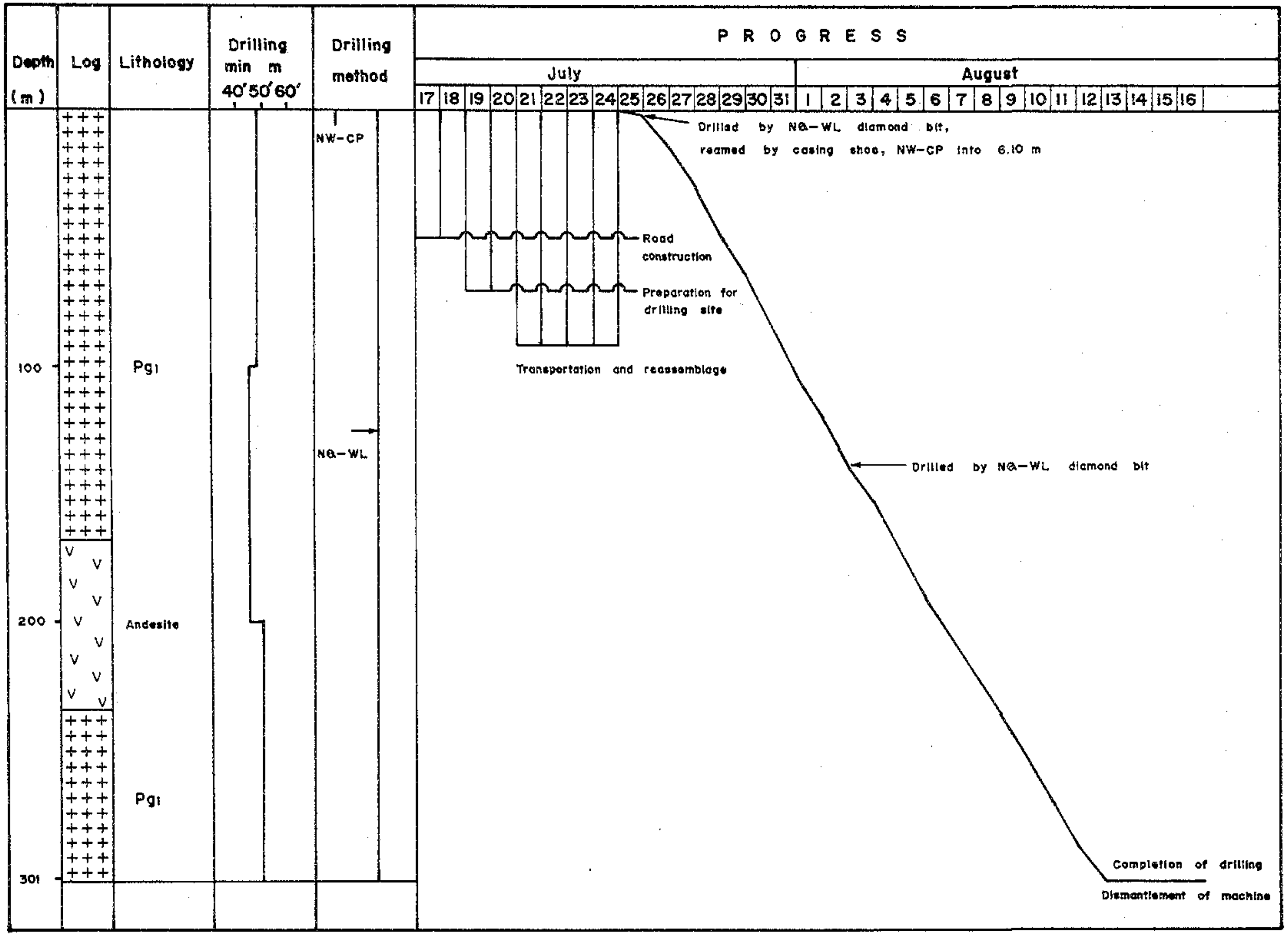


Fig. 41 Drilling Progress of MJT-8

was reamed by an NW casing shoe bit. NW casing pipes were inserted through porphyritic granite to 6.10m.

Below 6.10m, the drilling operation was carried out by NQ wire line method, circulating mud water mixed with bentonite and cutting oil. The rocks were strongly fractured from 84 to 234m, and collapse of the wall caused loss of water circulation. An especially sheared zone was from 112 to 123m in Pg1, and from 210 to 219m in andesite. The rock from surface to 169m in depth was strongly sericitized and chloritized and fractured porphyritic granite. Below 169m, severely fractured andesite continued to 234m, but below 234m the porphyritic granite underwent stronger biotitization and chloritization toward the deeper part. The hole was completed at 301.00m.

Depth (m)	0~93.00	93~114.00	114~224.00	224~301.00
Mud Water	Bentonite mud water Cutting oil			
Bit Exchange (pcs)	NQWL(3)	NQWL bit(1)	NQWL bit(4)	BQWL bit(2)
Pump Pre. (kg/cm^2) Pump Feed (ℓ/min) Pump deri (ℓ/min)	5~10 50 50	5~10 50 20	5~10 50 0~10	5~10 50 10
Bit Pre. (kg/cm^2) Bit Rot. (rpm)	500~2,000 300	2,000 300	2,000 300	2,000 300
Core Recovery (%)	100	100	96	100

5-4 Geology and Mineralization of Drill Holes

(1) MJT-4

【Geology】

0.00~ 5.00m: Limonitized altered porphyritic granite(Pg1). It has undergone biotitization and sericitization.

5.00~ 30.00m: Dark brown Pg1(biotite-sericite). Colour changes gradually from dark brown to pale grey at depth. There are well-developed fissures in Pg1, and pyrite-chalcocite bearing quartz veins within 10mm width are embedded along with these fissures.

30.00~ 84.00m: Pale grey Pg1(biotite-sericite) accompanied by molybdenite and chalcopyrite along with fractures.

84.00~150.00m: Dark green Pg1(biotite-sericite-chlorite), and pyrites and chalcopyrites are embedded in fissures. Very minor amounts of disseminated chalcopyrite is partly observed.

150.00～301.00m: Pale green biotitized and sericitized Pgl. Below 200m, sericitization and chloritization become stronger than biotitization. Molybdenites and chalcopyrites are embedded in fissures or accompanys quartz veins.

【Alteration】

Porphyritic granite(Pgl) has undergone biotitization and sericitization throughout the hole from surface to hole bottom(301m). Small amounts of chlorite are also evenly contained. It is considered the center of the potassic zone as a result of the geological survey. The drilling survey indicated the same zone, but anhydrite was not observed in this hole as it was in the potassic zone of MJT-3.

【Mineralization】

Mineralization accompanying pyrite, chalcopyrite and molybdenite is observed throughout from surface to hole bottom, but generally it is weak mineralization.

The range from 5m to 30m is regarded as the secondary enrichment zone because of the exsistance of chalcocite. Chalcopyrites and molybdenites are embedded in quartz veins and along fissures, while pyrites are disseminated in the rock and also in the quartz veins and along fissures. Comparatively strong mineralization occurs from 200m to 280.00m

(2) MJT-5

【Geology】

0.00～ 10.00m: Limonitized and sericitized porphyritic granite (Pgl).

10.00～133.90m: White sericitized Pgl. Chalcopyrites and molybdenites occur not only in fissures but also as disseminations in the rock. Chalcocites are observed in the range from 10m to 112m, native copper at 109.6m.

133.90～211.70m: Dark green basaltic andesite. The basaltic andesite has been brecciated and undergone slight sericitization, but chlorite-epidote are the main altered minerals. The rock was so severely fractured that the cores were mostly broken and recovery was espectially poor from 170 m to 180m. Some chalcopyrite accompanies quartz veins and fissures. Magnetites are predominantly disseminated in the rock.

211.70～223.10m: A basalt dyke has intruded into the basaltic andesite.

223.10～246.00m: Dark green basaltic andesite is the same as that found in the range from 133.9 m to 211.7m. Some molybdenite accompanies quartz veins and fissures, very fine-grained chalcopyrites occur as disseminations.

246.00～250.80m: White and pale green aplitic Pgl. Sericites are mainly seen as altered minerals. Molybdenites and chalcopyrites occur as disseminations in the rock.

250.80～300.00m: Dark green chloritized and epidotizated andesite. The ratio of distribution frequency per meter of quartz veins decreases slightly at depth, but emplacement of chalcopyrite and molybdenite along fissures is seen more predominantly.

300.00～301.00m: White and pale green aplitic Pg1 is the same as that in the range from 246m to 250.8m.

【Alteration】

Porphyritic granite (Pg1) has undergone sericitization, and small amounts of chlorite are also contained. Contrarily, basaltic andesite has undergone mostly chloritization and weak epidotization. Thus the alteration zone is classified into the phyllic and propylitic zones.

【Mineralization】

Mineralization with pyrite, chalcopyrite and molybdenite is emplaced in quartz veins and fissures. It also occures as disseminations in the rocks, but generally is weak. The range from 10m to 112m is regarded as the secondary enrichment zone because of the existance of chalcocite and native copper.

(3) MJT-6

【Geology】

0.00～ 6.00m: Limonite-stained porphyritic granite (Pg1).

6.00～ 43.00m: White and pale green sericitized Pg1. Chalcopyrites and molybdenites occur not only in fissures and quartz veins but also as disseminations in the rock. Chalcocites are observed in the range from 6m to 23m.

43.00～ 53.00m: White and pale green porphyritic granite(Pg2). The rock has intruded into Pg1, and weak alteration of sericite and chlorite occurs. The boundary between Pg1 and Pg2 was not recognizable because of crushed cores.

53.00～112.50m: Sericitized Pg1 with well-developed fissures. Chalcppyrites and molybdenites occur not only in fissures but also as disseminations in the rock.

112.50～244.00m: White and pale green Pg2. The rock suffers weak sericitization and chloritization. Very minor amounts of disseminated pyrite are observed. At some parts, there are small amounts of chalcopyrite and molybdenite along fissures. The boundary with Pg1 changes gradually.

244.00～289.00m: White and pale green Pg1. The rock has predominantly undergone sricitization, but chlorite increases towards the deeper section. Potassium feldspar occures in the range from 244m to 250m, and anhydrite and gypsum occur in the range from 248m to 250m. Chalcopyrites and molybdenites were embedded along fissures and were also disseminated in the rock.

289.00～298.40m: Black basalt. The rock is massive and intruded at a low angle (aproximately 50°).

298.40～299.90m: Pale green Pg1 is the some as that in the range from 244m to 298.40m.

299.90～300.40m: Black basalt.

300.40～301.00m: Pale green Pg1. There is no mineralization.

【Alteration】

The rock has undergone mainly sericitization from surface to hole bottom except for the intrusive rocks of Pg2 and basalt. Small amounts of chlorite are also evenly contained. Potassic feldspar begins to appear from around 244m in depth, anhydrite from around 248m in depth. Judging by this evidence, the alteration of the hole is divided into two zones, namely the phyllic zone from surface to 150m and the potassic zone from 150m to depth.

【Mineralization】

That is an oxidized and limonitized zone from surface to 1m. Thus sulphide minerals are not recognizable. The range from 1m to 23m, is regarded as the secondary enrichment zone because of the existance of chalcocite, but there are minor amounts of chalcopyrite and molybdenite disseminated in Pg1. Mineralization of chalcopyrite and molybdenite continues to 299.9m, but it tends to weaken toward the deep part. The mineralization is mostly emplaced as disseminations, along fissures and quartz veins.

(4) MJT-7

【Geology】

0.00～ 8.90m: Limonite-stained porphyritic granite (Pg1, sericite-chlorite)

8.90～254.00m: White and pale green sericitized-chloritized Pg1. There are well-developed fissures; pyrite occurs along these fissures, chalcopyrites and molybdenites occur not only in fissures and quartz veins but also as disseminations in the rock. However, mineralization is very weak. Chalcocites are observed in the range from 5m to 42m. The rock texture is clearly ribbon structure in the range from 25m to 254m. Therefore, cores collected were plate shaped. Disseminated chalcopyrites and molybdenites are usually observed on the plates of the core, but they were of comparatively low grade.

254.00～301.00m: Pale grey Pgl. The rock suffered strong silicification and was collected as massive cores by the drilling operation. Alteration minerals consist of biotite, sericite, gypsum and anhydrite. A minor amount of chalcopyrites and molybdenites can be found as disseminations or embedded in quart veins.

【Alteration】

Porphyritic granite (Pgl) has undergone silicification and sericitization throughout the hole from surface to hole bottom (301m). Small amounts of chlorite are also evenly contained. Biotite-anhydrite-gypsum begins to appear from around 254m in depth. Judging by this evidence, the alteration of the hole is divided into two zones, namely the phyllic zone from surface to 254m and the potassic zone below 254 m.

【Mineralization】

Mineralizations of pyrite, chalcopyrite and molybdenite are observed from surface to hole bottom, but generally are weak mineralization. The range of 5m to 42m is regarded as the secondary enrichment zone because of the exsistance of chalcocite. Below 42m, pyrites are disseminated in the rock and also in quartz veins and fissures, but minor amounts of chalcopyrite and molybdenite are embedded in quartz veins and along fissures. Comparatively strong mineralization occurs from 160m to 240m.

(5) MJT-8

【Geology】

0.00～ 9.60m: Limonite-stained porphyritic granite(Pgl)

9.60～112.00m: White and pale green Pgl. Sericites are mainly seen as altered minerals, chlorites occur below 40m. Chalcopyrites and molybdenites occur not only in fissures and quartz veins but also as dissemination in the rock. Mineralization is weak. Chalcocites and covellines are observed along fissures in the range from 9m to 84m.

112.00～123.00m: Dark green chloritized Pgl. Although the rock is sheared, there is molybdenite in quartz veins.

123.00～169.00m: Dark green chloritized Pgl. The rock has mostly undergone chloritization and weak sericitization, chalcopyrites and molybdenites occur in quartz veins.

169.00～233.40m: Dark green andesite and pale grey Pgl. The rock has well-developed fissures. Chlorites are mainly seen as altered minerals. Chalcopyrites and molybdenites occur in quartz veins and along fissures. This range consists of andesite, intrusion ofPgl in the ranges of 195m to 196m, 198m to 199.75m and 205.2m to 206m. Pgl has mainly undergone sericitization.

233.40~301.00m: Dark and pale green Pgl. Chlorites and biotites are mainly observed as altered minerals in the range from 233.4m to 283m. Below 283m, sericites are predominant. Chalcopyrites and molybdenites occur in quartz veins and along fissures.

【Alteration】

The rocks consist of pale green and dark green Pgl and andesite throughout the hole from surface to hole bottom (301 m). The alteration of the hole is divided into five zones as follows;

0.00~ 40.75m	Pale green Pgl	Phyllic zone
40.75~169.00m	Dark green Pgl	Propylitic zone
169.00~233.40m	Dark green andesite	Propylitic zone
233.40~283.00m	Dark brown Pgl	Potassic zone
283.00~301.00m	Pale green Pgl	Phyllic zone

【Mineralization】

Mineralizations of pyrite, chalcopyrite and molybdenite are observed from surface to hole bottom, but generally is weak mineralization. The range from 9m to 84m is regarded as the secondary enrichment zone because of the existance of chalcocite and covelline. Below 84m, pyrites are disseminated in the rock and also in quartz veins and fissures, but minor amount of chalcopyrites and molybdenites are embedded in quartz veins and along fissures. Comperatively strong mineralization occurs from 230m to 300m.

(6) Assay Result of Core

Drilling survey of the third phase resulted in five holes, totalling 1,505m in length. Whole core (1,498.60m) was split, and half of the split core was subjected to chemical analysis for two elements (Cu and Mo).

Taking into consideration that the ore deposit is porphyry copper type, the cores assayed were grouped and pulverized in each three meters. These samples (506 samples) were analyzed for Cu and Mo. Six samples which contained many sulphide ore minerals such as pyrite, chalcocite and covelline, had undergone strong biotitization and were regarded as scheelite by mineral-light. These six were selected to be analyzed for Au, Ag, Sn and W.

Average grades of these drill holes are as follows ;

MJT-4

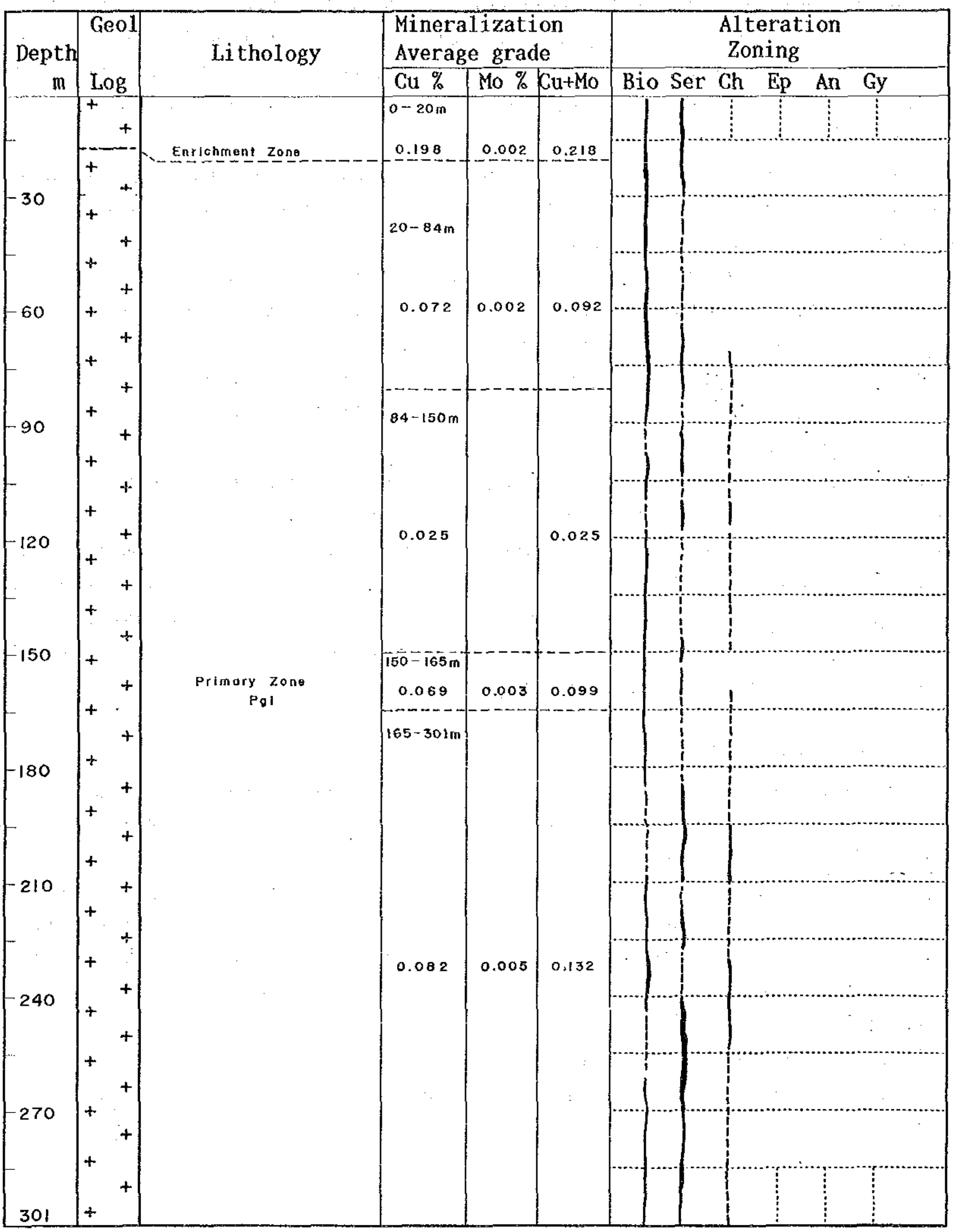


Fig. 42 Geological Log of MJT-4

MJT-5

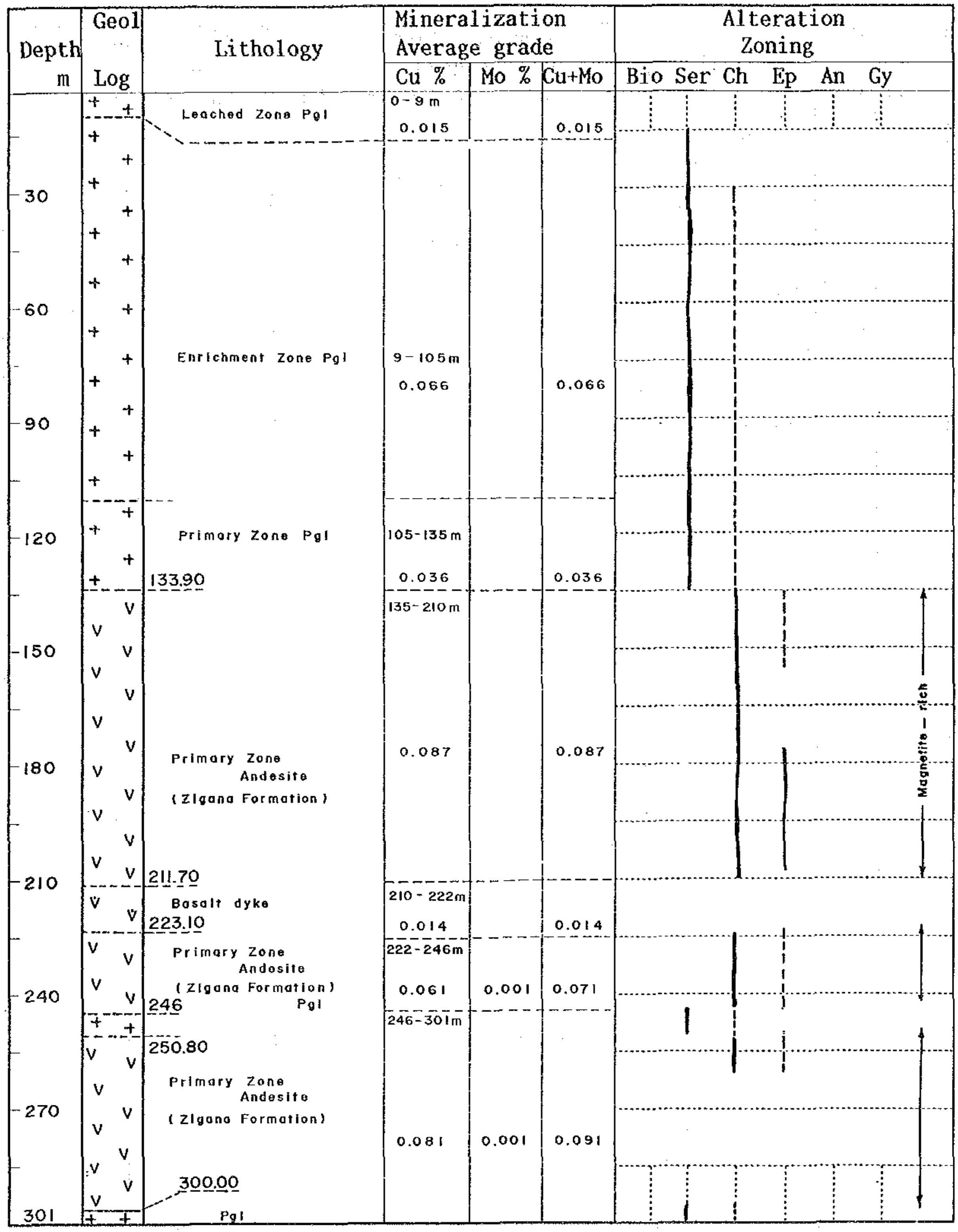


Fig. 43 Geological Log of MJT-5

MJT-6

Depth m	Geol Log	Lithology	Interval	Cu %	Mo %	Cu+Mo	Alteration Zoning (Bio Ser Ch Ep An Gy)
	+	Enrichment Zone Pgl	0~24m	0.404	0.032	0.724	
30	+	Primary Zone Pgl (43.00)	24~45m	0.289	0.013	0.419	
	×	Pgl (53.00)	45~53m	0.046	0.001	0.056	
60, 90	+	Primary Zone Pgl (112.50)	53~111m	0.294	0.011	0.404	
120, 150, 180, 210, 240	×	Pgl	111~244m	0.030		0.030	
270	+	Primary Zone Pgl	244~289m	0.217	0.010	0.317	
301	V	Basalt Dyke	289~301m	0.024	0.001	0.034	

Fig. 44 Geological Log of MJT-6

MJT-7

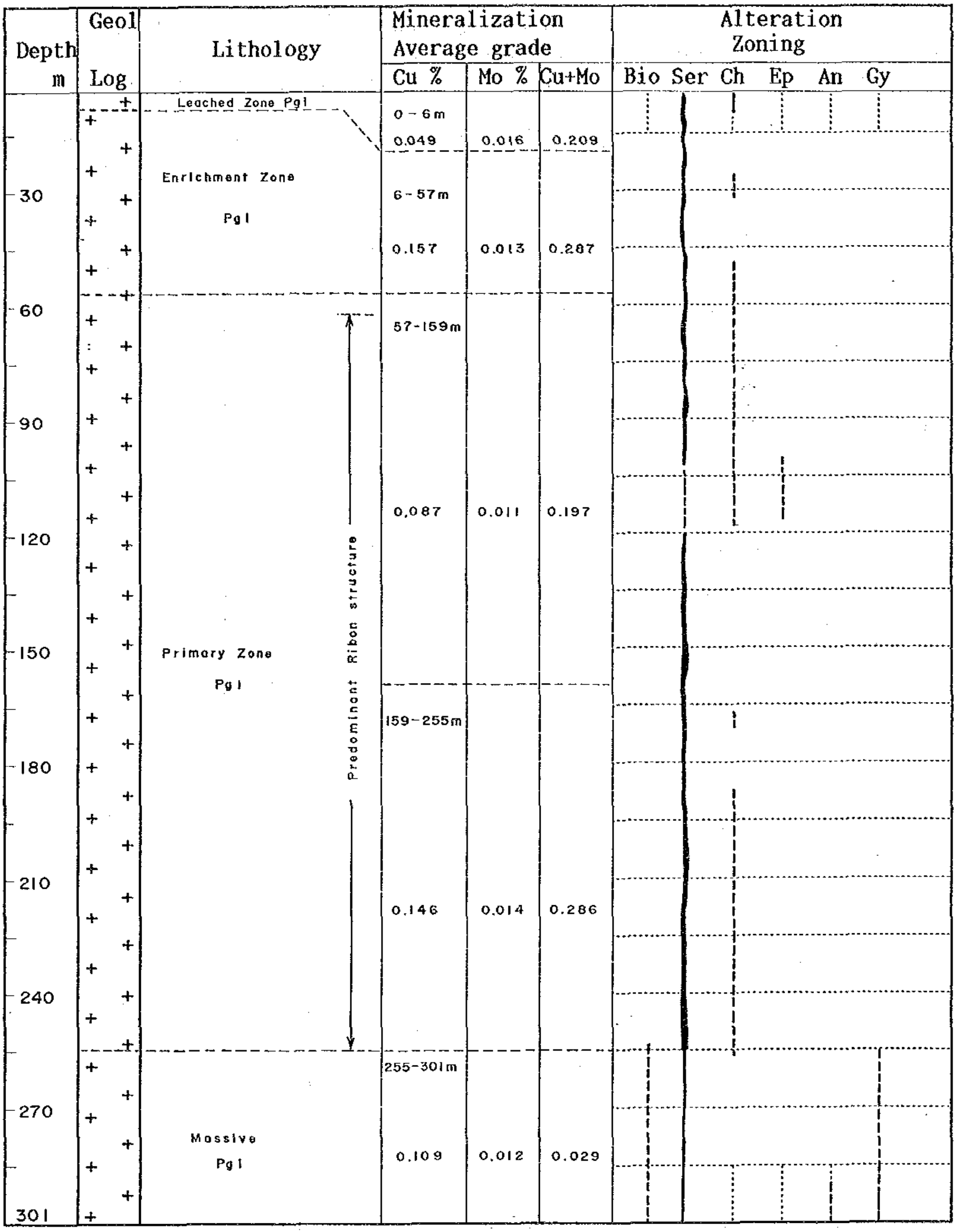


Fig. 45 Geological Log of MJT-7

MJT-8

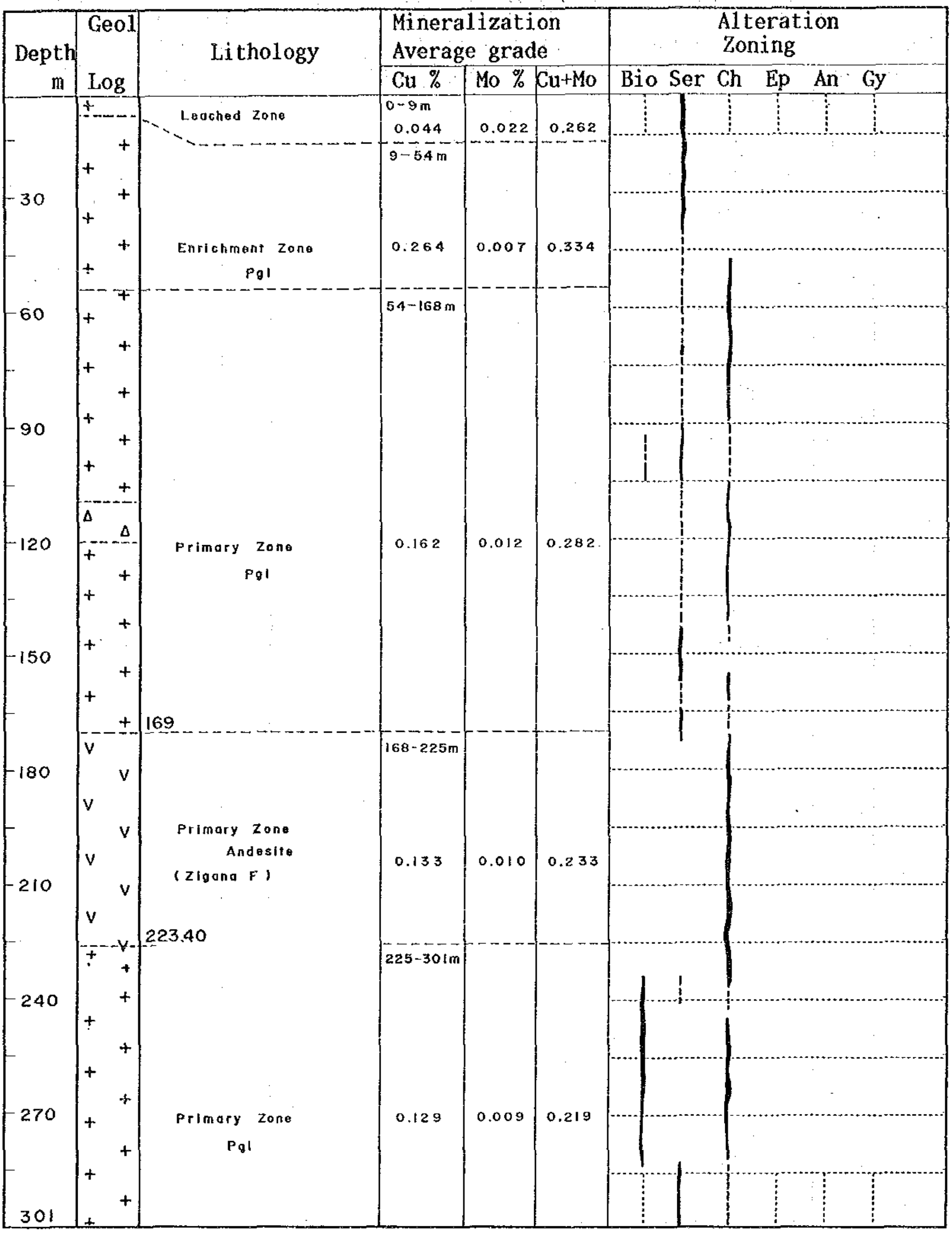


Fig. 46 Geological Log of MJT-8

MJT-4

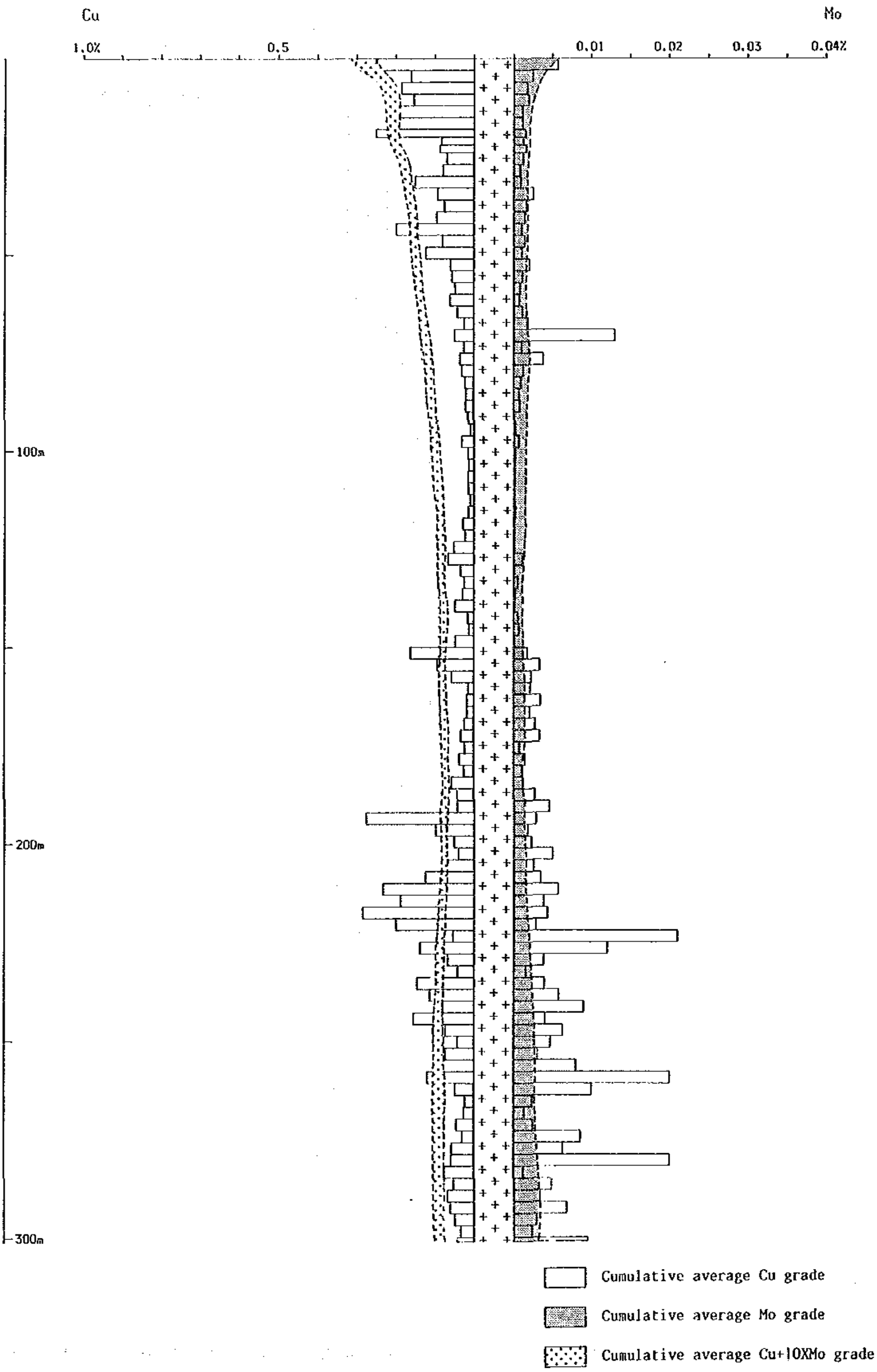


Fig. 47 Chemical Analysis Map of Copper and Molybdenum of MJT-4

MJT-5

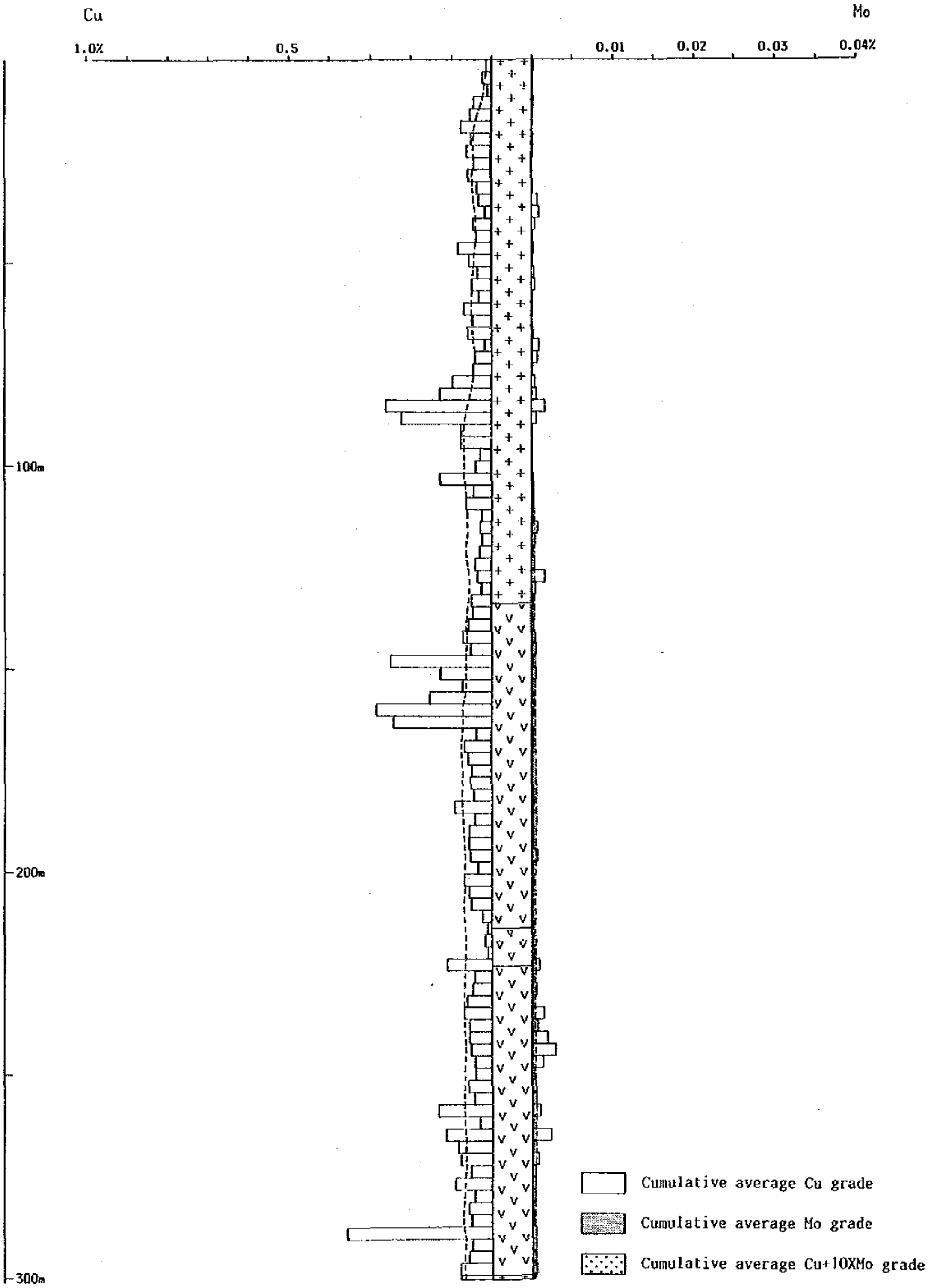


Fig. 48 Chemical Analysis Map of Copper and Molybdenum of MJT-5

MJT-6

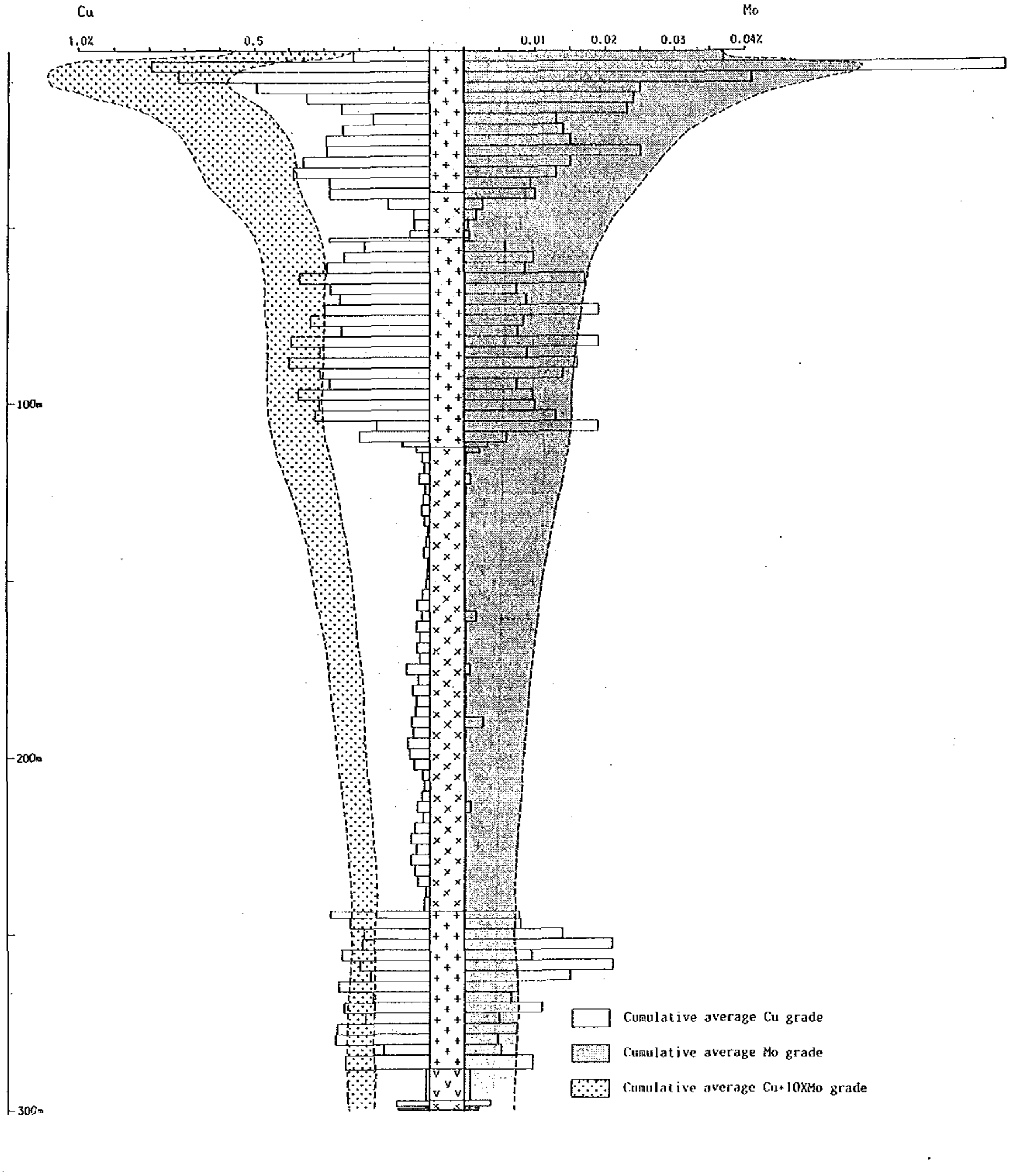


Fig. 49 Chemical Analysis Map of Copper and Molybdenum of MJT-6

MJT-7

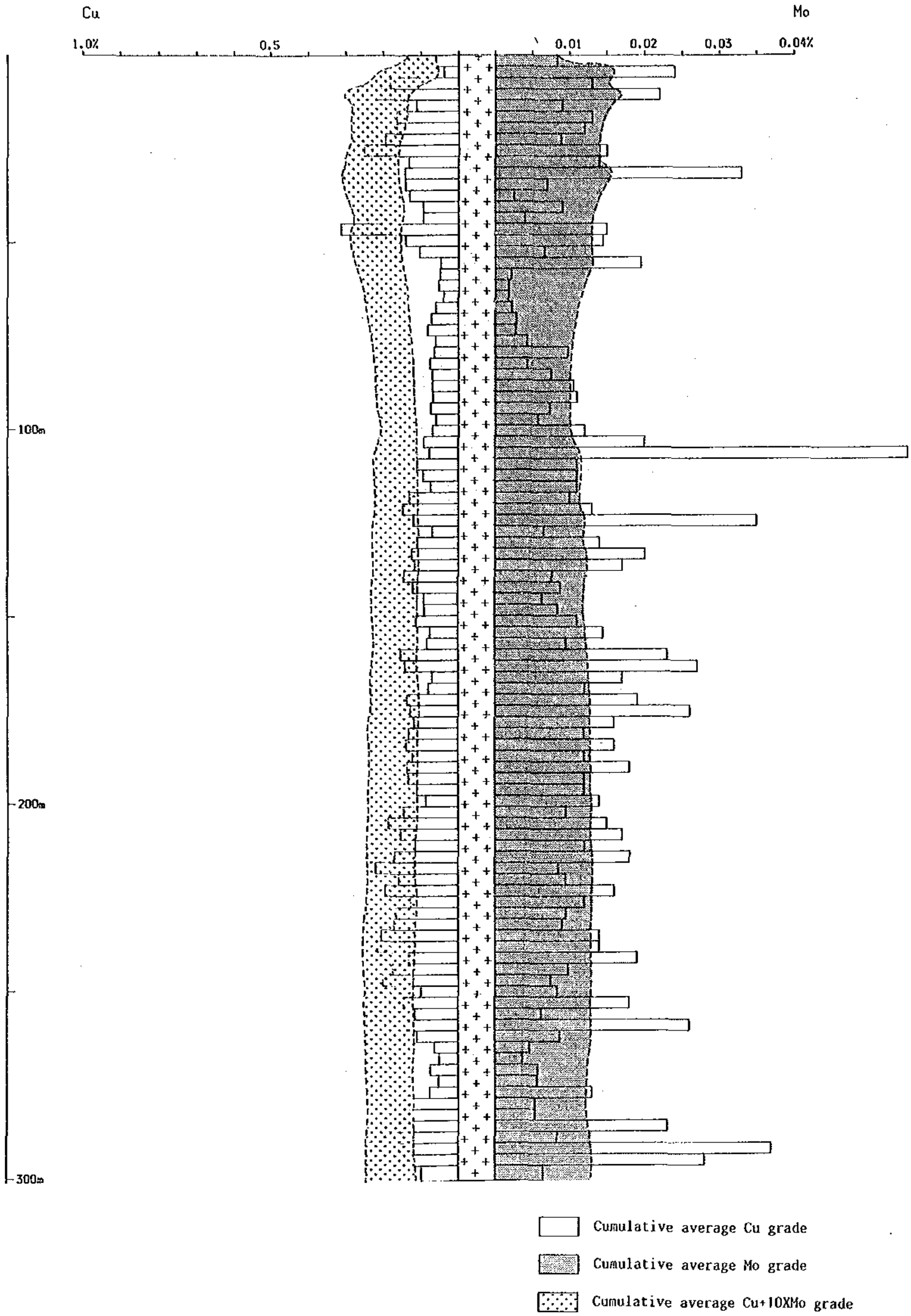


Fig. 50 Chemical Analysis Map of Copper and Molybdenum of MJT-7

.MJT-8

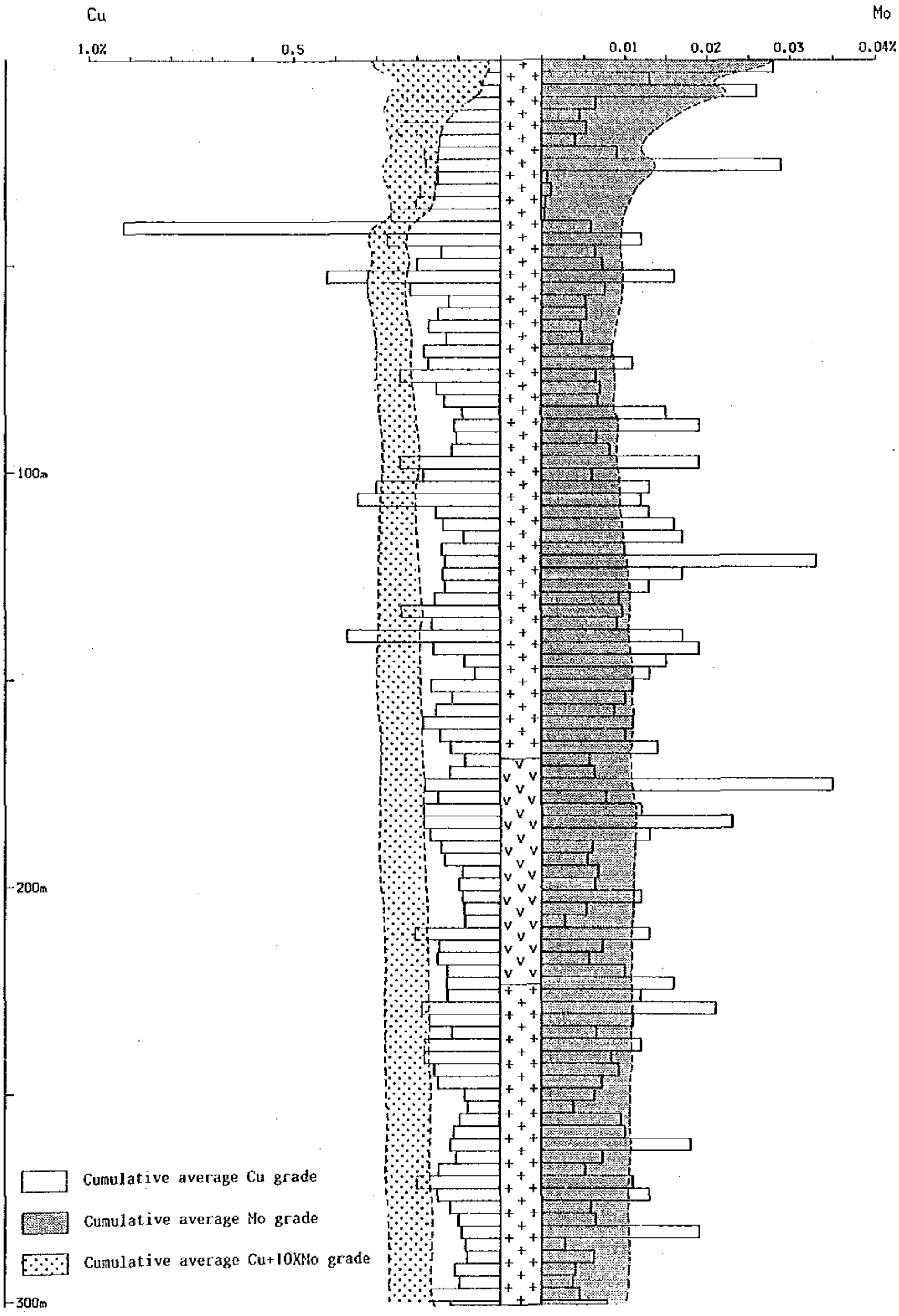


Fig. 51 Chemical Analysis Map of Copper and Molybdenum of MJT-8

Table 19 Cumulative Average Grade (No 1)

MJT-4

Sample No	Cu	Mo	Cu+10×Mo
335	2480.000	57.000	3050.000
336	2045.000	40.500	2450.000
337	1980.000	32.667	2306.670
338	1870.000	29.250	2162.500
339	1878.000	25.600	2134.000
340	1920.000	23.167	2151.670
341	1978.000	22.350	2201.500
342	1873.640	21.409	2087.730
343	1790.830	20.958	2000.420
344	1668.740	19.963	1868.370
345	1581.470	18.767	1769.130
346	1574.970	17.879	1753.760
347	1520.640	18.472	1705.360
348	1461.440	18.282	1644.260
349	1425.550	17.976	1605.310
350	1462.510	17.444	1636.960
351	1421.290	17.229	1593.580
352	1410.040	16.804	1578.080
353	1365.590	16.981	1535.410
354	1323.720	16.667	1490.390
355	1281.780	16.233	1444.120
356	1250.030	15.794	1407.970
357	1212.440	15.576	1368.200
358	1170.330	15.681	1327.150
359	1142.400	20.444	1346.850
360	1107.110	20.027	1307.370
361	1078.330	20.718	1285.510
362	1049.880	20.395	1253.830
363	1020.270	19.988	1220.150
364	991.782	19.540	1187.180
365	965.456	19.156	1157.010
366	938.925	18.570	1124.620
367	912.677	18.052	1093.200
368	894.535	17.687	1071.400
369	872.873	17.225	1045.130
370	851.762	16.762	1019.380
371	832.435	16.324	995.676
372	813.748	15.910	972.847
373	794.860	15.518	950.035
374	778.094	15.171	929.803
375	765.767	14.817	913.933
376	752.553	14.480	897.350
377	746.897	14.159	888.484
378	745.109	14.085	885.961
379	736.038	13.768	873.917
380	725.037	13.593	860.963
381	715.580	13.341	848.986
382	710.780	13.078	841.560
383	699.118	12.910	828.215
384	687.401	12.789	815.293
385	683.253	12.553	808.787
386	701.621	12.641	828.026
387	706.205	13.032	836.526
388	703.730	13.201	835.742
389	693.475	13.346	826.932
390	684.139	13.721	821.352
391	675.101	13.833	813.435
392	667.626	14.064	808.269
393	661.960	14.391	805.868
394	654.689	14.266	797.345
395	649.961	14.261	792.572
396	643.437	14.208	785.514
397	642.414	14.172	784.134
398	639.026	14.376	782.783
399	635.776	14.854	784.318
400	668.457	15.056	819.021
401	673.253	15.086	824.111
402	670.965	15.189	822.856
403	667.054	15.701	824.064
404	669.416	15.836	827.773
405	677.710	16.095	838.662
406	700.981	16.671	867.695
407	717.357	16.968	887.032
408	746.571	17.324	919.813
409	763.509	17.468	938.194
410	760.596	20.036	960.951
411	768.877	21.351	982.386
412	767.723	21.567	983.394
413	763.329	21.483	978.158
414	772.148	21.705	989.194
415	776.746	22.158	998.329
416	777.144	22.996	1007.100
417	786.569	23.203	1018.600
418	786.008	23.683	1022.840
419	781.698	23.960	1021.300
420	781.208	24.031	1021.520
421	781.892	24.682	1028.710
422	786.697	26.697	1053.670
423	783.280	27.530	1058.580
424	777.086	27.479	1051.880
425	771.441	27.319	1044.630
426	767.974	27.282	1040.790
427	762.953	27.920	1042.160
428	760.932	28.297	1043.910
429	759.060	30.124	1060.300
430	759.070	29.933	1058.400
431	756.736	30.122	1057.950
432	755.997	30.151	1057.510
433	754.558	30.537	1059.930
434	751.987	30.522	1057.210
435	747.917	30.447	1052.380
436	746.870	30.661	1053.480

MJT-5

Sample No	Cu	Mo	Cu+10×Mo
740	124.000	2.000	144.000
741	172.000	1.500	187.000
742	147.000	1.333	160.333
743	217.750	1.500	232.750
744	278.200	1.400	292.200
745	358.500	1.333	371.833
746	376.571	1.429	390.857
747	403.875	1.500	418.875
748	405.111	1.444	419.556
749	421.100	1.400	435.100
750	415.091	1.364	428.727
751	406.583	1.833	424.917
752	387.615	2.385	411.462
753	392.071	2.500	417.071
754	390.067	2.400	414.067
755	418.188	2.375	441.938
756	425.647	2.294	448.588
757	420.889	2.333	444.222
758	423.842	2.421	448.053
759	417.650	2.350	441.150
760	430.143	2.286	453.000
761	431.045	2.227	453.318
762	437.739	2.217	459.913
763	426.375	2.500	451.375
764	425.720	2.680	452.520
765	426.654	2.615	452.808
766	446.963	2.667	473.630
767	477.071	2.786	504.929
768	550.966	3.276	583.724
769	606.933	3.367	640.600
770	611.871	3.290	644.774
771	616.500	3.219	648.688
772	606.000	3.152	637.515
773	599.206	3.088	630.088
774	618.657	3.057	649.229
775	613.833	3.000	643.833
776	614.270	2.973	644.000
777	604.421	2.921	633.632
778	595.974	3.026	626.231
779	586.825	3.050	617.325
780	579.585	3.000	609.585
781	575.238	3.024	605.476
782	569.768	3.349	603.256
783	562.159	3.386	596.023
784	560.533	3.356	594.089
785	558.130	3.304	591.174
786	558.170	3.277	590.936
787	561.542	3.292	594.458
788	560.694	3.327	593.959
789	599.680	3.280	632.480
790	613.020	3.314	646.157
791	615.269	3.269	647.962
792	632.717	3.245	665.170
793	673.963	3.222	706.185
794	705.891	3.182	737.709
795	699.804	3.161	731.411
796	699.193	3.140	730.597
797	697.052	3.103	728.086
798	693.373	3.068	724.051
799	690.483	3.033	720.817
800	686.541	3.016	716.705
801	690.629	3.000	720.629
802	686.254	2.968	715.937
803	684.203	2.953	713.734
804	682.369	2.938	711.754
805	680.061	3.000	710.061
806	674.911	2.970	704.612
807	675.059	2.956	704.618
808	673.391	2.928	702.667
809	670.914	2.900	699.914
810	664.535	2.873	693.268
811	656.444	2.861	685.056
812	649.740	2.836	678.096
813	642.216	2.824	670.459
814	648.587	2.907	677.653
815	645.513	2.882	674.329
816	643.169	2.922	672.390
817	642.808	2.897	671.782
818	643.342	3.051	673.848
819	642.175	3.100	673.175
820	640.975	3.309	674.062
821	639.317	3.634	675.659
822	636.434	3.759	674.024
823	633.500	3.750	671.000
824	632.812	3.765	670.459
825	630.570	3.779	668.361
826	638.724	3.851	677.230
827	634.875	3.818	673.057
828	640.663	4.045	681.112
829	642.989	4.022	683.211
830	644.495	4.066	685.154
831	643.141	4.065	683.793
832	646.065	4.065	686.710
833	643.660	4.064	684.298
834	642.884	4.032	683.200
835	641.365	4.010	681.469
836	671.557	4.021	711.763
837	669.806	4.020	710.010
838	668.849	4.020	709.051
839	670.110	4.030	710.410
840	670.508	4.027	710.774

MJT-6

Sample No	Cu	Mo	Cu+10×Mo
437	2170.000	370.000	5870.000
438	5060.000	570.000	10760.000
439	5766.670	516.667	10933.300
440	5560.000	450.000	10060.000
441	5146.000	408.000	9226.000
442	4710.000	378.333	8493.330
443	4265.710	342.857	7694.290
444	4043.750	317.500	7218.750
445	3922.220	298.889	6911.110
446	3823.000	294.000	6763.000
447	3803.640	280.909	6612.730
448	3810.830	268.333	6494.170
449	3736.920	254.846	6285.390
450	3673.570	243.786	6111.430
451	3506.670	229.333	5800.000
452	3315.000	216.125	5476.250
453	3145.180	203.765	5182.820
454	3047.020	196.377	5010.790
455	3043.370	192.889	4972.260
456	2980.560	185.789	4838.460
457	2953.530	181.400	4767.530
458	2951.940	176.857	4720.510
459	2986.850	176.545	4752.300
460	2980.460	172.043	4700.900
461	2963.360	168.500	4648.360
462	2964.430	169.360	4658.030
463	2981.180	166.038	4641.560
464	2964.470	162.667	4591.140
465	2999.670	163.643	4636.100
466	3004.160	161.034	4614.510
467	3037.360	161.000	4647.360
468	3040.020	160.323	4643.250
469	3034.080	157.625	4610.330
470	3055.470	155.788	4613.350
471	3057.960	154.147	4599.430
472	3063.730	153.457	4598.300
473	3020.300	154.472	4565.020
474	2992.720	151.919	4511.910
475	2963.150	150.333	4466.480
476	2929.240	148.645	4415.690
477	2859.650	144.885	4308.490
478	2792.030	141.288	4204.900
479	2731.150	138.061	4111.760
480	2669.270	134.821	4017.480
481	2611.520	131.709	3928.610
482	2557.190	128.761	3844.800
483	2503.630	125.922	3762.850
484	2450.420	123.207	3682.480
485	2400.340	120.628	3606.620
486	2353.730	118.135	3535.090
487	2306.530	115.745	3463.980
488	2261.740	113.450	3396.240
489	2219.280	111.245	3331.730
490	2180.450	109.125	3271.700
491	2145.910	107.104	3216.950
492	2110.390	105.435	3164.740
493	2079.110	103.536	3114.480
494	2047.160	101.705	3064.220
495	2017.580	99.939	3016.970
496	1987.640	98.233	2969.970
497	1965.310	96.703	2932.340
498	1938.050	95.108	2889.140
499	1914.280	93.566	2849.940
500	1889.540	92.089	2810.420
501	1865.780	90.643	2772.210
502	1844.500	89.648	2740.990
503	1823.200	88.300	2706.200
504	1804.900	86.977	2674.670
505	1786.240	85.694	2643.180
506	1766.440	84.449	2610.930
507	1743.700	83.239	2576.090
508	1721.070	82.064	2541.720
509	1699.990	80.923	2509.210
510	1681.380	79.924	2480.610
511	1661.080	78.842	2449.510
512	1644.330	77.791	2422.230
513	1629.400	76.767	2397.070
514	1612.940	75.770	2370.630
515	1598.870	74.799	2346.860
516	1583.760	73.853	2322.280
517	1567.960	72.930	2297.270
518	1549.740	72.031	2270.050
519	1526.660	70.867	2235.330
520	1537.260	70.925	2246.510
521	1546.090	71.034	2256.430
522	1549.940	71.855	2268.490
523	1554.410	73.480	2289.220
524	1565.640	73.731	2302.950
525	1570.630	75.297	2323.600
526	1572.100	76.146	2333.560
527	1583.770	76.133	2345.100
528	1584.060	76.020	2344.260
529	1593.570	76.394	2357.510
530	1596.360	76.107	2357.430
531	1607.580	76.095	2368.530
532	1618.990	75.796	2376.950
533	1615.630	75.556	2371.200
534	1626.830	75.853	2385.160
535	1580.250	73.834	2318.590
536	1576.950	73.854	2313.490
537	1574.480	73.545	2309.930
538	1573.110	73.440	2307.510

Table 19 Cumulative Average Grade (No 2)

MJT-7

Sample No	Cu	Mo	Cu+10×Mo
639	290.000	280.000	3090.000
640	375.000	205.000	2425.000
641	436.333	223.333	2671.670
642	928.750	183.500	2763.750
643	1203.000	155.800	2761.000
644	1409.170	138.667	2795.830
645	1413.570	124.571	2659.290
646	1463.130	120.250	2665.630
647	1496.110	139.111	2887.220
648	1494.500	125.900	2753.500
649	1531.360	115.545	2686.820
650	1570.420	106.333	2633.750
651	1651.150	98.462	2635.770
652	2188.210	95.571	3143.930
653	2225.000	97.200	3197.000
654	2173.440	95.063	3124.060
655	2163.240	93.706	3100.290
656	2276.390	97.389	3250.280
657	2270.790	96.211	3232.890
658	2218.250	94.000	3158.250
659	2183.100	92.048	3103.570
660	2161.590	89.955	3061.140
661	2122.830	88.130	3004.130
662	2110.210	87.958	2989.790
663	2094.200	88.840	2982.600
664	2105.960	87.923	2985.190
665	2083.890	87.259	2956.480
666	2056.610	86.536	2921.960
667	2016.210	88.724	2903.450
668	1985.670	92.100	2906.670
669	1955.160	91.226	2867.420
670	1930.000	90.906	2839.060
671	1944.550	93.909	2883.640
672	1941.760	92.912	2870.880
673	1972.000	93.971	2911.710
674	2013.060	94.694	2960.000
675	2000.000	95.649	2956.490
676	1982.890	97.342	2956.320
677	1954.100	99.205	2946.150
678	1939.750	99.225	2932.000
679	1924.150	104.854	2972.680
680	1910.710	106.405	2974.760
681	1896.510	106.954	2966.050
682	1888.640	106.636	2955.000
683	1899.560	106.422	2963.780
684	1893.910	106.065	2954.570
685	1932.770	107.426	3007.020
686	1925.830	109.146	3017.290
687	1903.780	109.980	3003.570
688	1877.700	110.380	2981.500
689	1873.240	110.373	2976.960
690	1859.130	110.173	2960.870
691	1852.920	109.736	2950.280
692	1852.870	109.741	2950.280
693	1845.180	109.564	2940.820
694	1833.130	110.107	2934.200
695	1815.530	109.175	2907.280
696	1804.740	108.379	2888.530
697	1804.490	112.475	2929.240
698	1798.920	111.883	2917.750
699	1799.590	112.016	2919.750
700	1800.240	113.919	2939.440
701	1798.330	114.175	2940.080
702	1792.270	113.328	2925.550
703	1785.000	112.415	2909.150
704	1771.360	111.727	2888.640
705	1759.550	111.000	2869.550
706	1746.760	111.132	2858.090
707	1733.770	110.290	2836.670
708	1720.790	109.114	2811.930
709	1725.420	109.408	2819.510
710	1721.600	108.903	2810.630
711	1718.420	108.192	2800.340
712	1712.090	108.081	2792.910
713	1706.070	108.773	2793.800
714	1699.930	108.921	2789.140
715	1702.400	110.234	2804.740
716	1702.500	110.231	2804.810
717	1695.510	109.658	2792.090
718	1697.060	109.788	2794.940
719	1698.700	109.457	2793.270
720	1697.260	109.244	2789.700
721	1694.760	108.795	2782.710
722	1684.580	108.250	2767.080
723	1673.760	107.424	2748.000
724	1665.410	107.279	2738.200
725	1658.910	107.195	2730.860
726	1653.470	108.023	2733.690
727	1646.570	107.629	2722.870
728	1644.500	107.011	2714.610
729	1648.410	107.044	2718.850
730	1646.790	107.293	2719.730
731	1641.990	106.763	2709.620
732	1635.160	106.309	2698.240
733	1627.630	107.189	2699.530
734	1619.320	106.365	2682.970
735	1610.740	105.907	2669.810
736	1605.330	105.235	2657.670
737	1598.910	104.545	2644.360
738	1602.920	103.950	2642.420
739	1601.520	103.864	2640.150

MJT-8

Sample No	Cu	Mo	Cu+10×Mo
539	600.000	83.000	1430.000
540	491.000	161.500	2106.000
541	930.667	151.000	2440.670
542	1373.000	168.250	3055.500
543	1322.400	152.600	2848.400
544	1375.330	148.833	2863.670
545	1413.140	144.714	2860.290
546	1480.250	137.625	2856.500
547	1594.670	139.000	2984.670
548	1566.200	139.100	2957.200
549	1552.910	156.455	3117.450
550	1541.000	149.250	3033.500
551	1522.460	139.769	2920.150
552	1480.210	136.214	2842.360
553	1443.730	129.800	2741.730
554	1549.130	131.063	2859.750
555	1540.940	131.882	2859.770
556	1513.110	128.222	2795.330
557	1458.530	131.737	2775.900
558	1410.600	126.250	2673.100
559	1369.140	121.095	2580.100
560	1324.860	116.409	2488.950
561	1293.040	112.348	2416.520
562	1268.960	108.875	2357.710
563	1250.800	105.640	2307.200
564	1225.960	103.231	2258.270
565	1204.440	103.037	2234.820
566	1188.570	100.893	2197.500
567	1171.720	100.000	2171.720
568	1156.000	100.167	2157.670
569	1140.810	100.484	2145.650
570	1128.440	99.625	2124.690
571	1112.580	98.333	2095.910
572	1100.440	98.971	2090.150
573	1095.140	101.857	2113.710
574	1085.970	114.306	2229.030
575	1086.350	114.189	2228.240
576	1082.370	114.079	2223.160
577	1073.590	113.974	2213.330
578	1079.250	113.625	2215.500
579	1089.020	114.024	2229.270
580	1091.670	119.643	2288.100
581	1082.560	118.372	2266.280
582	1082.950	118.864	2271.590
583	1086.440	120.667	2293.110
584	1088.040	121.739	2305.430
585	1095.740	120.766	2303.400
586	1097.920	120.083	2298.750
587	1093.980	118.918	2283.160
588	1090.100	118.220	2272.300
589	1090.690	118.059	2271.270
590	1084.040	118.577	2269.810
591	1079.150	118.132	2260.470
592	1087.500	120.204	2289.540
593	1093.550	122.927	2322.820
594	1086.520	123.768	2324.200
595	1081.490	123.702	2318.510
596	1086.470	124.845	2334.910
597	1089.750	127.136	2361.100
598	1090.920	127.683	2367.750
599	1094.510	127.557	2370.080
600	1099.110	128.081	2379.920
601	1101.030	127.952	2380.560
602	1105.080	128.766	2392.730
603	1108.540	128.631	2394.850
604	1108.410	128.500	2393.410
605	1104.700	128.672	2391.420
606	1109.930	128.176	2391.690
607	1120.800	128.493	2405.720
608	1126.790	129.086	2417.640
609	1127.110	128.958	2416.690
610	1135.070	129.667	2431.740
611	1149.520	129.055	2440.070
612	1155.340	128.595	2441.280
613	1165.800	129.013	2455.930
614	1167.040	128.895	2455.990
615	1173.310	128.455	2457.860
616	1180.190	127.962	2459.810
617	1191.080	128.114	2472.220
618	1203.060	128.263	2485.690
619	1204.510	129.025	2494.750
620	1211.040	128.646	2497.500
621	1220.540	127.988	2500.420
622	1217.920	127.452	2492.440
623	1220.650	128.071	2501.350
624	1219.830	127.302	2492.850
625	1221.550	128.828	2509.830
626	1220.170	128.352	2503.690
627	1213.600	127.427	2487.870
628	1205.720	126.422	2469.940
629	1200.710	125.659	2457.310
630	1193.370	124.902	2442.390
631	1188.760	124.957	2438.330
632	1189.950	124.191	2431.860
633	1190.260	123.442	2424.680
634	1194.840	124.552	2440.360
635	1198.090	124.124	2439.330
636	1201.990	126.633	2468.320
637	1203.480	128.182	2485.300
638	1200.650	127.329	2473.940

Drill hole	Assayed range	Average grade		
		Cu%	Mo%	Equivalent Cu% *
MJT-4	0.00~ 301.00m	0.075	0.003	0.105
MJT-5	0.00~ 301.00m	0.067	-	0.071
MJT-6	0.00~ 301.00m	0.157	0.007	0.231
MJT-7	0.00~ 301.00m	0.120	0.013	0.247
MJT-8	0.00~ 301.00m	0.160	0.010	0.264

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

Histograms of assayed results in each drill hole are presented in Figs.47~ 51.

MJT-4 is situated in the center of the potassic zone. It has its highest grade in the interval 165m to 301m showing 0.005% Mo and 0.082% Cu. Other sections contain very low grades of Cu and Mo in spite of the existence of mineralization.

In the case of MJT-5, although 9.0m to 105.0m contains chalcocite and covelline as secondary copper, the grade is very low. The mean grade from 0.00m to 301.00m is 0.067% Cu, the grade of Mo is less than 0.001% .

MJT-6 was expected to have a higher ore grade because it was close to MJT-3, but Pg2 had intruded into Pg1. The mean ore grade is 0.487% copper equivalent in Pg1.

As mentioned already, MJT-7 and 8 are situated close to the center of mineralization, associated with phyllic to potassic alteration zones, and mainly characterized by well-developed fractures and dissemination type mineralization. Thus ore grade of MJT-7 and 8 were expected to be higher than those of MJT-4, 5, and 6, but they show 0.120% Cu, 0.013% Mo and 0.247% equivalent Cu in the range from 0m to 301m in MJT-7, and 0.160% Cu, 0.010% Mo and 0.264% equivalent Cu in the range from 0m to 301m in MJT-8.

The average ore grades of the secondary enrichment zone are as follows;

Drill hole	Assayed range	Average grade		
		Cu%	Mo%	Equivalent Cu% *
MJT-4	0.00~ 21.00m	0.198	0.002	0.218
MJT-5	9.00~ 105.00m	0.066	-	0.066
MJT-6	0.00~ 24.00m	0.404	0.032	0.724
MJT-7	6.00~ 57.00m	0.157	0.013	0.287
MJT-8	9.00~ 54.00m	0.264	0.007	0.314

* Equivalent Cu% = Cu% + 10 × Mo%