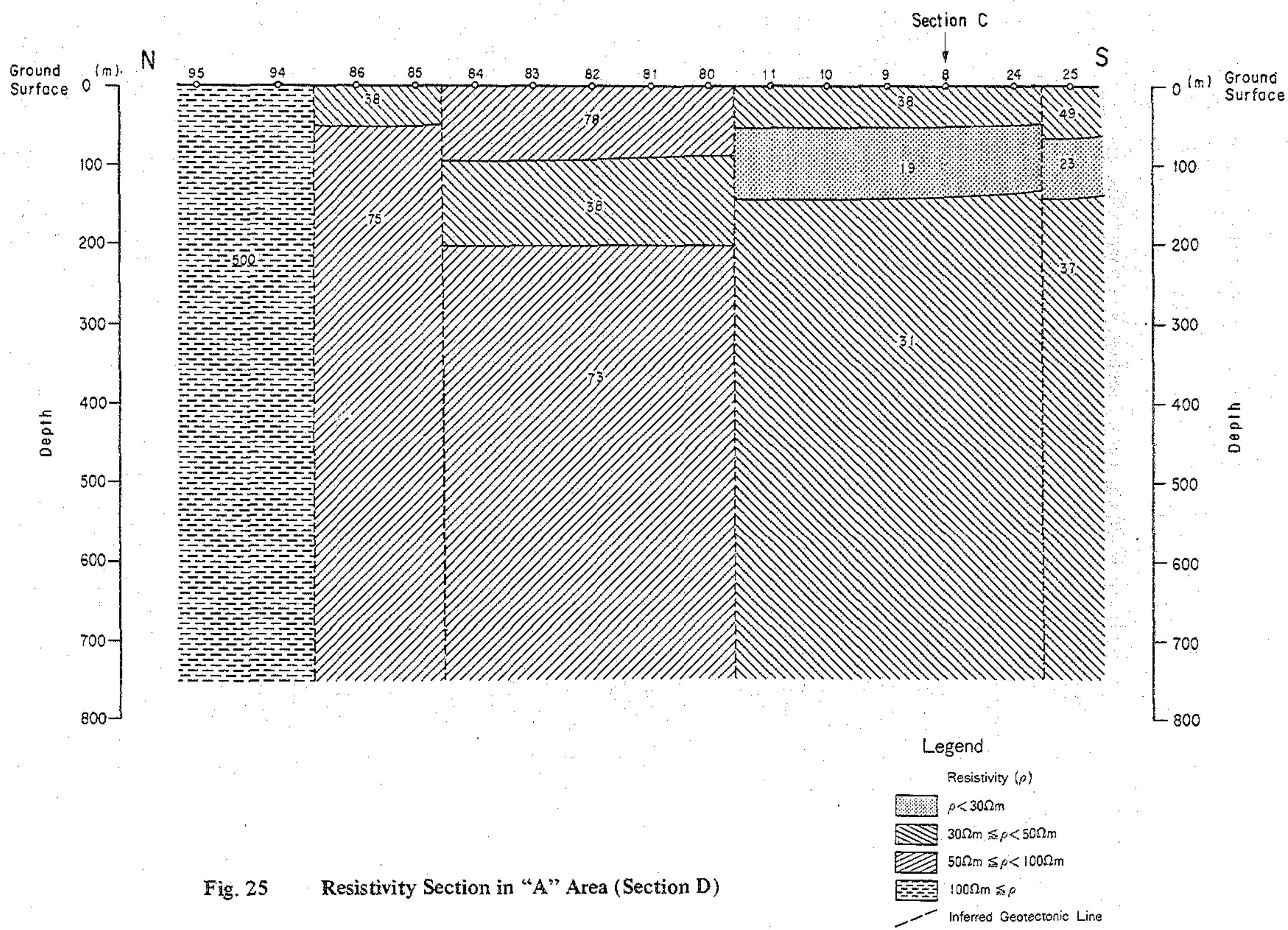


Fig. 25 Resistivity Section in "A" Area (Section D)

Second layer exept for that between Nos. 12 and 16 is a resistivity layer of more than 100ohm-m and may reflect adamellite and peridotite.

First layer of a resistivity of 40–70ohm-m is distributed between Nos. 89 and 5 and may correspond to the Pinosuk Formation.

A low resistivity layer between Nos. 12 and 16 may be due to a fracture zone of Bambangan fault, striking in the same direction as the section, and small faults.

Several faults are assumed, where low resistivity layers can be seen. Remarkable faults crossing the section are found at four locations; at No. 9, between Nos. 12 and 8, near No. 16, at No. 35 and at No. 46.

Section D

A three-layer structure is assumed on the whole section.

Between Nos. 86 and 109, resistivities of the upper and lower layers are high and one of the middle layer is low. The first and third layers of the south of No. 11 correspond to the second layer of resistivity of 30–500ohm-m. There is no layer between Nos. 84–80, corresponding the second layer of resistivity of less than 30ohm-m found in the south of No. 11.

Between Nos. 86 and 85, resistivities of the first and second layers are of 30–70ohm-m and of more than 70ohm-m, respectively. It is thought that the first layer in this part may correspond to the Pinosuk Formation, but as this layer shows higher resistivity and larger thickness than the first layers of both sides, this formation in this part may be thin.

The second layer between Nos. 84 and 80 may correspond to the Crocker Formation judging from its resistivity, but it is not clear what the causes resistivity change to 40ohm-m.

The high resistivity layer found in the north of No.94 may reflect outcropping peridotite.

2–1–4 Discussion

A CSAMT method, used in this survey, has been utilized for mapping resistivity distributions and to detect small scale vein and/or faults because this technique has been also characterized by its high resolution in laterial direction. In spite of this, the discrimination of layers with a little resistivity contrast is not an easy task.

In this A area, the distribution of the high and low resistivities has been clearly delineated, however, it is not easy to distinguish Pinosuk, Crocker and Trusmadi Formations, which have a little resistivity contrast among each other.

As a potential area for mineral exploration and its alteration zone, the low resistivity zones are selected according to the example indicated in Fig. 8, where a strong resistivity contrast zone

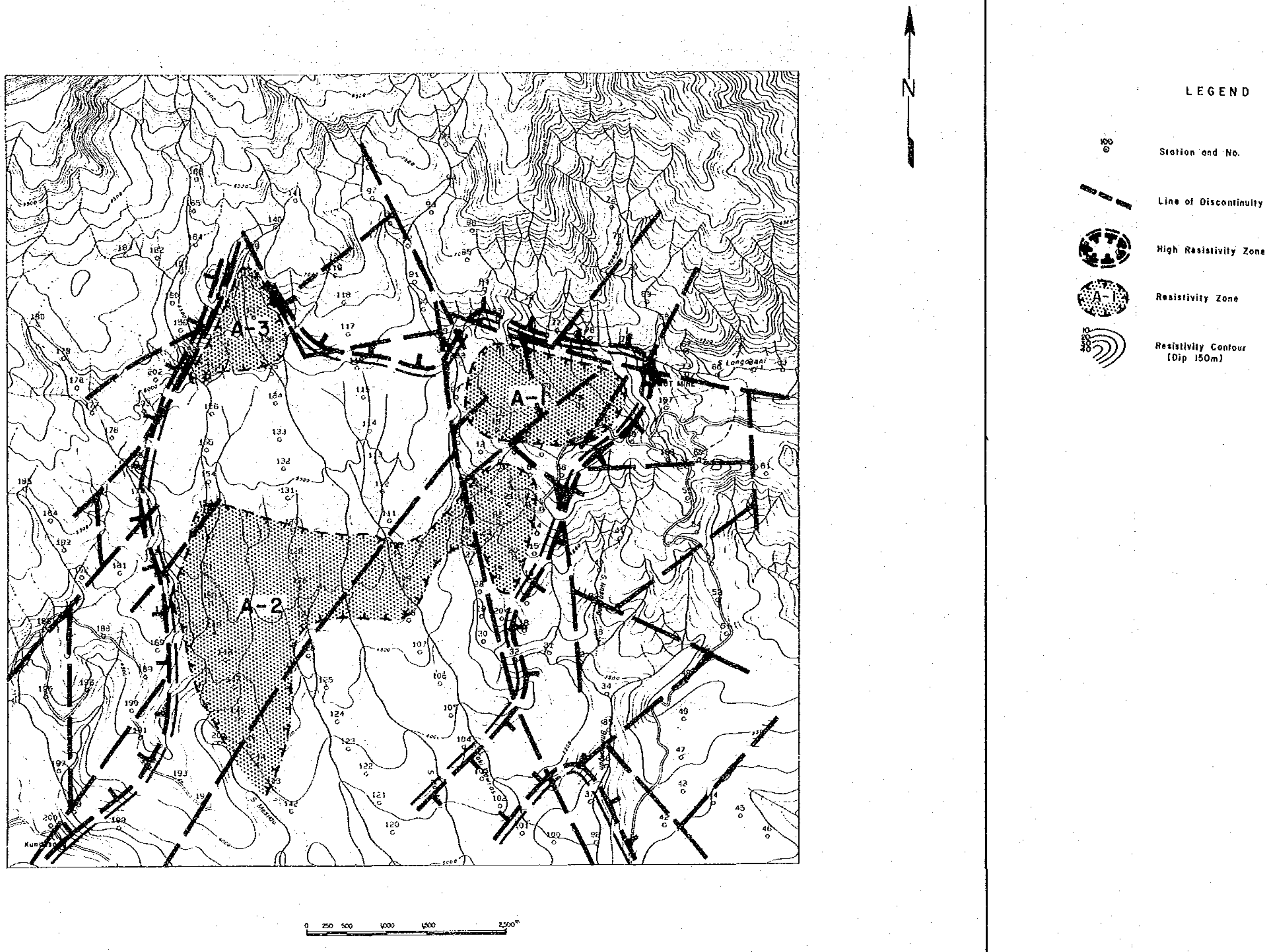


Fig. 26 CSAMT Interpretation Map in "A" Area

reflects the complex geological structure which may have a high potential of mineralization.

The resistivities of the orebody itself show values from 50 to 100ohm-m including the strong altered zone, from 100 to 150ohm-m for the weak altered zone and more than 150ohm-m for the mother rock.

In comparison with the Mamut mine, the A-1 and A-3 resistivity zones resulted to be the more interesting areas, that is why in this survey the low resistivity detected in the high resistivity zone is a promising one.

In order to clarify the distribution (thickness) of the Pinosuk formation in the area A, a two dimentional analysis was carried out which allowed us to clarify the way in which the deep resistivity is affected by lateral geological changes.

As a result, a boundary between the Pinosuk Formation and the Crocker Formation was not clearly identified, not only because the upper Crocker Formation is rugged (its resistvity decrease to 50–70ohm-m, almost the same as the Pinosuk Formation), but also because the ground water near the boundary decreases the resistivity.

The thickness of the Pinosuk Formation in the south of the area, is partly interpreted as being 200 m, however, its average thickness is around 100–150 m at the Kundasang in the middle of the survey area.

In the frequency range of 2,048–1,024 Hz which reflects the shallow information, the Pinosuk Formation in the A-1 resistivity zone does not show the 50–70ohm-m. The resistivity detected around 50ohm-m owes to the fact that the thickness is either too thin, either strongly weathered or containing abundant ground water. However, judging from the geology and its resistivity structure, an average thickness of 50 m is interpreted in the "A" area.

The interpreted resistivity zone which seems to be connected with mineralization, may be the A-1 and A-2 resistivity zones.

2–2 IP and SIP Surveys

2–2–1 Objectives and Method of Survey

(1) Objectives

IP and SIP survey was conducted in order to clarify the nature of the A-1 low resistivity zone, which was assummed to be due to the mineralization by the previous CSAMT survey, and to examine the existence of the mineralization, especially sulfide minerals, in the low resistivity zone.

(2) Method of Survey

i) Method

Both IP and SIP methods are adopted to clarify the underfround structure electrically using the transient phenomenon (IP phenomenon) caused by the electro-chemical nature of the minerals and/or rocks.

IP method is classified into two, "frequency-domain method" and "time-domain method". In this survey, the former was adopted using three frequencies of 3.0 Hz, 0.375 Hz and 0.3 Hz because Spectral IP (SIP) method was applied simultaneously in this area.

SIP method is worldwidely applied in the mineral exploration in order to clarify the nature of the IP anomalous source by measuring the magnitude, phase shift, etc. in the wide-band frequency from 0.1 Hz to 100 Hz.

ii) Stations and Electrode Configuration

IP and ISP survey lines were set by means of open traverse method using compasses and measuring tapes.

Stations were settled at 50 m spacing apart on each survey line, and for SIP method, receiver lines were set at 25 m to 30 m apart from the main survey line.

Electrode configuration adopted was a dipole-dipole array as shown in Fig. 28, and three electrodes were used for potential electrode.

Specifications and survey amount are given in Table 4.

Table 4 Specifications and Survey Amount for IP, SIP Survey in "A" Area

Method	Line length	Measuring Points	Measuring Interval and n-factor	Electrode Configuration
SIP	1.1 Kmx1 line 1.3 Kmx2 lines 1.7 Kmx1 line (5.4 Km)	166 points	a = 100 m n = 1 to 5	Dipole-dipole
IP	1.1 Kmx1 line 1.3 Kmx2 lines 1.7 Kmx1 line (5.4 Km)	190 points	a = 100 m n = 1 to 5	Dipole-dipole

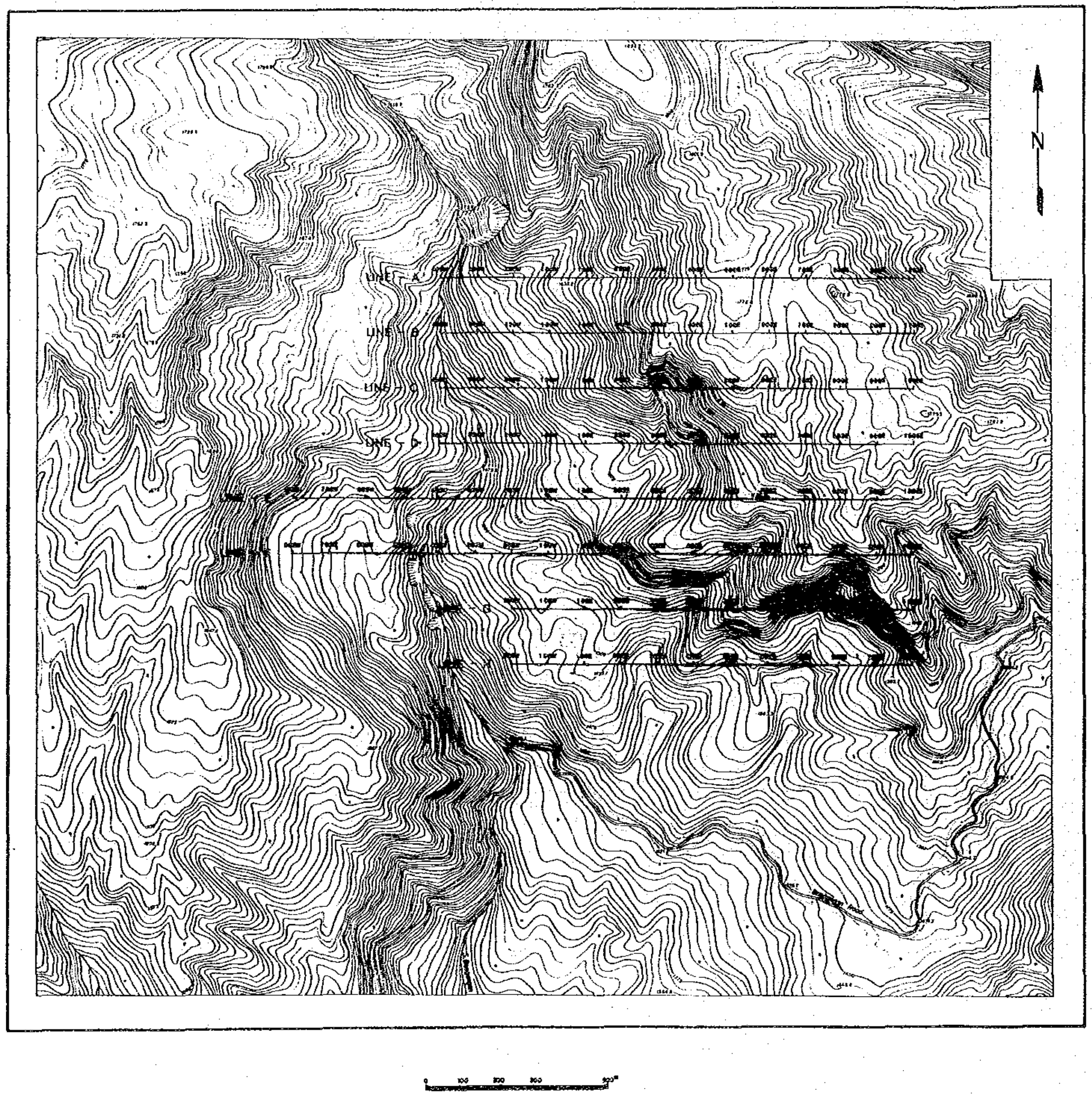


Fig. 27 Location Map of SIP and IP Survey Lines in "A" Area

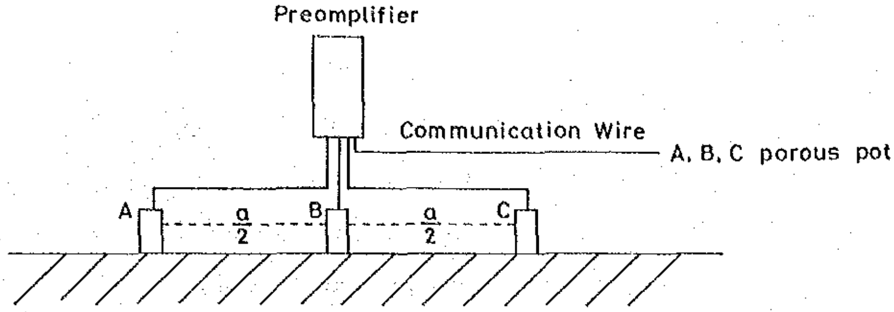


Fig. 28 Potential Electrode Configuration

iii) Instrument

In SIP method, ZERO (Zonge Engineering & Research Organization, U.S.A.) system was adopted, same as in the previous CSAMT survey (refer 2–1–1 (2) in Chapter 2).

IP instrument systems used are described below.

Transmitting system

Transmitter Model CH-T7801, made by Chiba Electronics Co., Japan.

Output Current	0.1A to 2.5A
Maximum output voltage	800V
Frequency used	0.3Hz and 3Hz

Engine Generator Model 421, made by Geotronics Co., U.S.A.

Output 5Hp, 400Hz, 115V

Receiving system

IP Receiver Model CH-R7802, made by Chiba Electronics Co., Japan.

Frequency used	0.3Hz and 3Hz
Input impedance	2 Mega-ohm

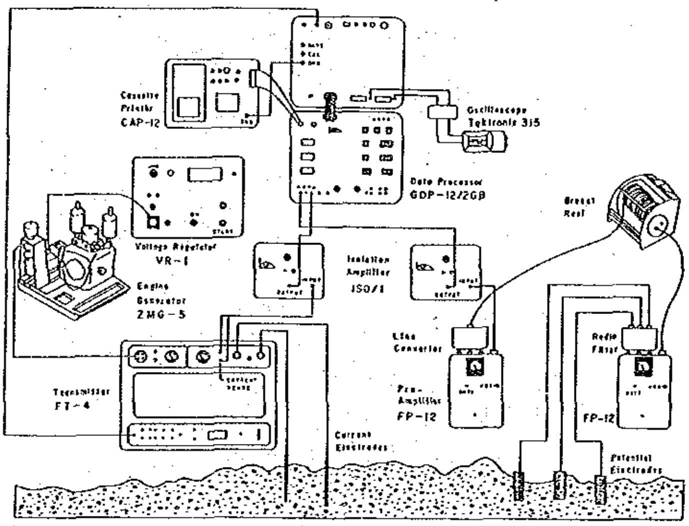


Fig. 29 Diagram of SIP Survey System

2–2–2 Data Processing

(1) Data Processing

In this survey, two kinds of methods, IP and SIP, were applied, so the various pseudosections such as apparent resistivity and PFE pseudosections were made using three frequencies of 3.0 Hz, 0.375 Hz and 0.3 Hz, to make the same presentation for both methods. Moreover, 3-pt decoupling phase and raw phase pseudosections were made also for SIP method.

Calibration correction for these observed values and terrain correction for apparent resistivity were applied.

The following maps and diagrams are the final results:

(i) Apparent resistivity pseudosection (3.0 Hz)

(ii) Apparent resistivity plan map (3.0 Hz)

(iii) PFE pseudosection (0.375 Hz and 3.0 Hz)

(iv) PFE plan map (0.375 Hz and 3.0 Hz)

(v) Raw phase pseudosection (0.125 Hz)

(vi) 3-pt decoupling phase pseudosection (0.125 – 0.375 – 0.625 Hz)

(vii) Cole-Cole diagram

(viii) Phase Spectrum diagram

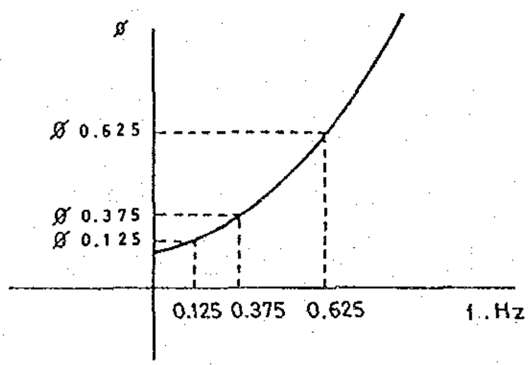
(ix) Magnitude Spectrum Diagram

(x) Interpretation Map

Within these maps, (v) to (ix) are derived only from the SIP method, which are very useful to clarify the nature of the IP anomalous source by examining its spectral response.

3-pt decoupling phase is an approximate phase at DC current calculated by assuming the second order polynomial between frequency and phase using phases at three frequencies, 0.125 Hz, 0.375 Hz and 0.675 Hz. Approximate value, C, is calculated using the following formulae;

$$C = \frac{15}{8}\phi_{0.125} - \frac{10}{8}\phi_{0.375} + \frac{3}{8}\phi_{0.625}$$



(2) Terrain Correction

Terrain correction was made for apparent resistivity sections because the terrain effect due to steep and rugged topography was observed in apparent resistivity values.

To eliminate these terrain effects, the program of the finite elemeht method was applied using the topographical data of each survey line.

(3) Physical Property

The measurement of physical properties of rock samples are usually made to get the resistivity, phase shift, magnitude and spectral response of the rocks distributed in the survey area. But, the measured value does not necessary reflect the observed value in the field survey because the measuring condition is not same as the field.

A total of 25 samples were collected in this survey, namely, 14 pieces inthe survey area and 11 pieces near the open pit of the Mamut mine. A diagram of the measurement is shown in Fig. 30 and the results are presented in Table 5.

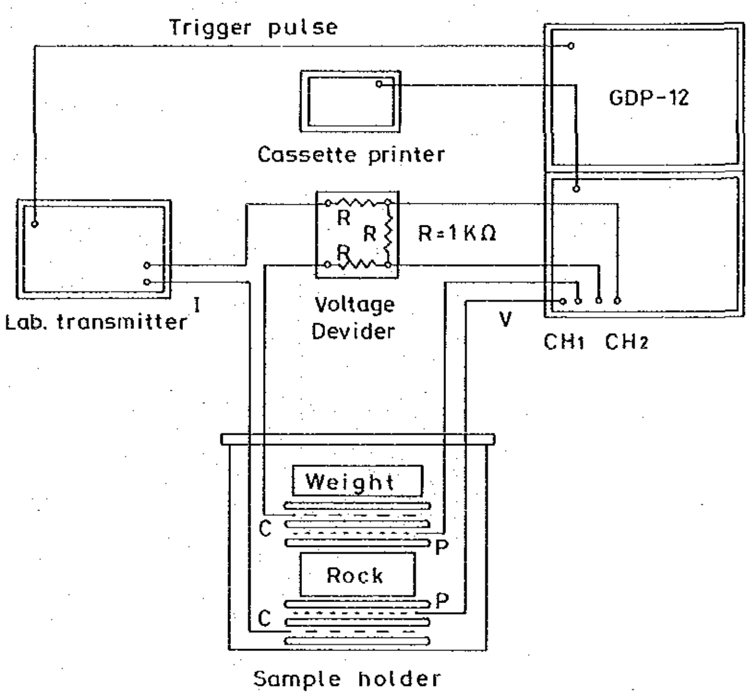


Fig. 30 **Physical Property of Measuring System**

Average resistivities of rock and ore samples are 6,144ohm-m and 9,843ohm-m, respectively. Ore samples show a strong IP effect with large phase-shift.

Rock samples collected in the survey area have an average resistivity of 2,930ohm-m and

Table 5 Physical Property

Location and Sample No.	PFE (%)	ρ (Ωm)	Rock Name
1	0.5	281	Adamellite porphyry
2–1	0.3	7036	Microdiorite
2–2	0.8	140	Microdiorite
3–1	1.3	2387	Microdiorite
3–2	0.9	327	Microdiorite
4	1.0	5147	Hornfels
5	0.1	5195	Quartz vein
6	0.9	8830	Adamellite porphyry
7–1	1.8	35	Pinosuk
7–2	0.7	754	Adamellite porphyry
8	0.7	739	Adamellite porphyry
9	–0.3	7124	Hornfels
10	0.8	4107	Adamellite porphyry
11	0.3	141	Serpentinite (brecciated)
12	15.1	64351	Hornfels
13	6.2	6952	Hornfels
14	14.0	1106	Quartz vein
15	38.5	2114	Quartz vein
16	21.9	8688	Quartz vein
17	12.5	408	Adamellite porphyry
18	2.5	1729	Adamellite porphyry
19	16.1	17212	Hornfels
20	4.6	953	Adamellite porphyry
21	4.0	3130	Adamellite porphyry
22	31.4	1630	Adamellite porphyry

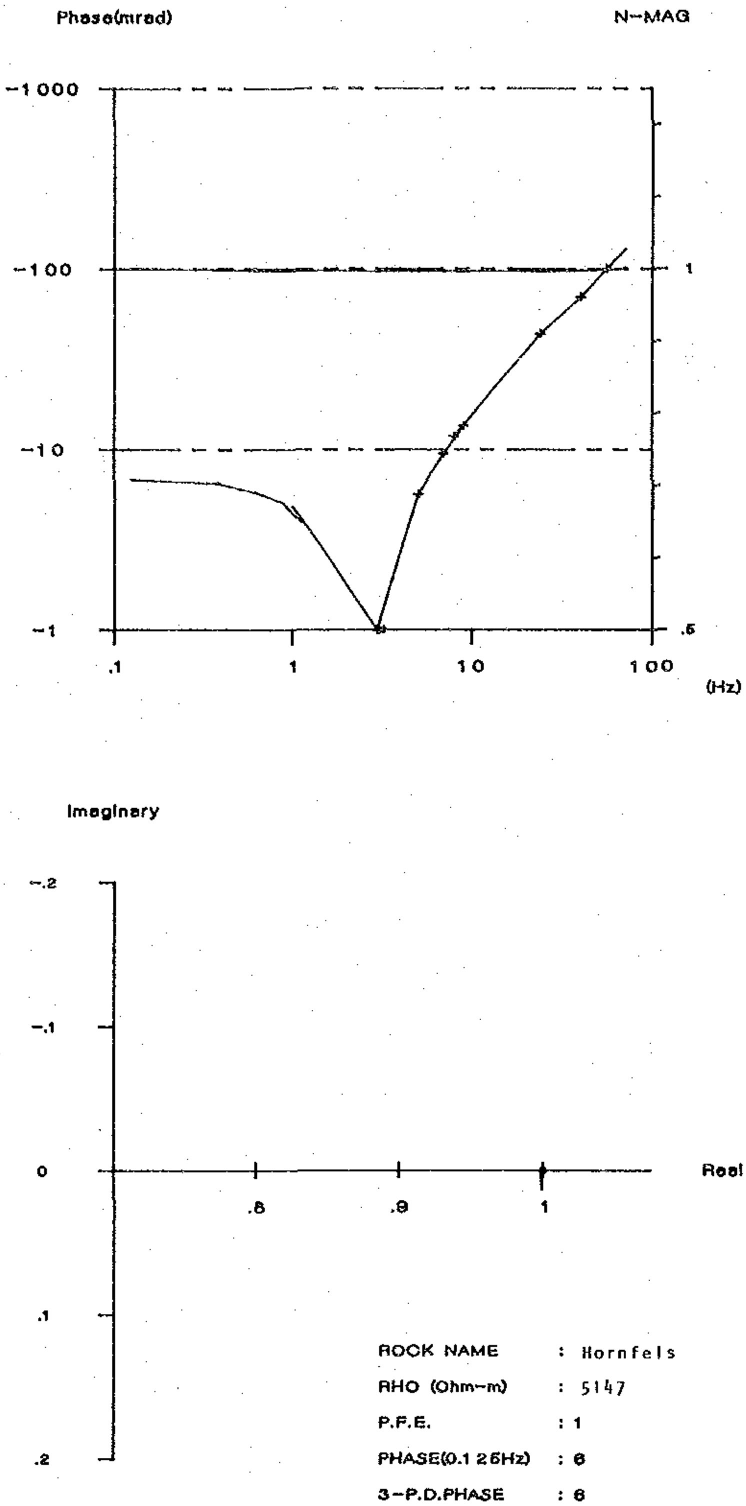
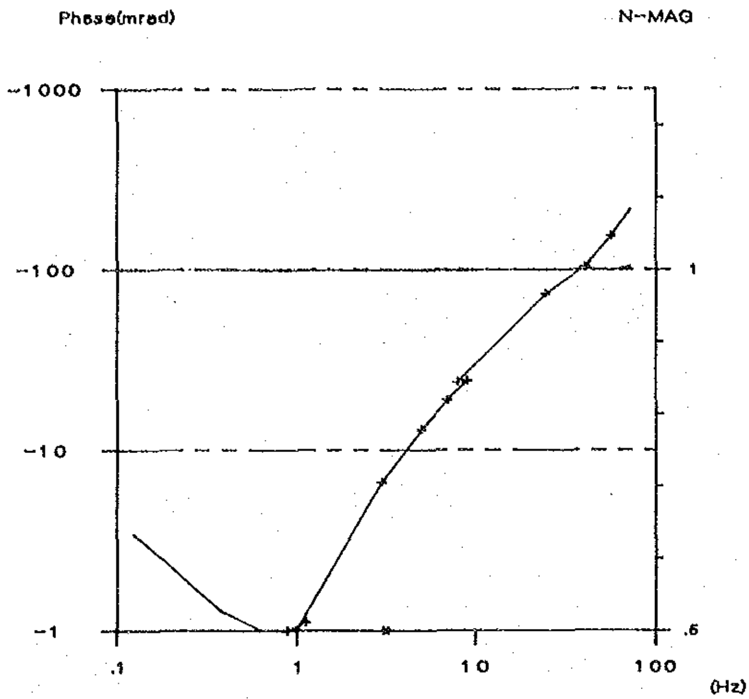


Fig. 31-1 Spectrum for Rock Samples



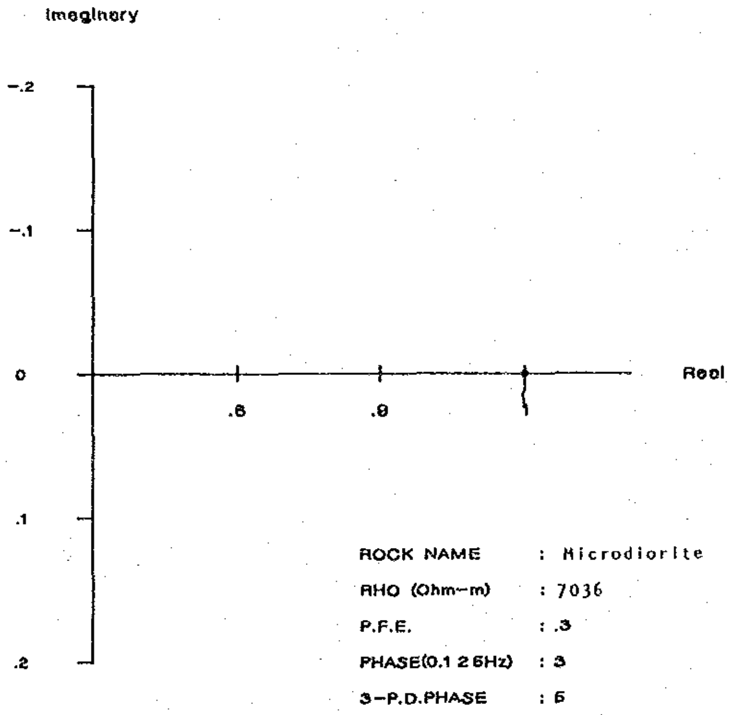
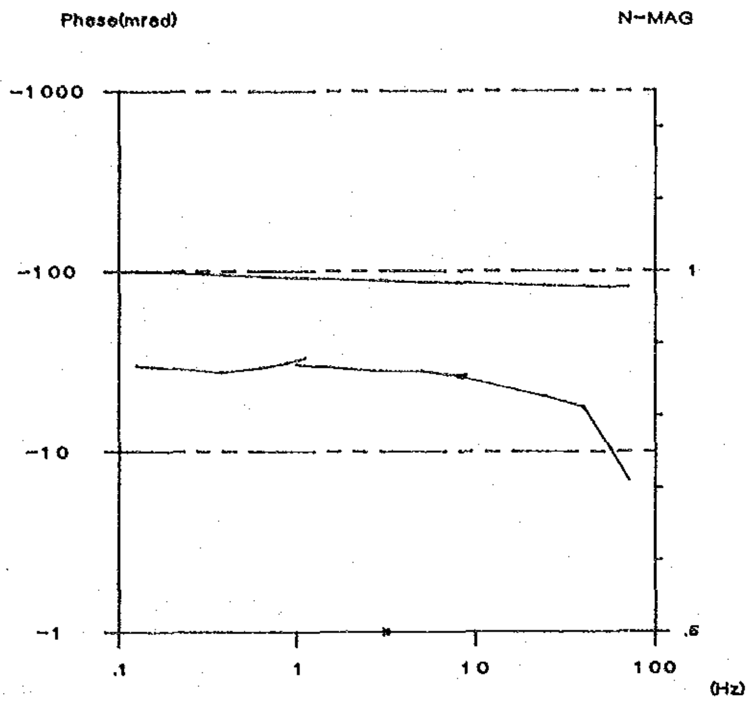
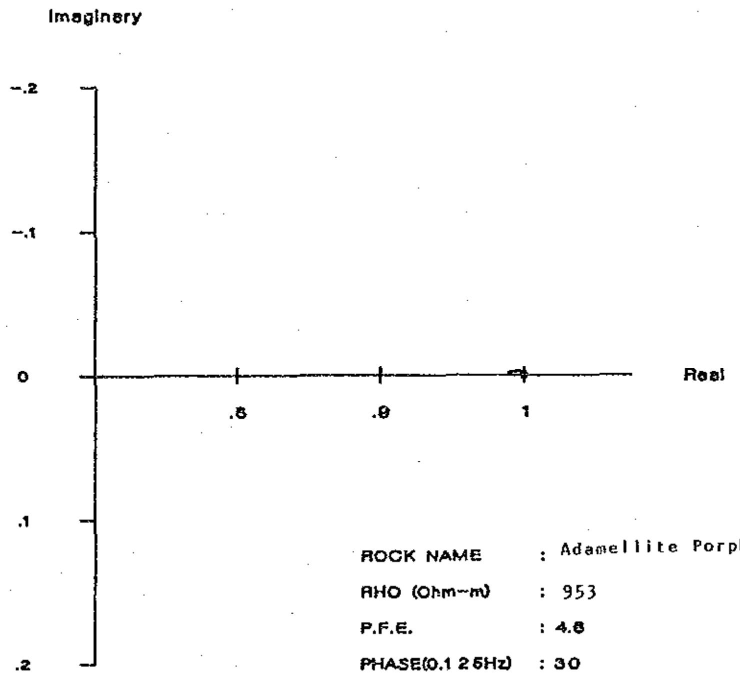


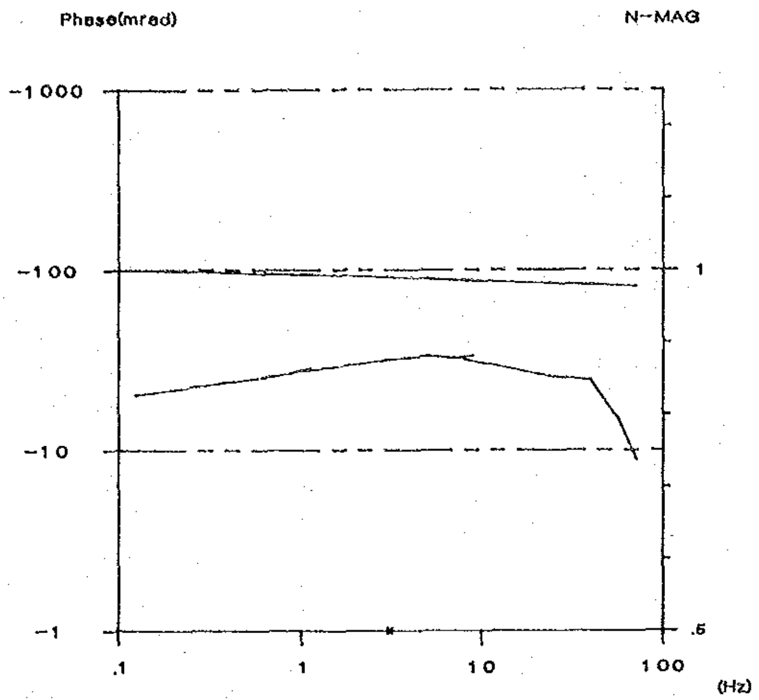
Fig. 31−2 Spectrum for Rock Samples





ROCK NAME : Adamellite Porphyry
RHO (Ohm-m) : 953
P.F.E. : 4.8
PHASE(0.125Hz) : 30
3-P.D.PHASE : 32

Fig. 31–3 Spectrum for Rock Samples



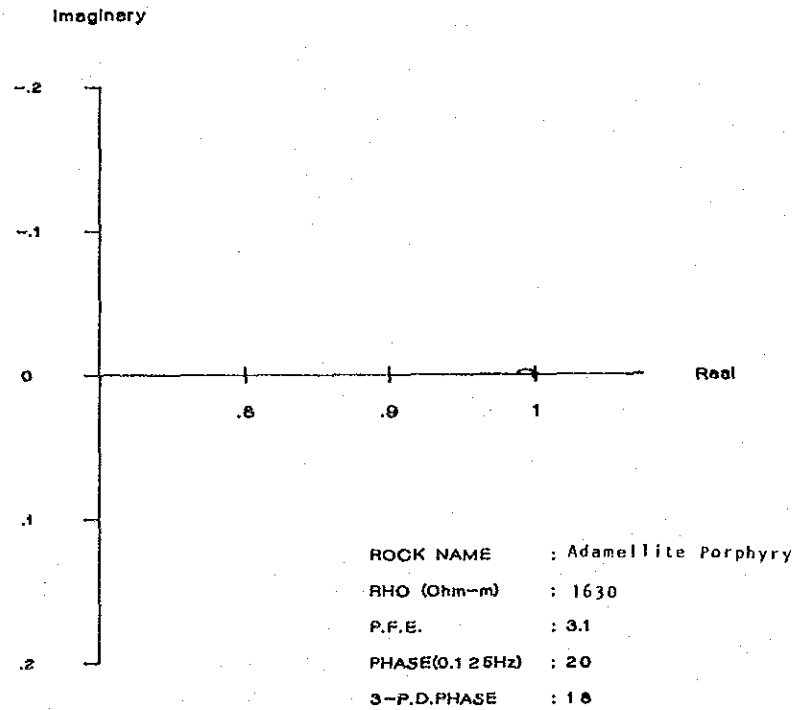


Fig. 31–4 Spectrum for Rock Samples

show a little phase-shift and very weak PFE same as field data.

Two types of phase spectrum were obtained; (1) ore samples with a typical spectral type in which phase in higher frequency range than 11 Hz decreases with frequency, (2) other rock samples with negative coupling phenomenon in the frequency range of higher than 1 Hz, which seems to be an own nature of rock samples collected.

Typical spectral types are chosen and shown in Figs. 31–1 to 31–4.

(4) Model Calculation

Model calculation was made for five SIP survey lines, B, D, E, F and H, until a satisfactory fit between the observed and calculated data is arrived, taking into consideration of the results of physical property measurement, geology and drilling survey.

In this survey, no remarkable IP anomaly was obtained so that model calculation was made mainly for resistivity structure. The following are the results of the interpretation for the best fit model. The results of the model calculation are given in Figures 32–1 to 32–5.

Line B

Model structure is given as follows:

(i) Code-1; 200ohm-m and PFE of 1.0%. High resistivity rock, locating near ground surface at 300E and extending to the depth of 200E with east-dip.

(ii) Code-2; 20ohm-m and PFE of 1.0%. Low resistivity layer near ground surface.

(iii) Code-3; 60ohm-m and PFE of 0.5%.

The resistivity distribution due to this model gives a good fit to the observed data except for the shallower part between 200E and 400E. A little difference will be corrected if a thin and moderate layer is located at the shallower part between 200E and 300E, adjacent to a low resistivity block (Code-2).

On the other hand, as no remarkable PFE anomalies were obtained in this line except for local PFE values of more than 2.0%, PFE was assumed to be 1.0%. Therefore, PFE values of less than 1.0%, "background", are widely distributed on the PFE pseudosection except for 1.0% PFE in the depth of 100E.

Line D

Model structure is as follows;

(i) Code-1; 300ohm-m and 3.0% PFE. Dyke model to explain high resistivity and 1.0% to 2.0% PFE between 300W and 300E.

(ii) Code-2; 20ohm-m and 0.5% PFE. Plate model from surface to 80 m depth below between 200W and 200E, and between 500E and 700E.

(iii) Code-3; 50ohm-m and 0.5% PFE.

Contour feature of resistivity of more than 40ohm-m and PFE of less than 1.5% almost fits with the observed pattern, which are located at the depth between 200E and 400E with west-dip.

But PFE indication of less than 3.0% at n = 3 to 5 of 200E – 400E could not be detected because no model was settled below 400E. If a dyke model with resistivity of 50ohm-m and 4.0% PFE is settled at depth of 100 m below 400E, it is expected to get a good fit.

Code-1 is corresponded to intrusive rocks of adamellite porphyry and peridotite, and Code-2 to the Pinosuk Formation and sandstone. Code-2 corresponding to the Pinosuk Formation is distributed more widely than that of line B.

Line E

In this line, Code-1 and Code-2 used for Line D are also adopted, but Code-3 is changed to resistivity of 70ohm-m and 1.5% PFE. And Code-4 with 70ohm-m and 4.0% PFE below 300E is added to explain an IP anomaly with PFE of less than 3.5% near the surface at 400W.

A good fit for resistivity feature was obtained at the east portion from 500W. If a layer with moderate resistivity is settled near Code-2 block, better fit will be given.

The result to explain an IP anomaly with a width of 200 m at 400W could not be obtained because FE value of Code-4 corresponding to anomalous source is low and a disseminated source is not assumed near an anomalous source. But contour feature suggesting a center of IP anomaly could be obtained.

Line F

Code-1 (300ohm-m and 5.0% PFE) was settled to explain a deep anomaly with high resistivity and PFE of less than 2.5% below 200W. And Code-2 (300ohm-m and 0.5% PFE) was assumed to be as block-shape models between 100W and 400W, and between 200E and 700E, to explain the low resistivity anomalies with east-dip in the depth between 400E and 600E, and between 100W and 300W, respectively.

As a result, it is thought that a depth of the actual high-resistivity rocks is shallower than the model, and that a disseminated anomalous source has PFE of more than 5%,

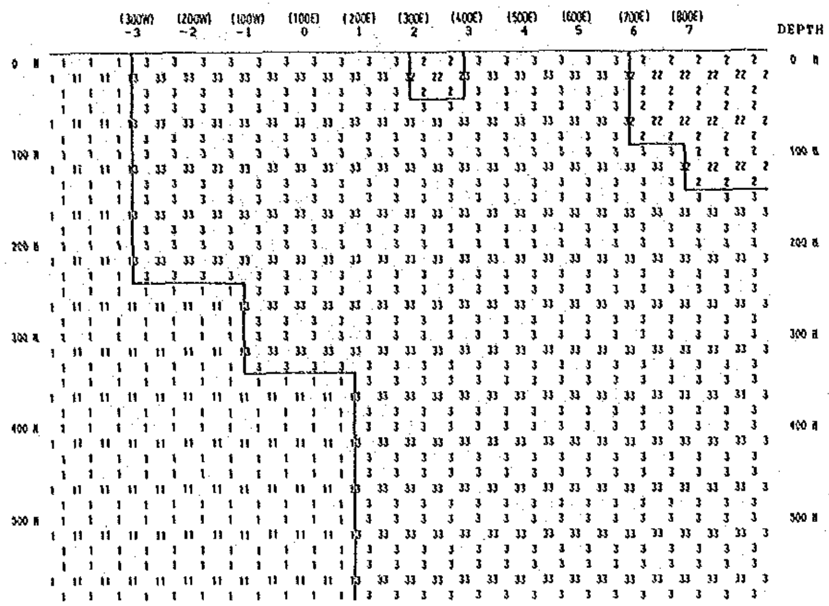
High resistivity rocks and low resistivity rocks are distributed deeply and more widely, respectively, than those of the above-mentioned survey lines.

Line H

Code-1 (200ohm-m and 3.0% PFE) was assumed as dyke model below 300E – 400E to explain high resistivity anomaly of more than 100ohm-m and low PFE of less than 1.5% with east-dip from the surface of 300E. Code-1 was also adopted at the western part of 100E where contour feature of resistivity of higher than 100ohm-m and PFE of more than 1.5% with east-

LINE–B

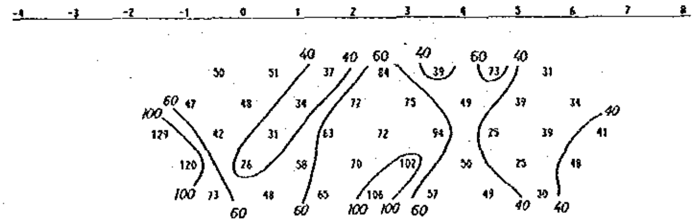
** SIMULATED MODEL BY CODE NUMBER **



SURVEY AREA: SAB	SURVEY LINE: LINE-B								
CODE NUMBER	1	2	3	4	5	6	7	8	9
RESISTIVITY(OHM-M)	200	20	60	0	0	0	0	0	0
FREQUENCY EFFECT(%)	1.0	1.0	.5	0.0	0.0	0.0	0.0	0.0	0.0

SURVEY AREA:SAB SURVEY LINE:B

** RESISTIVITY(OHM-M) **



** FREQUENCY EFFECT(%) **

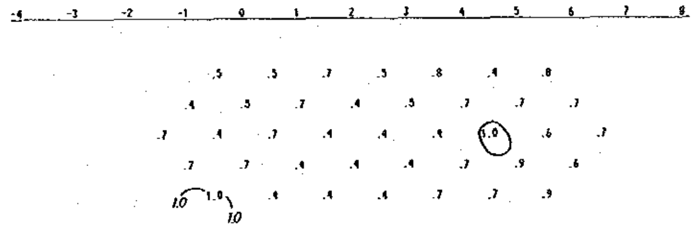
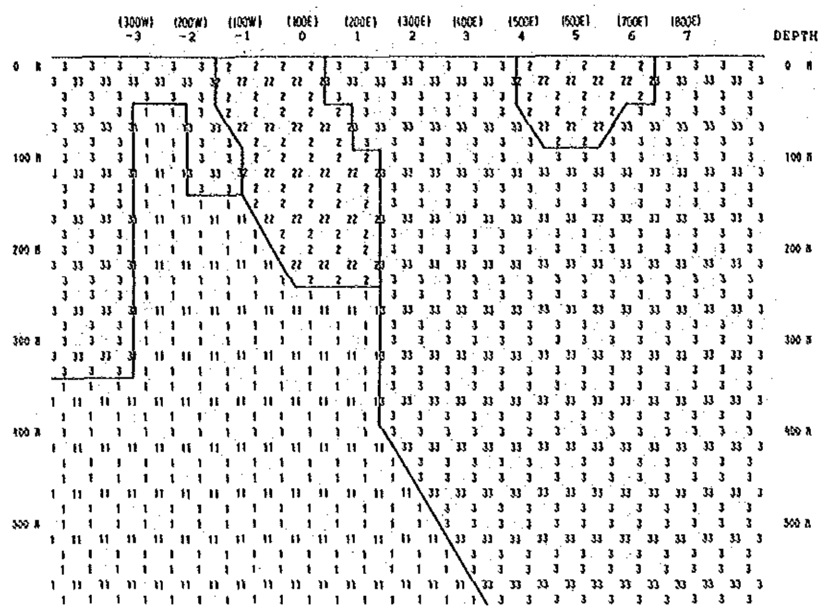


Fig. 32–1 2-D Model Calculation

** SIMULATED MODEL BY CODE NUMBER **

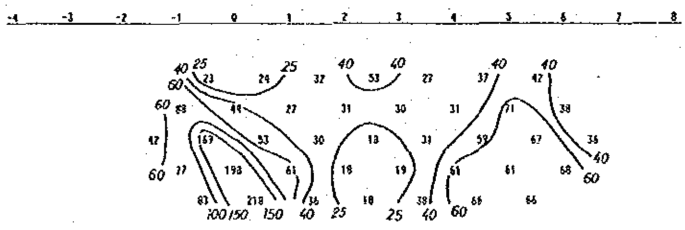


SURVEY AREA: SAB SURVEY LINE: LINE-D

CODE NUMBER	1	2	3	4	5	6	7	8	9
RESISTIVITY(OHM-M)	300	20	50	0	0	0	0	0	0
FREQUENCY EFFECT(%)	3.0	.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0

SURVEY AREA:SAB SURVEY LINE:D

** RESISTIVITY(OHM-M) **



** FREQUENCY EFFECT(%) **

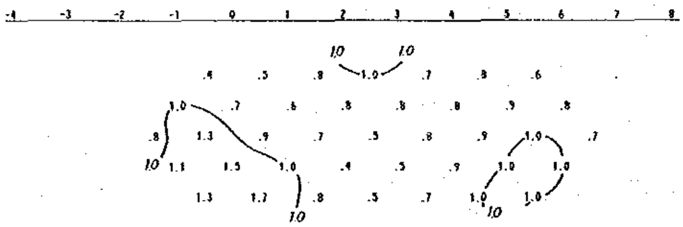
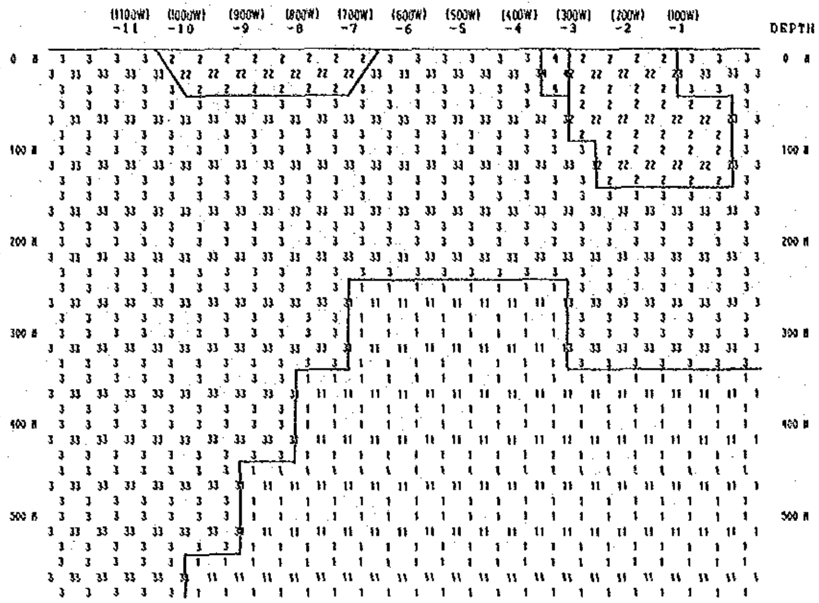


Fig. 32–2 2-D Model Calculation

LINE-SE

** SIMULATED MODEL BY CODE NUMBER **

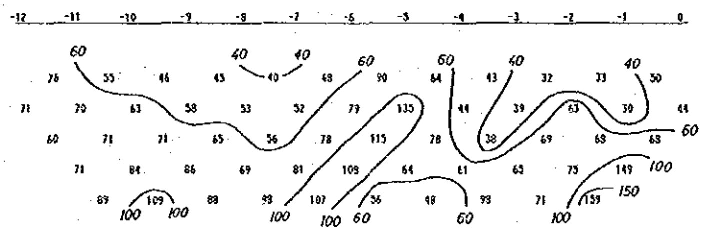


SURVEY AREA: SAB SURVEY LINE: LINE-Z

CODE NUMBER	1	2	3	4	5	6	7	8	9
RESISTIVITY(OHM-M)	300	20	70	70	0	0	0	0	0
FREQUENCY EFFECT(%)	4.0	.5	1.5	4.0	0.0	0.0	0.0	0.0	0.0

SURVEY AREA:SAB SURVEY LINE:Z

** RESISTIVITY(OHM-M) **



** FREQUENCY EFFECT(%) **

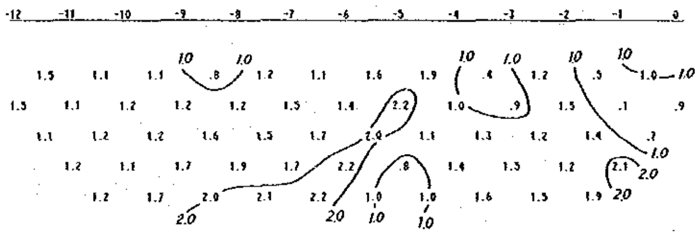
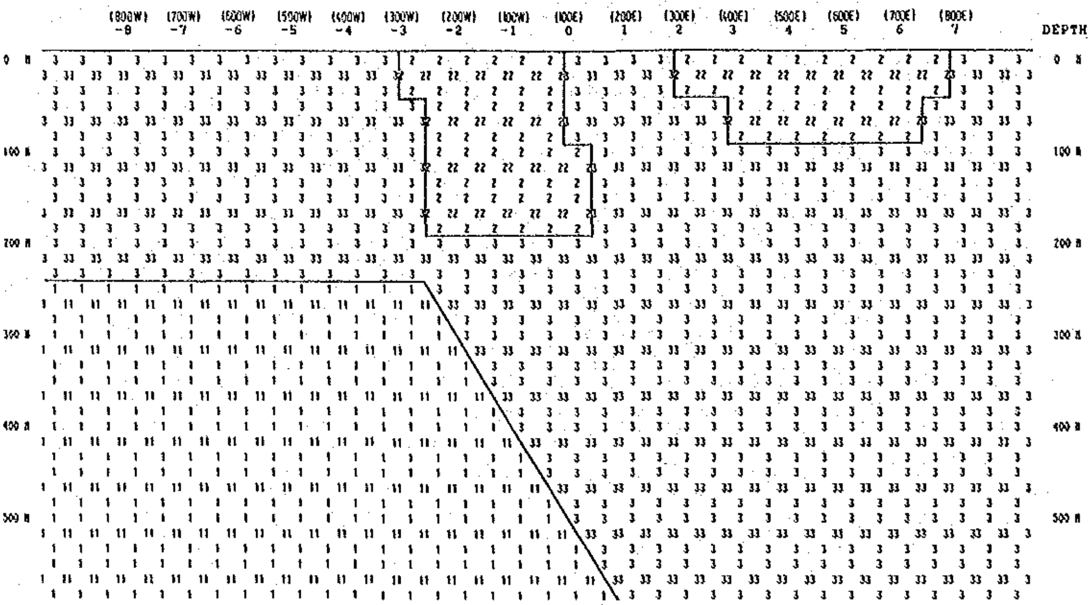


Fig. 32–3 2-D Model Calculation

LINE-F

** SIMULATED MODEL BY CODE NUMBER **

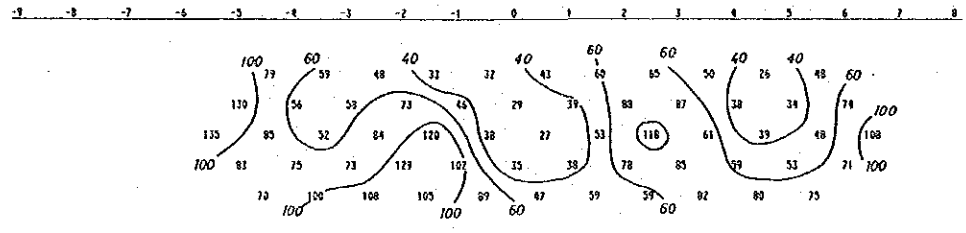


SURVEY AREA: SAB   SURVEY LINE: LINE-F

CODE NUMBER	1	2	3	4	5	6	7	8	9
RESISTIVITY(OHM-M)	300	30	80	0	0	0	0	0	0
FREQUENCY EFFECT(%)	5.0	.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0

SURVEY AREA:SAB   SURVEY LINE:F

** RESISTIVITY(OHM-M) **



** FREQUENCY EFFECT(%) **

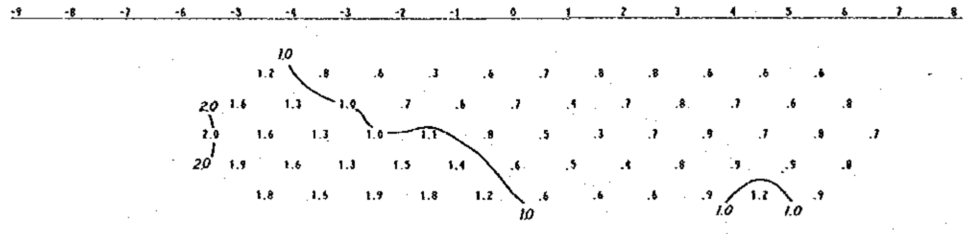
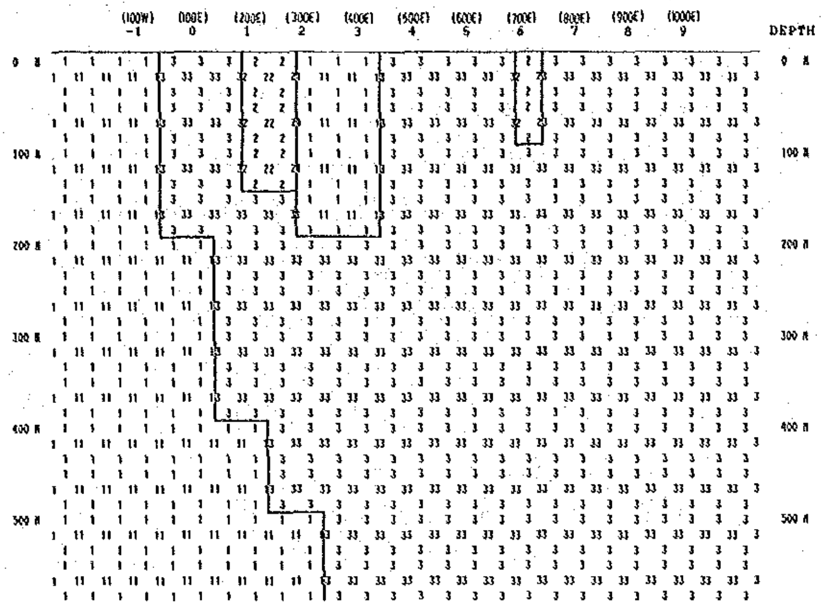


Fig. 32–4 2-D Model Calculation

LINE-H

** SIMULATED MODEL BY CODE NUMBER **

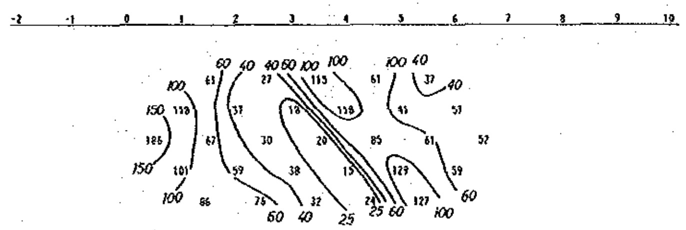


SURVEY AREA: SAB SURVEY LINE: LINE-H

CODE NUMBER	1	2	3	4	5	6	7	8	9
RESISTIVITY(OHM-M)	200	20	60	0	0	0	0	0	0
FREQUENCY EFFECT(%)	3.0	.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0

SURVEY AREA:SAB SURVEY LINE:H

** RESISTIVITY(OHM-M) **



** FREQUENCY EFFECT(%) **

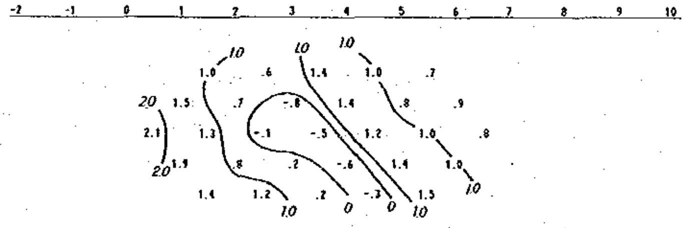


Fig. 32–5 2-D Model Calculation

dip was observed. Code-2 (20ohm-m and 0.5%) was settled between 200E and 300E to explain low resistivity pattern of less than 40ohm-m with east-dip at 300E – 400E. Code-3 (60ohm-m and 1.0% PFE) was adopted as "background".

Good fit is obtained between the observed and the calculated. However, distribution area of negative PFE of the calculated at n = 2 to 5 of 300E – 400E is larger than that of the observed. This calculated negative anomaly seems to be mainly due to high resistivity contrast, so if resistivity of Code-2 is set to about 40ohm-m, the negative anomaly will be distributed more narrowly.

2–2–3 **Results of Survey**

(1) Pseudosections (Fig. 33 – Fig. 36)

IP and SIP were carried out on eight survey lines: IP on lines A, C, E and G, and SIP on lines B, D, F and H respectively.

Apparent resistivity on each line range from 20 to 190ohm-m with a strong constrast on lines A–D without any dominant resistivity contrast.

Frequency effect is generally small and almost background values of less than 1% were detected over the central to eastern part of the survey area except in the western end of lines E and F. It is inferred that no promising sulphide exist in the mentioned area of very small PFE.

Line-A

Apparent resistivity values range from 260 to 190ohm-m, with a low resistivity less than 60ohm-m distribute widely in the east of station 200W and a higher resistivity are seen between stations 300E and 500E, as well as in the western side from the depth at station 100E. Judging from the distribution of apparent resistivity, conductive overburden exist between 100E – 200E, and between 300E – 400E. A thick conductive layer is distributed in the east of station 500E.

Most of the FE values show less than 1% except in the depths (n = 5) between 200W and 100W where more than 2% of FE were detected, suggesting that the source must be small as the anomaly is not detected in the adjoining lines.

Line-B

This line was measured by SIP method. The apparent resistivity range from 23 to 143 ohm-m and the patern of distribution resembles that of Line A. Resistivity higher than 60ohm-m are seen between stations 300E – 500E at the depth at n = 2 – 5 and in the western side of station 100E. Low resistivities less than 40ohm-m are widely detected in the east of station 500E, and spotly seen in the following areas;

100W – 100E, n = 1

200E, n = 2 – 3

400E – 500E, n = 1

Both raw-phase and 3-pt decoupling phase show less than –10 mrad and PFE detected on this line are almost same as Line A, which suggest that no sulphide mineralization are expected on this line.

Line-C

Compared with lines A and B, this line exhibited a strong apparent resistivity contrast showing several anomalies. High resistivities more than 60 ohm-m are seen in the west of station 300E, while resistivities less than 40 ohm-m are dominantly seen in the east of 500E.

In the shallow part of 300E and 500E, a block model with a resistivity of more than 60 ohm-m is assumed, and in the east of 500E, a thick and conductive model with less than 40 ohm-m is interpreted.

No IP anomalous source could be expected here towards north since PFE values are less than 1% as detected on lines A and B.

Line-D

Resistivity pattern of this line looks like that of lines A and B. A high resistivity zone of more than 100 ohm-m extends from the surface of 200W – 100W easterly dipping to the depth of 200E – 300E. Apparent resistivities from 40 to 100 ohm-m are seen between 500E – 700E and in the west of 200E.

Raw phase values are the same as Line B showing –10 mrad, however some anomalies caused by a negative coupling are seen between 300E and 500E with a maximum phase of 37 mrad at 0.125 Hz. A couple of positive and negative PFE anomalies were detected at the depth between 200E and 500E, showing 2.0 to 3.0% of positive and –5.4% of negative anomalies. Such kind of anomalies are sometimes seen near a conductive orebody, however no promising anomaies were detected around here.

Lien-E

This line was run by SIP method, extending the line by 500 m towards west as a FE anomaly of more than 2% was detected at the end of the line.

A general boundary of resistivity is seen around 200W with more than 60 ohm-m in the west and less than 60 ohm-m widely in the east.

A high resistivity of more than 100 ohm-m is seen between 400W – 500W westerly dipping to the depth of 600W and accompanied by FE anomalies higher than 3%. An assumed anomalous source is supposed to exist near the surface around 500W slightly dipping to the west. Maximum values of Raw Phase and 3-pt decoupling phase (–15 to –20 mrad at 0.125 Hz) were detected between 400W and 600W.

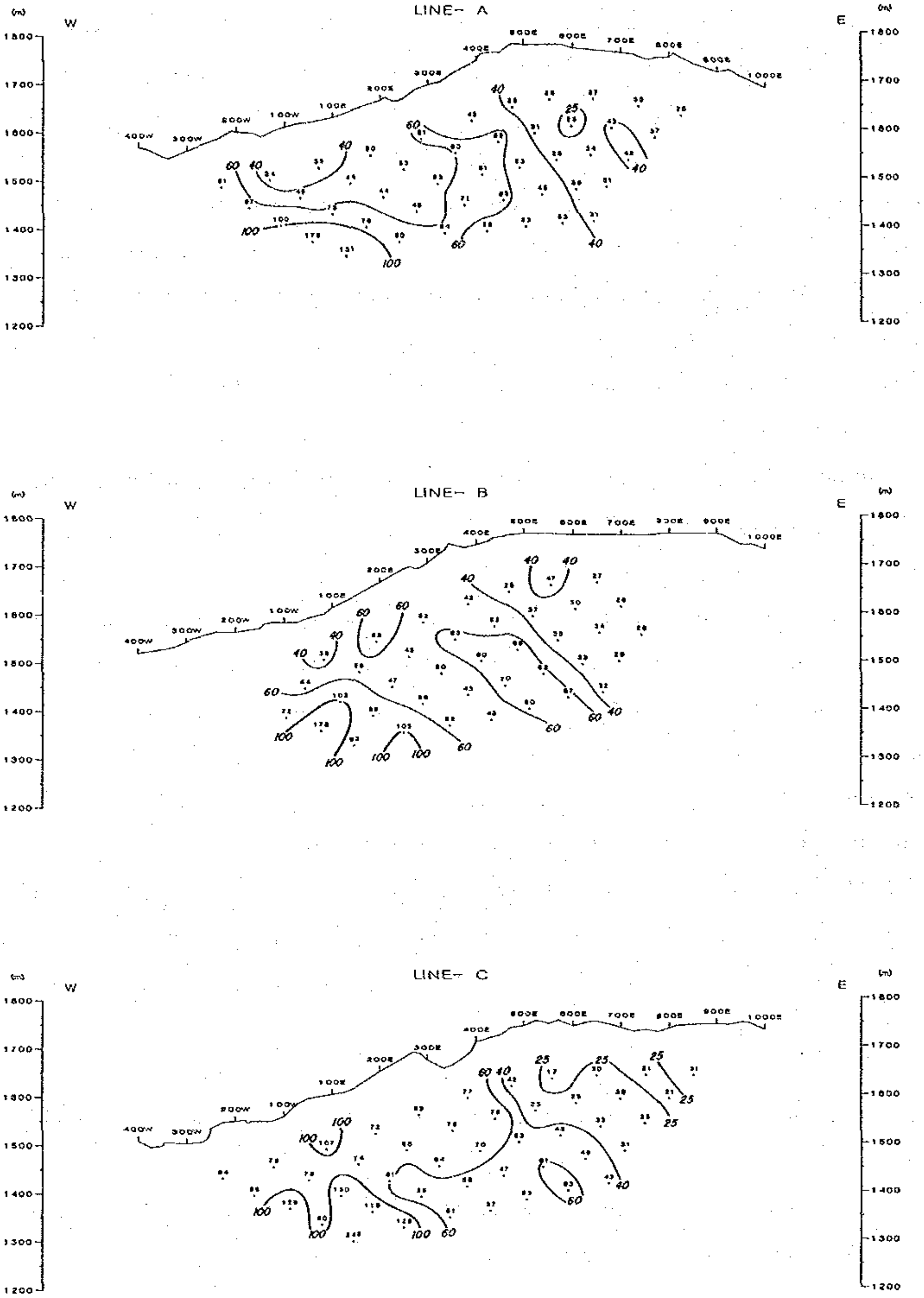


Fig. 33–1 Apparent Resistivity Pseudosection

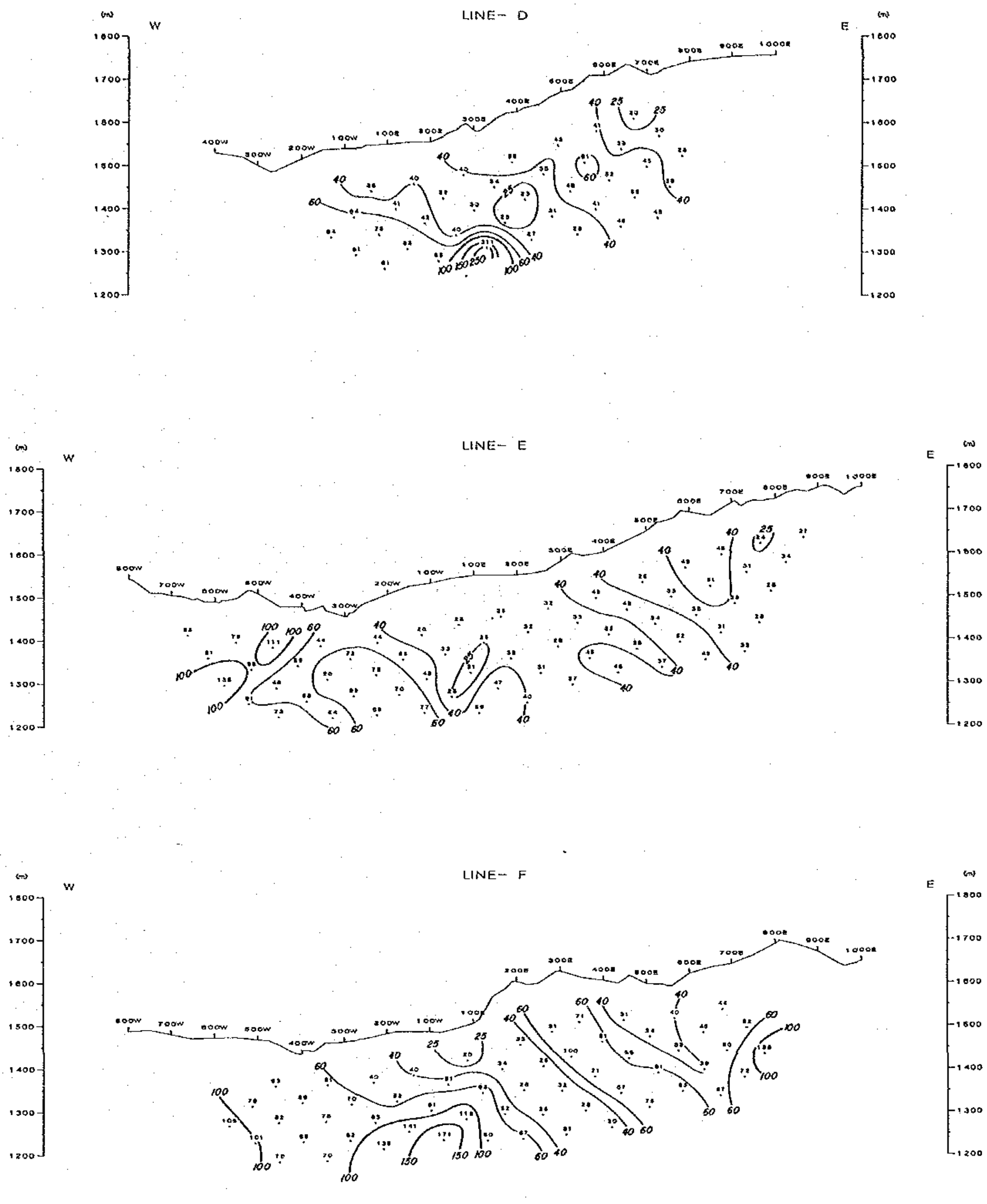


Fig. 33-2 Apparent Resistivity Pseudosection

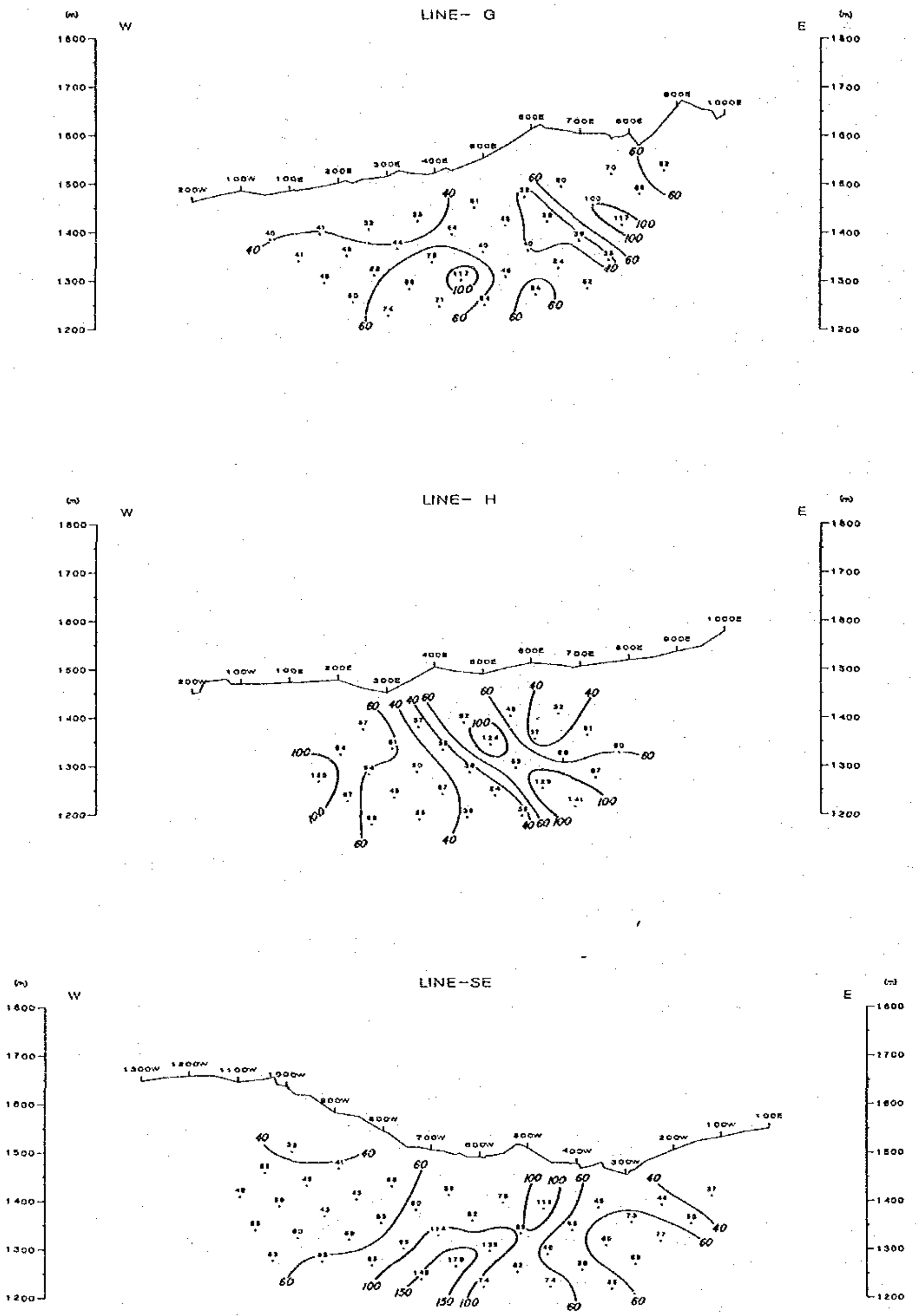


Fig. 33–3 Apparent Resistivity Pseudosection

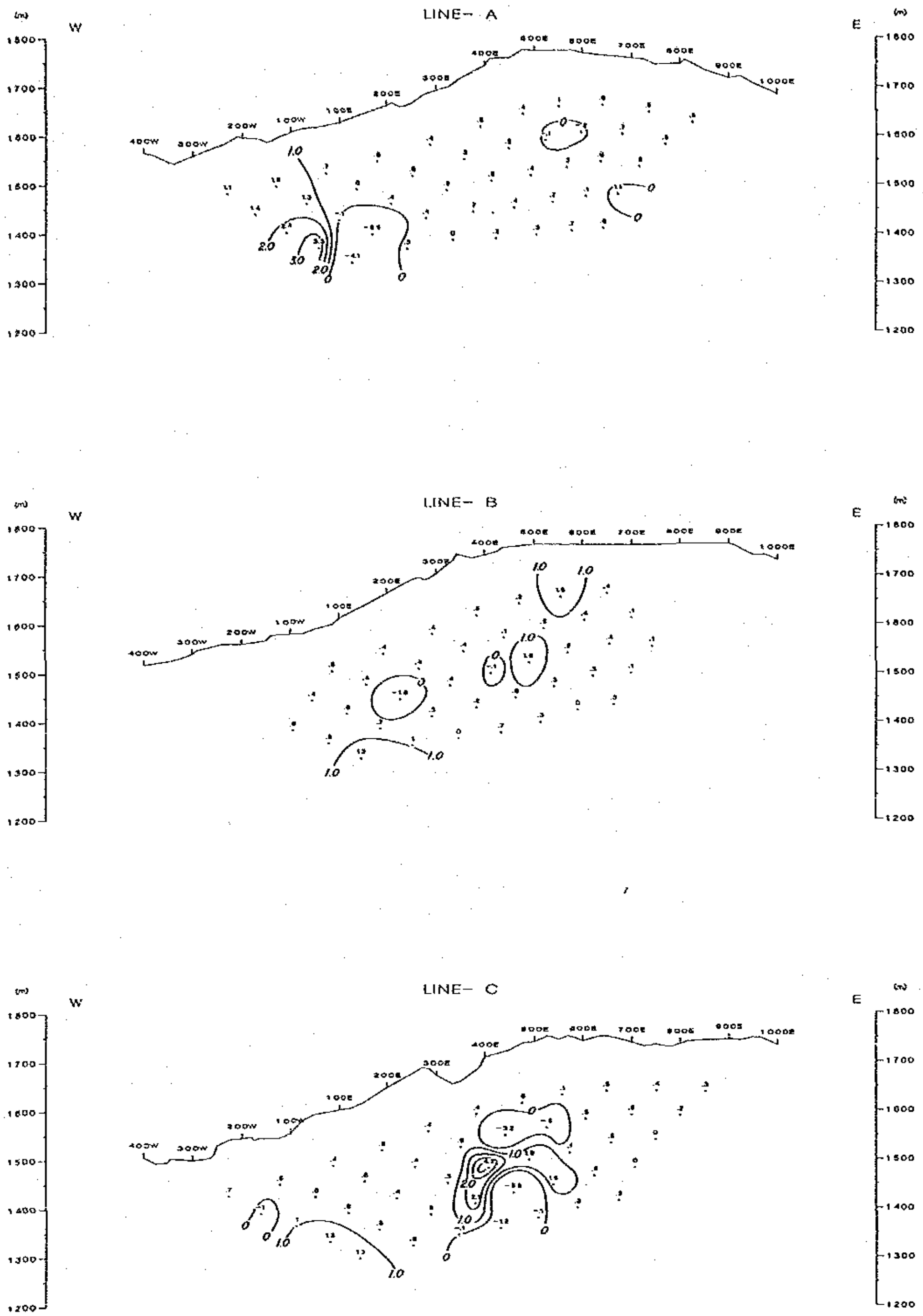


Fig. 34–1 PFE Pseudosection

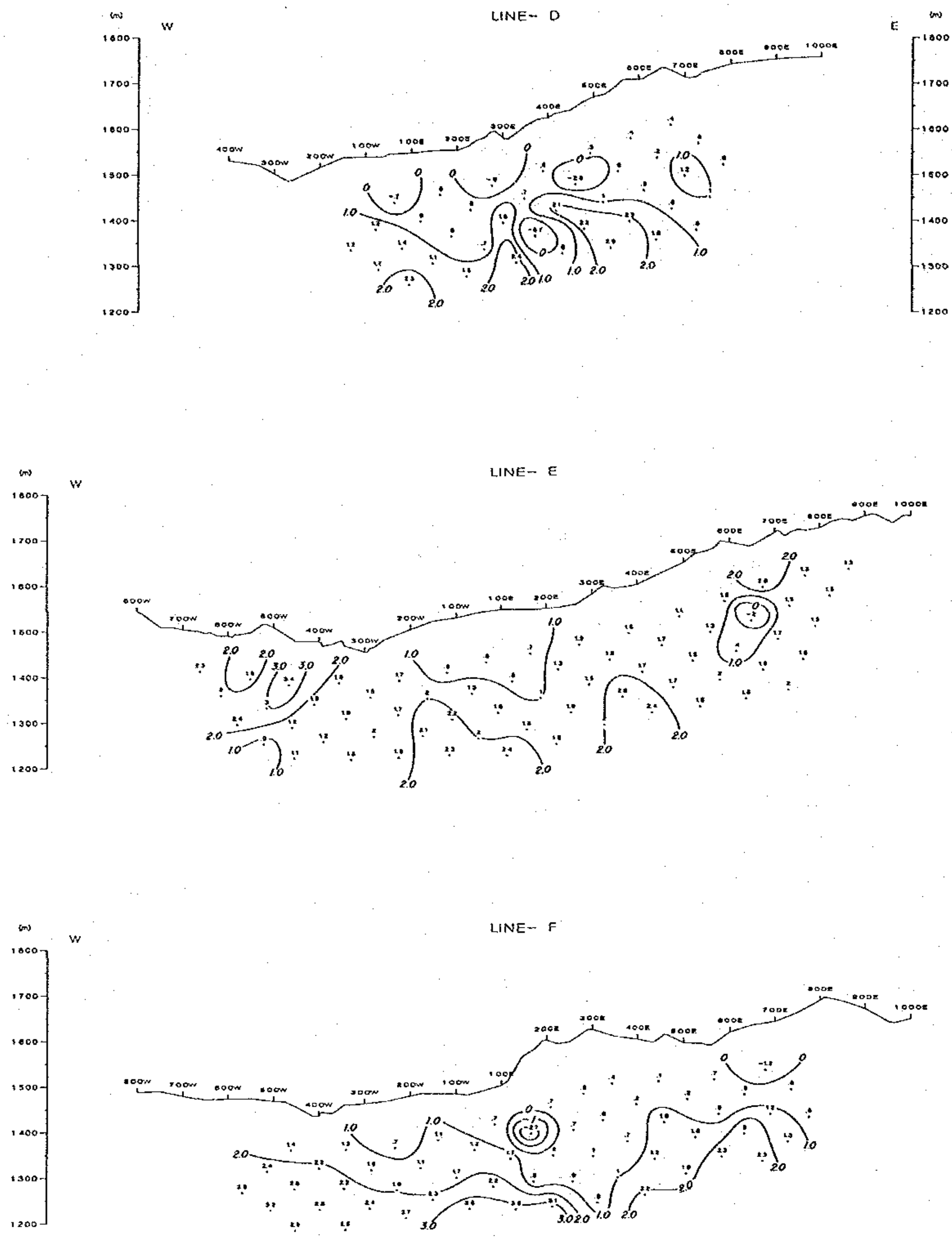


Fig. 34–2 PFE Pseudosection

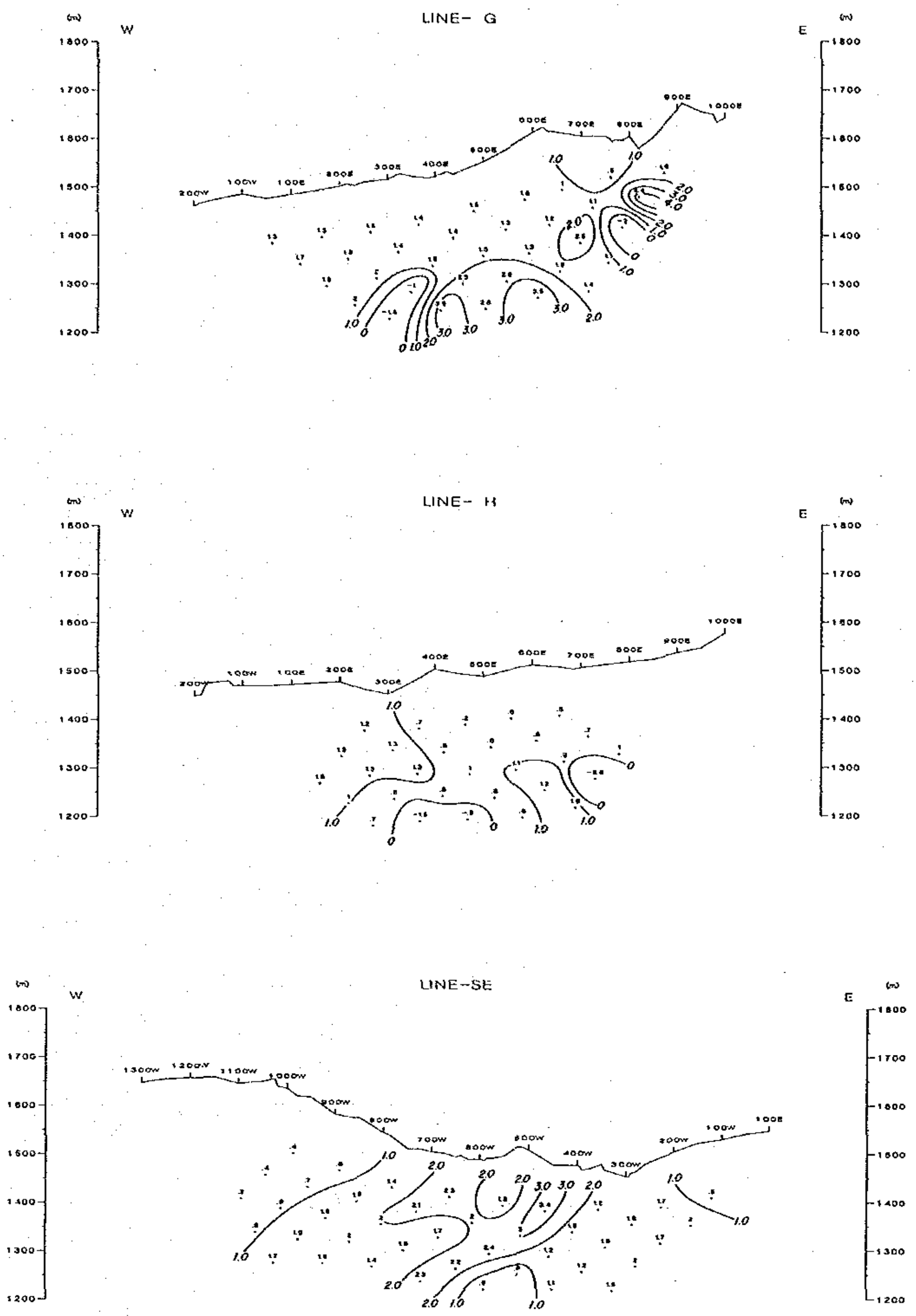


Fig. 34–3 PFE Pseudosection

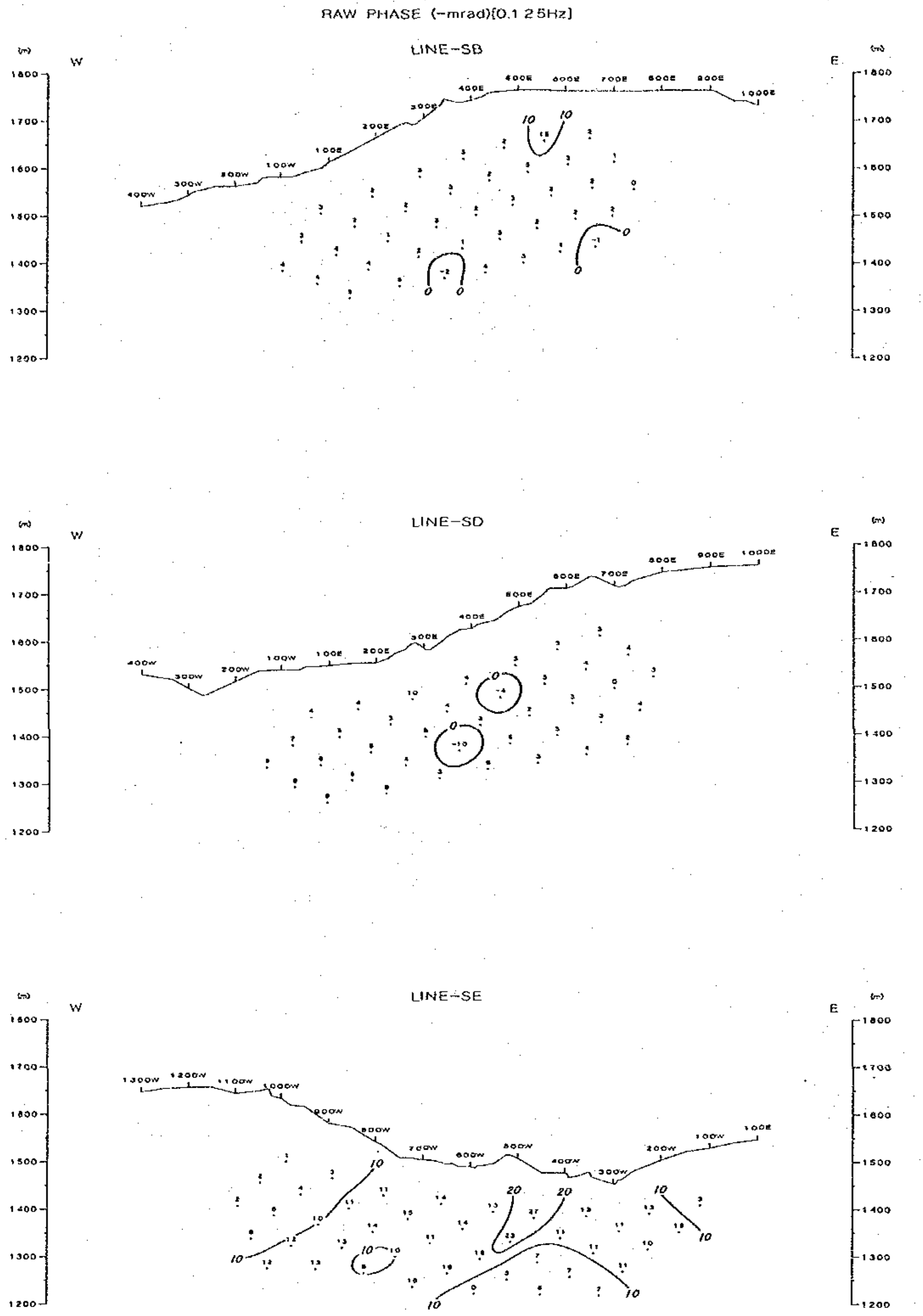


Fig. 35−1 Phase Pseudosection

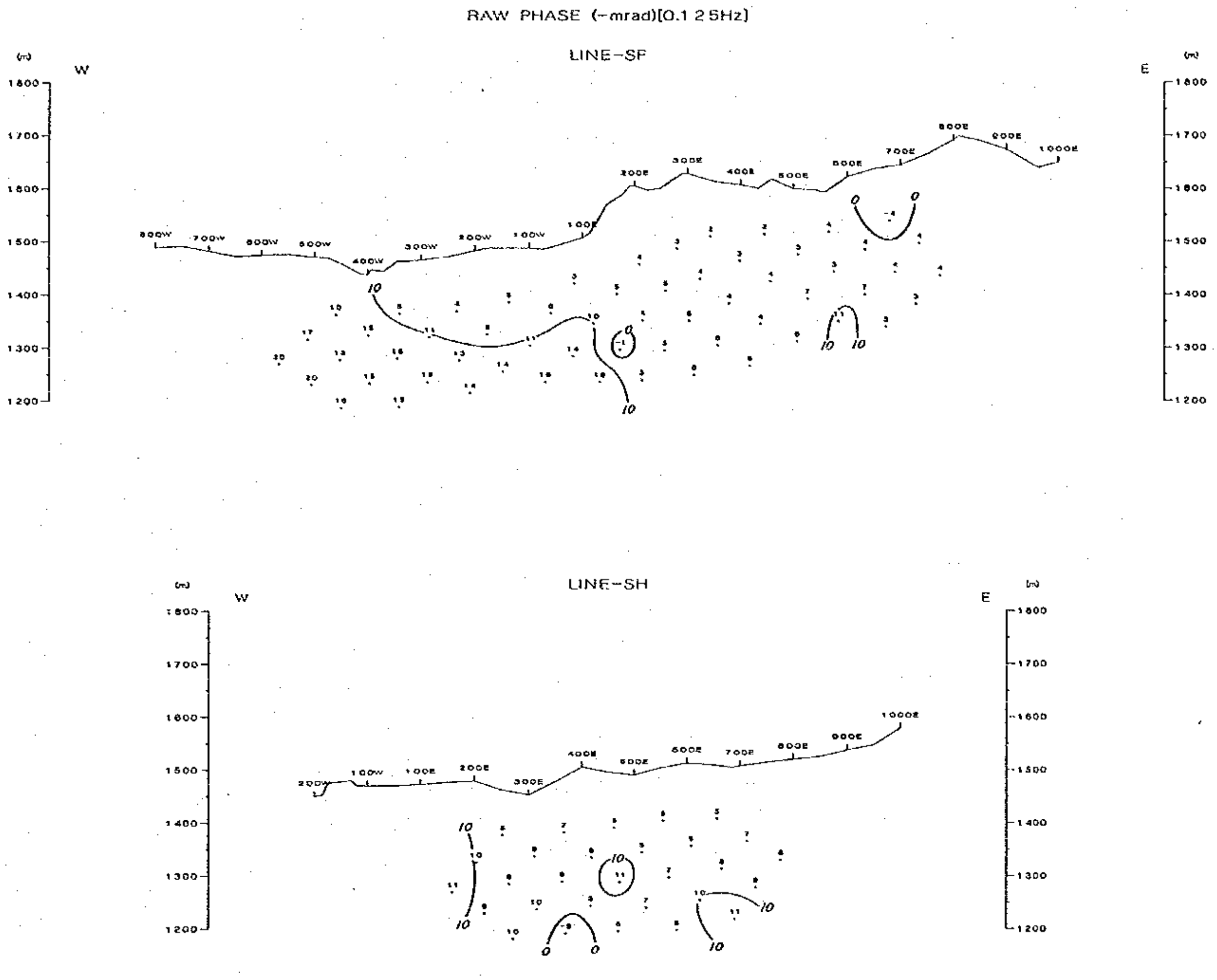


Fig. 35–2 Phase Pseudosection

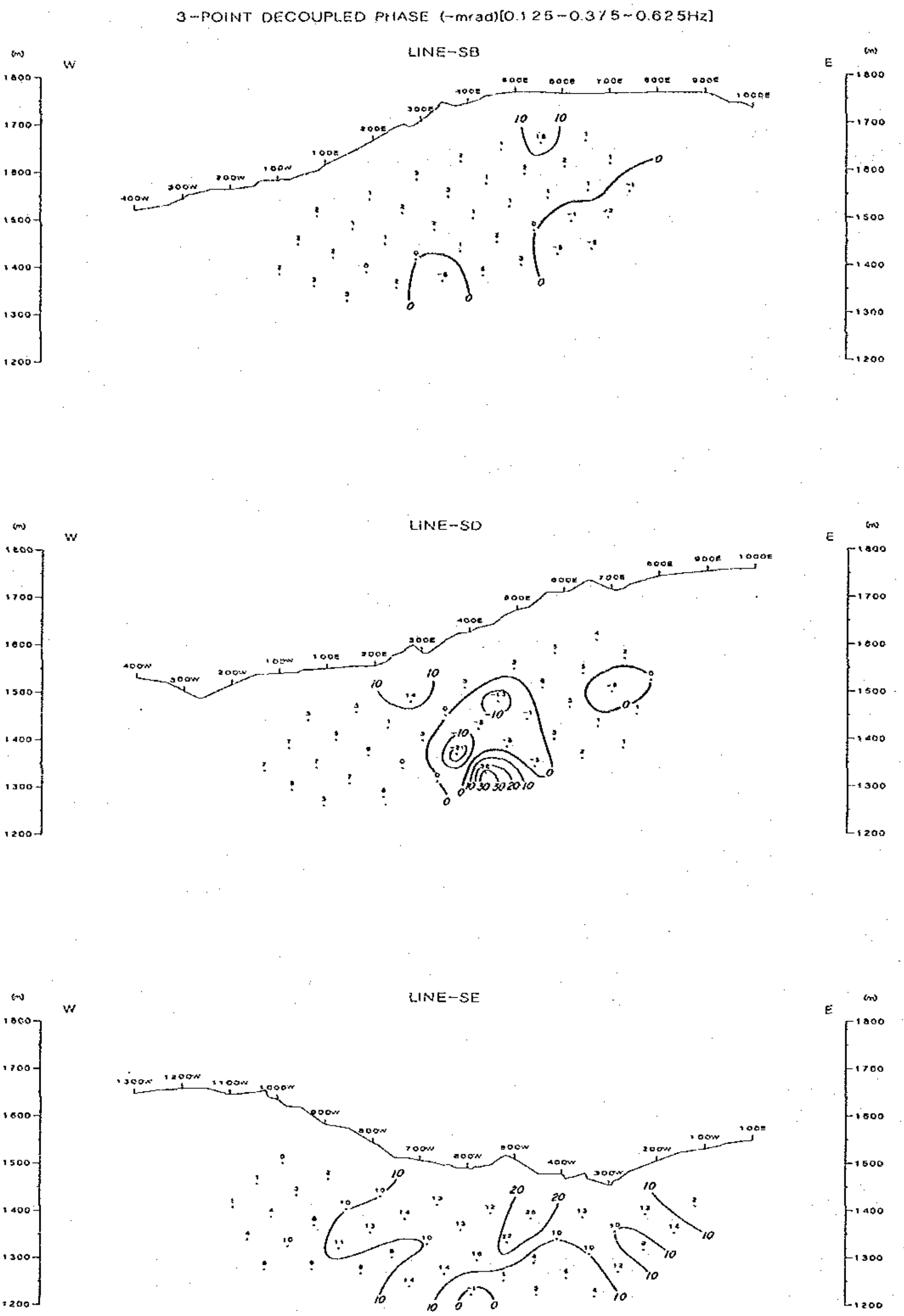


Fig. 36−1 3-pt Decoupled Phase Pseudosection

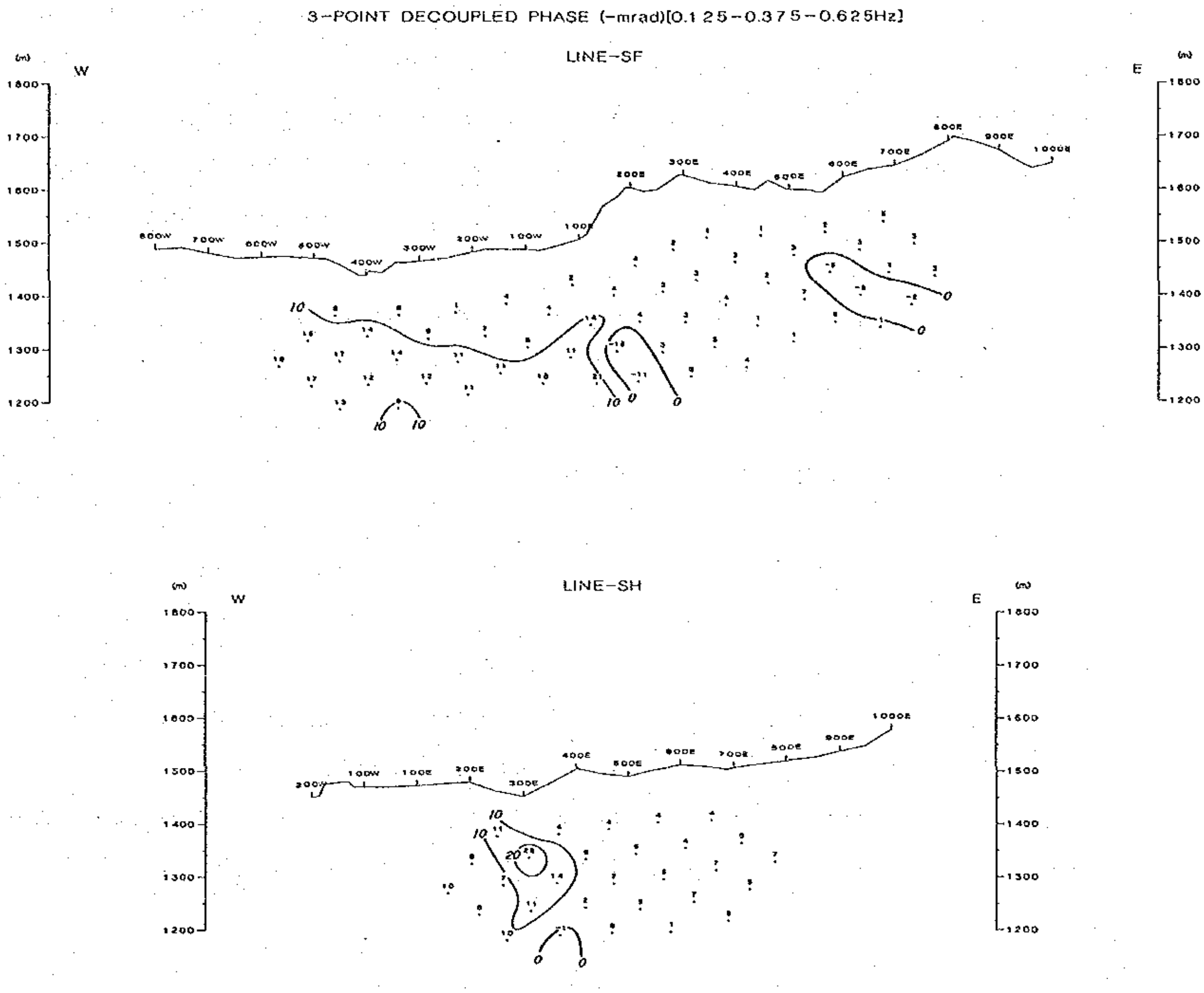


Fig. 36−2 3-pt Decoupled Phase Pseudosection

In the area between 300W and 700W, an anomalous pattern of 2.0 to 3.0% suggest the disseminated source and more than 3% vein or network sources.

Line-F

An apparent resistivity of less than 60ohm-m is detected in 300W – 400E and 400E – 600E. The former is distributed dipping toward east and the latter vertically. There are two patterns of resistivity more than 100ohm-m, one is seen in 300E – 400E dipping east and at the depth of 300W – 200W. Two patterns suggest the existance of a resistive rock around 100E – 200E accompanied by a conductive formation with resistivities less than 30ohm-m.

Phase more than –10mrad are seen from 500W toward west to the depth of 100W dipping east, showing a tendency to increase toward west.

As same as phase, PFE more than 2% are detected in the west of 300W. It is inferred that this anomalous pattern may be caused by an anomalous source existing in the west of this line.

It is difficult to identify whether 2% FE detected in the depth at 600E is caused by a continuous source from Line E or by an independent one.

Line-G

On the shallower part in the west of 600E, low resistivity less than 40ohm-m were detected. Around 600E – 800E, apparent resistivities ranging from 60 to 138ohm-m are distributed to the depth of 500E with west dipping, and a low resistivity of less than 30ohm-m were detected on either side of the zone with resistivity of 60ohm-m. Judging from this resistivity patern, it is considered that high and low resistivity blocks are alternatively distributed on this line.

PFE are slightly higher than the others although they are generally less than 2%, however, more than 2% were detected at the depth of 400E – 500E accompanied by negative values on either side.

Line-H

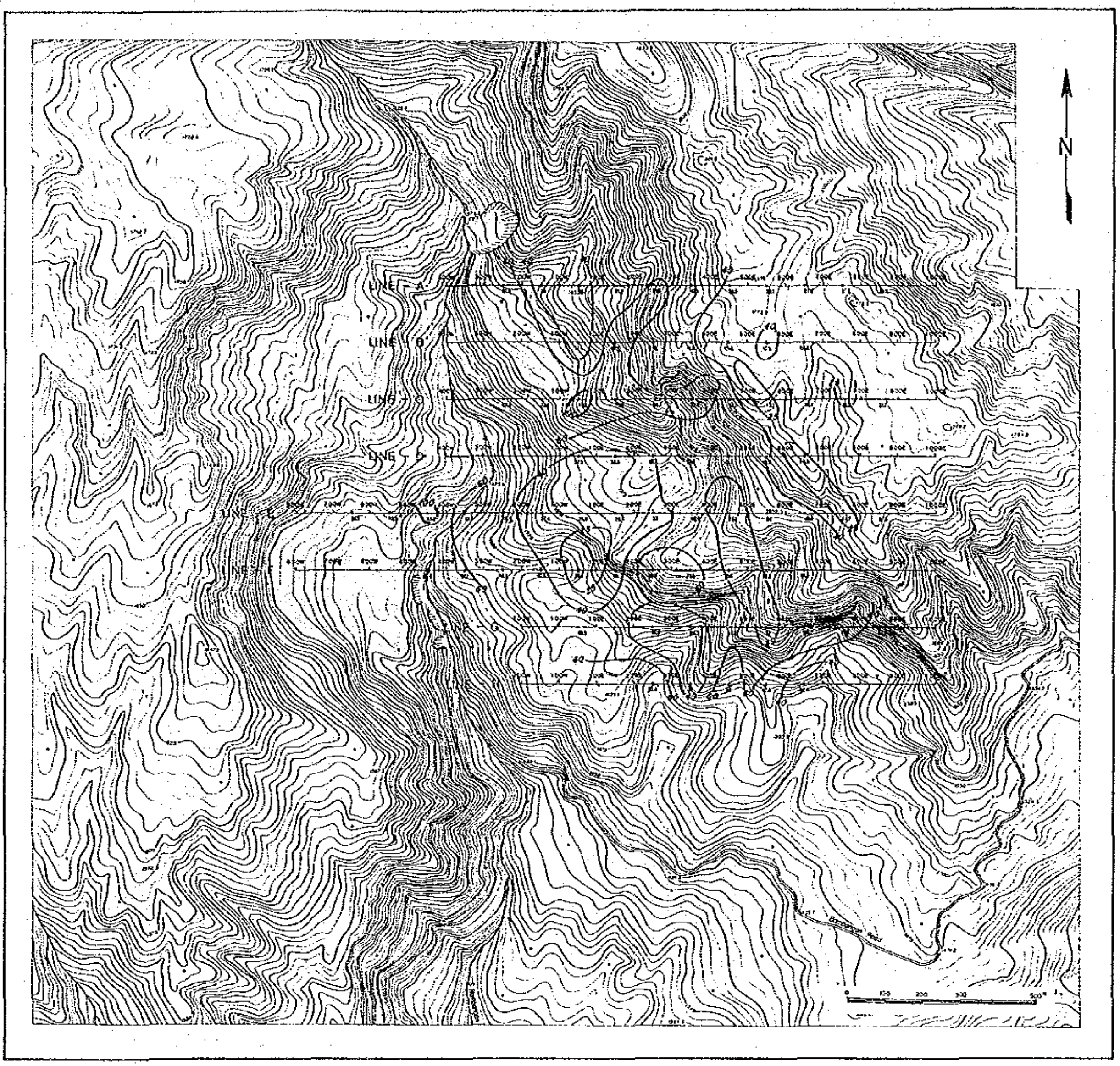
An apparent resistivity of more than 100ohm-m is seen on the west of 200E and on the surface of 400E – 500E dipping east to the depth of 700E. A general resistivity change here is seen high to low toward east. Raw phase values are generally less than –10mrad and a group of –10mrad values are seen in the west of 300E. This must be due to the spectrum difference having a higher phase in the low frequency range.

PFE more than 1% are widely detected to the west of the line.

(2) Plan Maps (Figs. 37–1 ~ 37–3)

Three kinds of plan maps, n = 1, 3, 5 were prepared corresponding to depth of 100 m, 200 m and 300 m respectively.

i) Apparent Resistivity Plan Map

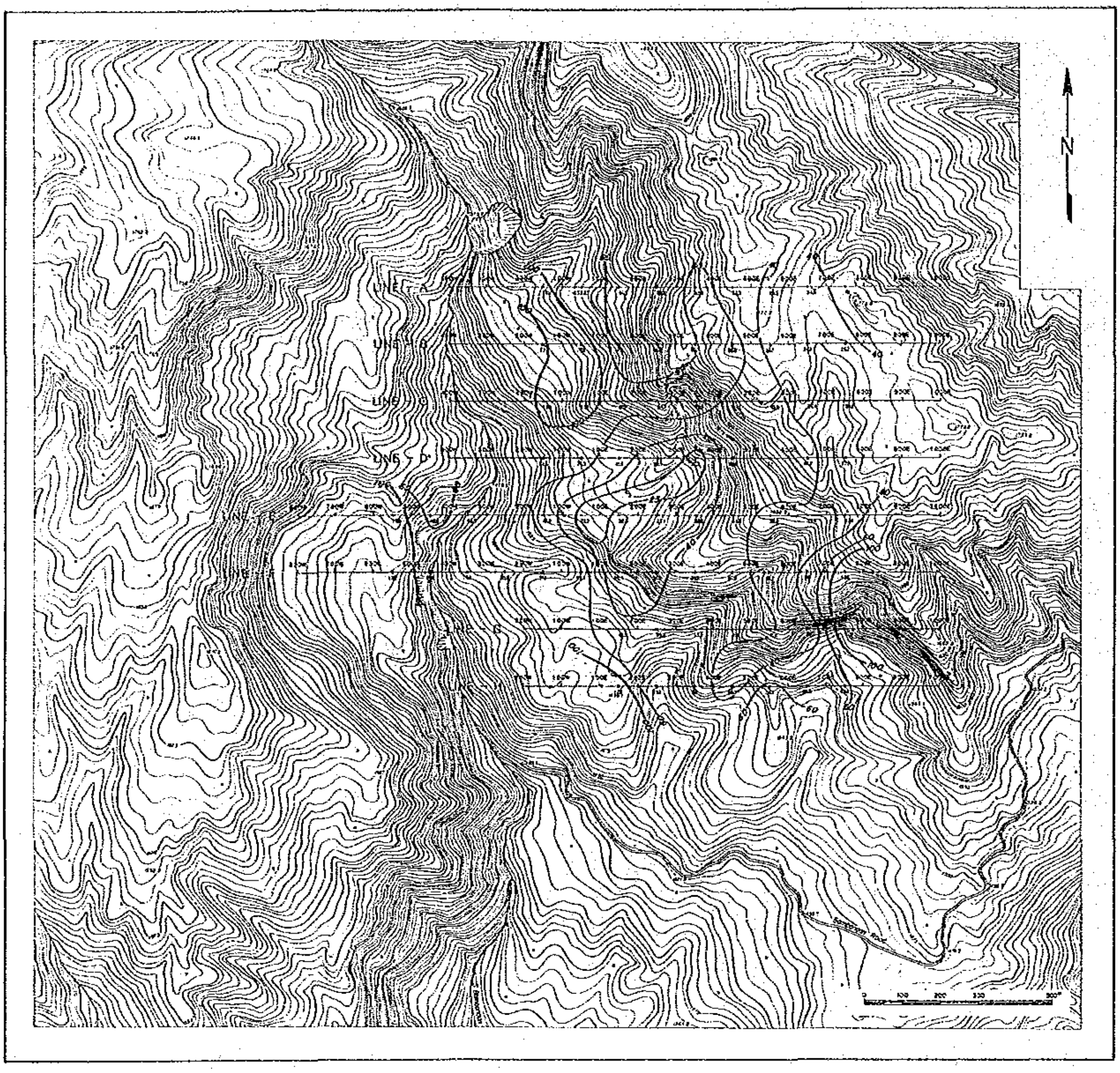


LEGEND

LINE-A 100W 100E 200E Survey Line
SIP (B,D,F,H)
IP (A,C,E,G)

100
60
40
Apparent Resistivity Contour

Fig. 37-1 Apparent Resistivity Plan Map

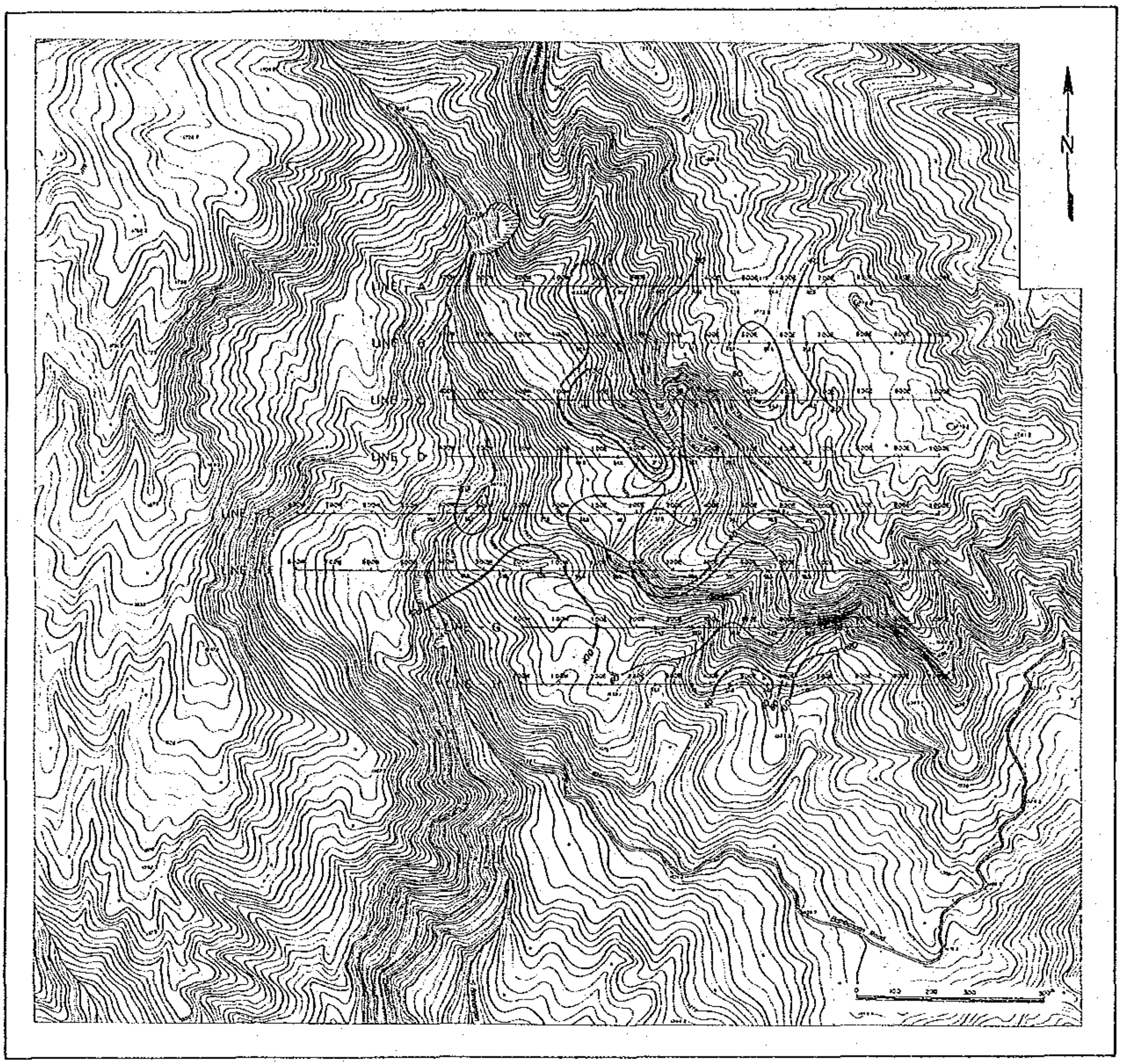


LEGEND

LINE-A 100W 100E 200E Survey Line
SIP (B,D,F,H)
IP (A,C,E,G)

100 60 40 Apparent Resistivity Contour

Fig. 37–2 Apparent Resistivity Plan Map



LEGEND

LINE-A 100W 100E 200E — Survey Line
SIP (B,D,F,H)
IP (A,C,E,G)

100 60 40 — Apparent Resistivity Contour

Fig. 37–3 Apparent Resistivity Plan Map

i) Apparent Resistivity Plan Map

Topographic corrections have been made for the apparent resistivity maps. A general tendency of the resistivity indicates that the deeper resistivities are higher than the shallower ones, suggesting that resistive rocks exist at the depths and that the conductive formations are dominant in the center of the area.

n = 1

Apparent resistivity less than 40ohm-m distribute in the center and northeast of the survey area. 60 – 100ohm-m are widely seen in the northeast of the area surrounding the low resistivity zone. Resistive zones more than 100ohm-m are seen in three areas: 300E on Line-C, 700E on Line-G and 400E – 500E on Line-H.

n = 3

Apparent resistivity less than 40ohm-m is eminently detected in an eclipse chape in the center of the area and in the northeast of the area extending in NE-SW direction from south of Line-E to Line-H.

Resistivities ranging from 60 to 100ohm-m are seen in the west of the area near the Bambangan river, in the middle of the area and in the west of Lines-G, H.

n = 5

Low resistivity less than 40ohm-m are delineated in the center of the area with 300E on Lines D, E as its center which is a continuation to the depth from the shallower part.

Because of the lack of the stations, low resistivities less than 40ohm-m are not seen in this map. However, low resistivities a re detected in 600E – 700E on Lines B, E and they may extend to the east. CSAMT data suggest that they will not extend to the depths.

ii) PFE Plan Map (Fig.s 38–1 ~ 38–3)

Around 1% FE, background values are widely distribute all over the area. Some 2 to 4% of FE are seen in the low resistivity zone but no eminent FE are seen here. High FE anomaly are generally seen in the depth and probably due to EM coupling effect.

n = 1

More than 2% of FE are seen only in 400W – 600W and 600E – 700E on Line-E, all the rest show 0.5 to 1.5%. Near 400W –6 600W on Line-E, 2.3 to 3.4% of FE were detected which may be extending to Line-D. However, 2.6% between 600E and 700E does not expand around and therefore, may be an independent one.

n = 3

More than 2% of FE are seen in five areas: 100W – 200W on Line-A, 100W – 200W on Line-E, 600E – 700E on Line-G are the partial anomalies, 400E on Lines- C, D, and 300W –

500W on Lines- E, F which may be extended to southwest of the survey area.

n = 5

More than 2% of FE including 3.5% are seen around 200W – 100E on Lines- D to F and 200E – 600E on Lines- D to G. The former ones are stronger towards south and may extend further south. The latter forms V-shape distribution but not seen in n = 3 map.

(3) Spectral Analysis

Raw Phase Spectrum, Magnitude Spectrum and Cole-Cole Maps which are the characteristic maps of SIP method, enables us to examine the characteristics of the anomaly and the anomalous source. However, field data contains various factors unlike an uniform rock sample, taking a lot of time to remove unwanted factors. In spite of frequent trials or checks, final data still contains some noise factors such as thunder, SP and topographic effects. No decoupling procedures were taken in the high frequency rangs as IP effect is so small and spectral change is negligible.

Line-B

Phase Spectrum at n = 1 and 2 show almost flat change in the low frequency range, but at n = 3 to 5 no anomalous IP effects reflecting a conductive layer are confirmed.

Magnitude Spectrum seem to reflect the conductive zone just as Phase Spectrum show no anomaly at all.

Line-D

Most of the Phase Spectrum are same as Line-B except at n = 2 and 4 which show some negative coupling, sometimes seen near the strong contrast of resistivity.

Line-E

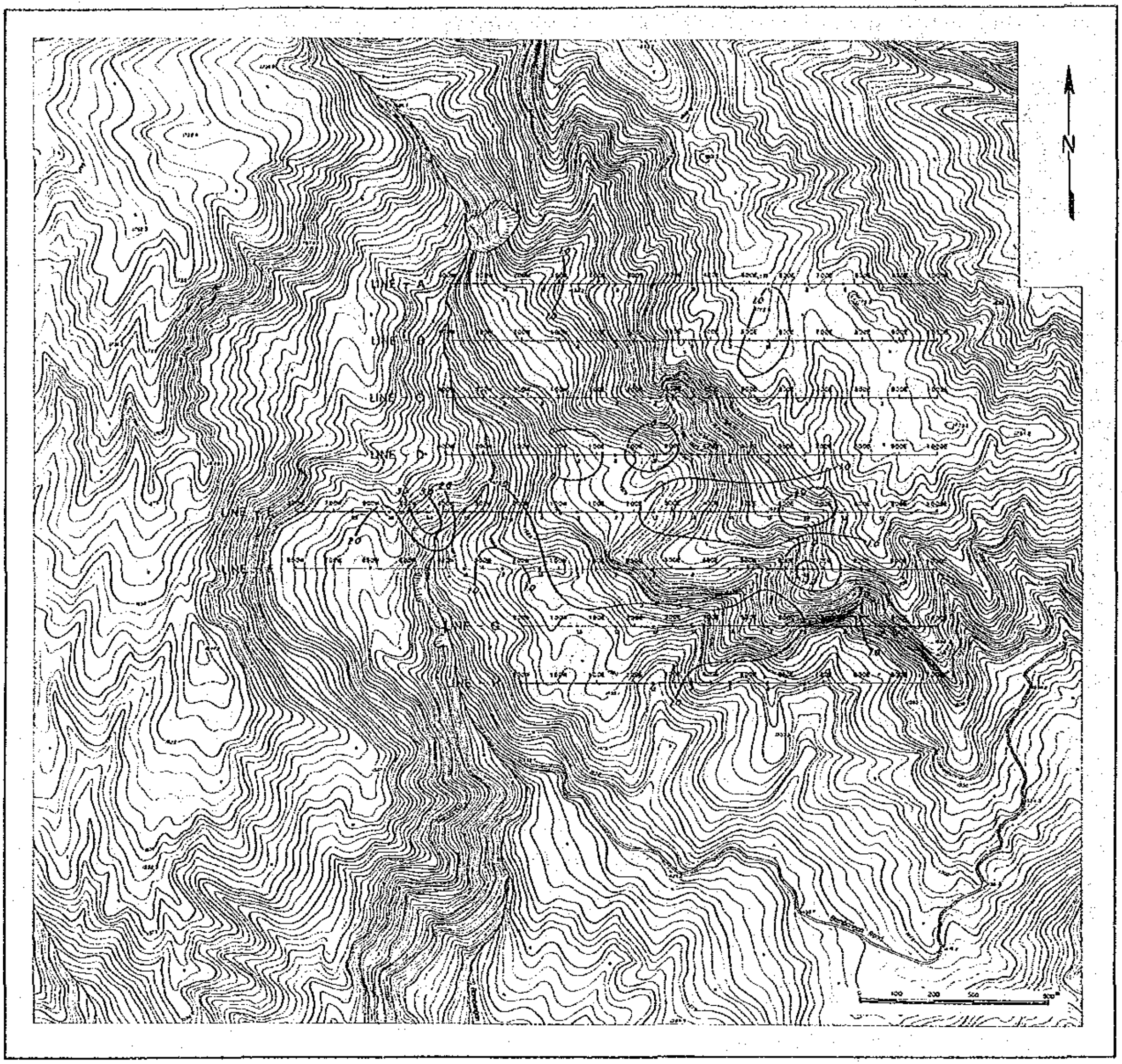
In order to confirm the extension of IP anomalies detected at the western end of Line-F, was extended 500 m to the west.

Flat or slightly decreasing phase spectral is detected with –20 mrad of phase in the low frequency range at n = 1 and 2 at 500W. Compared with an in-situ survey inside the pit, this type looks like that of the low grade mineralization. A vein shaped source with a little pyrite dissemination is assumed here.

Line-F

Two different types of spectral are detected with a boundary near station 500W. In the west of the boundary, spectral types look like that of 500W on Line-E, however, in the east of the boundary, simply increasing spectral are widely seen.

The former spectral type shows –3 mrad phase in the frequency range of 0.125 – 1.0 Hz. Near stations 600E and 700E, negative coupling which suggest some conductive body with high resistivity contrast, and data fluctuation due to SP phenomena are recognized.

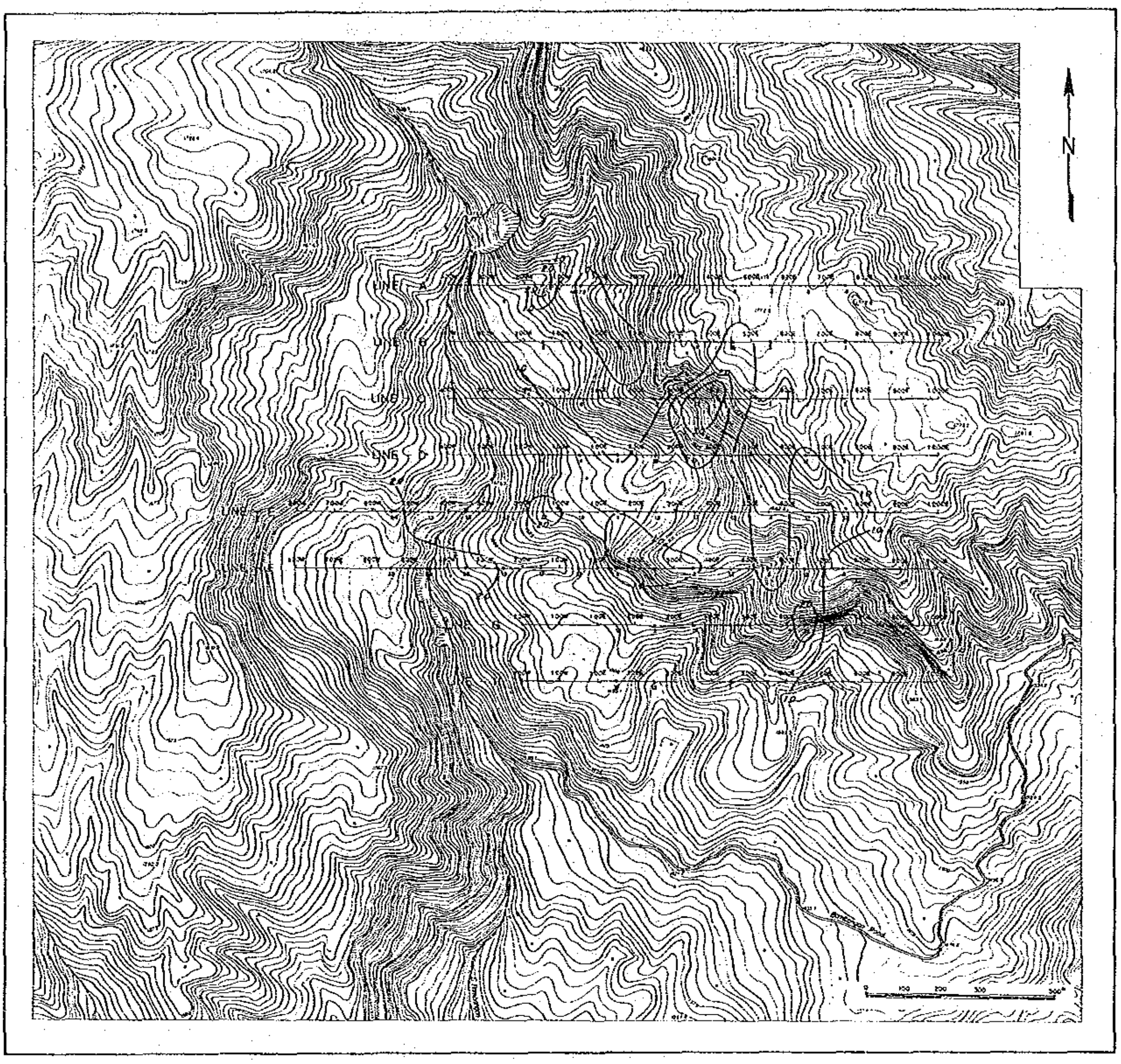


LEGEND

LINE-A 100W 100E 200E — Survey Line
SIP (B,D,F,H)
IP (A,C,E,G)

1.0 2.0 3.0 — FE Contour

Fig. 38–1 PFE Plan Map

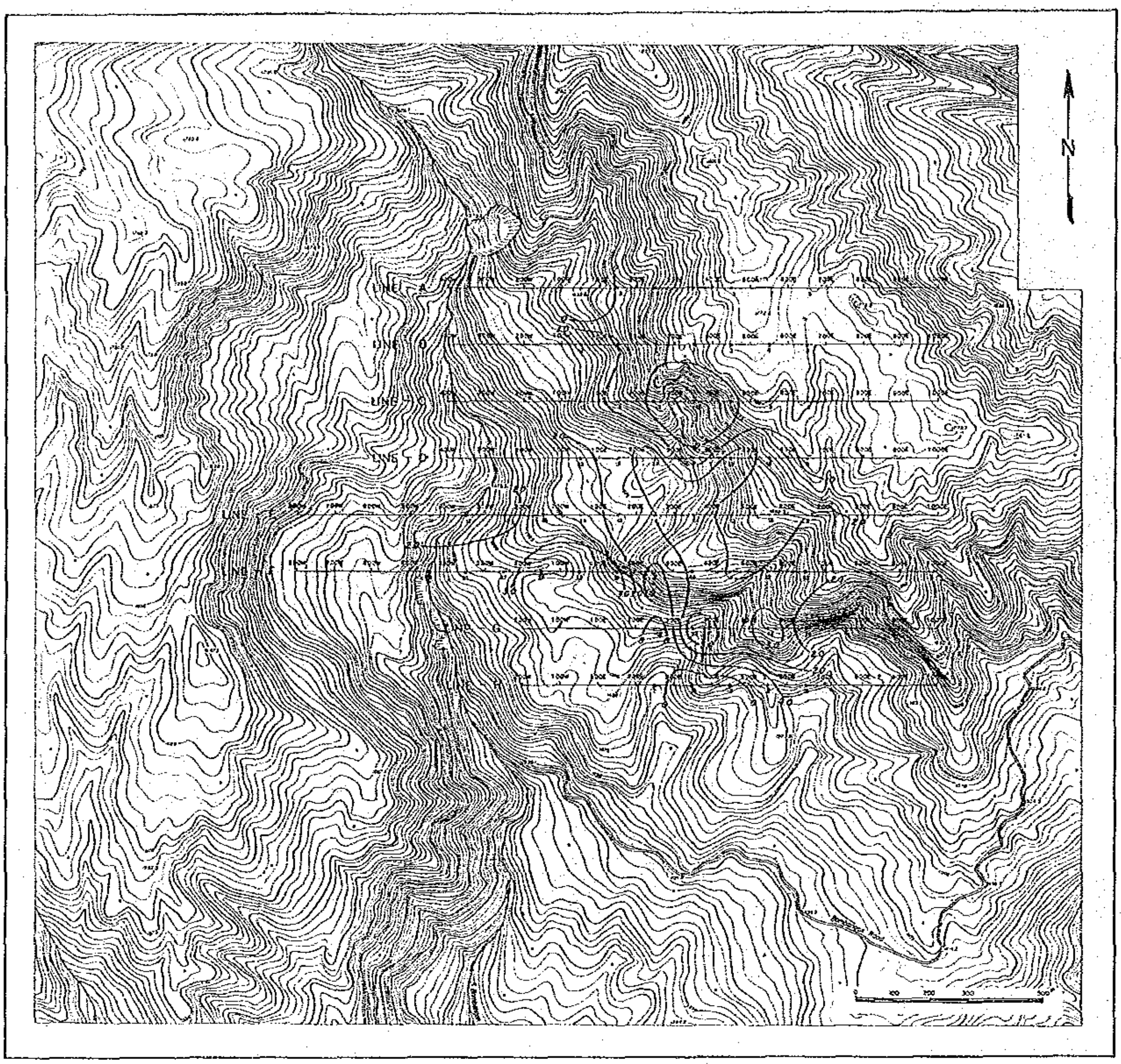


LEGEND

LINE-A 100W 100E 200E Survey Line
SIP (B,D,F,H)
IP (A,C,E,G)

1.0
2.0
3.0 FE Contour

Fig. 38–2 PFE Plan Map



LEGEND

LINE-A 100W 100E 200E Survey Line
SIP (B,D,F,H)
IP (A,C,E,G)

1.0
2.0
3.0 FE Contour

Fig. 38–3 PFE Plan Map

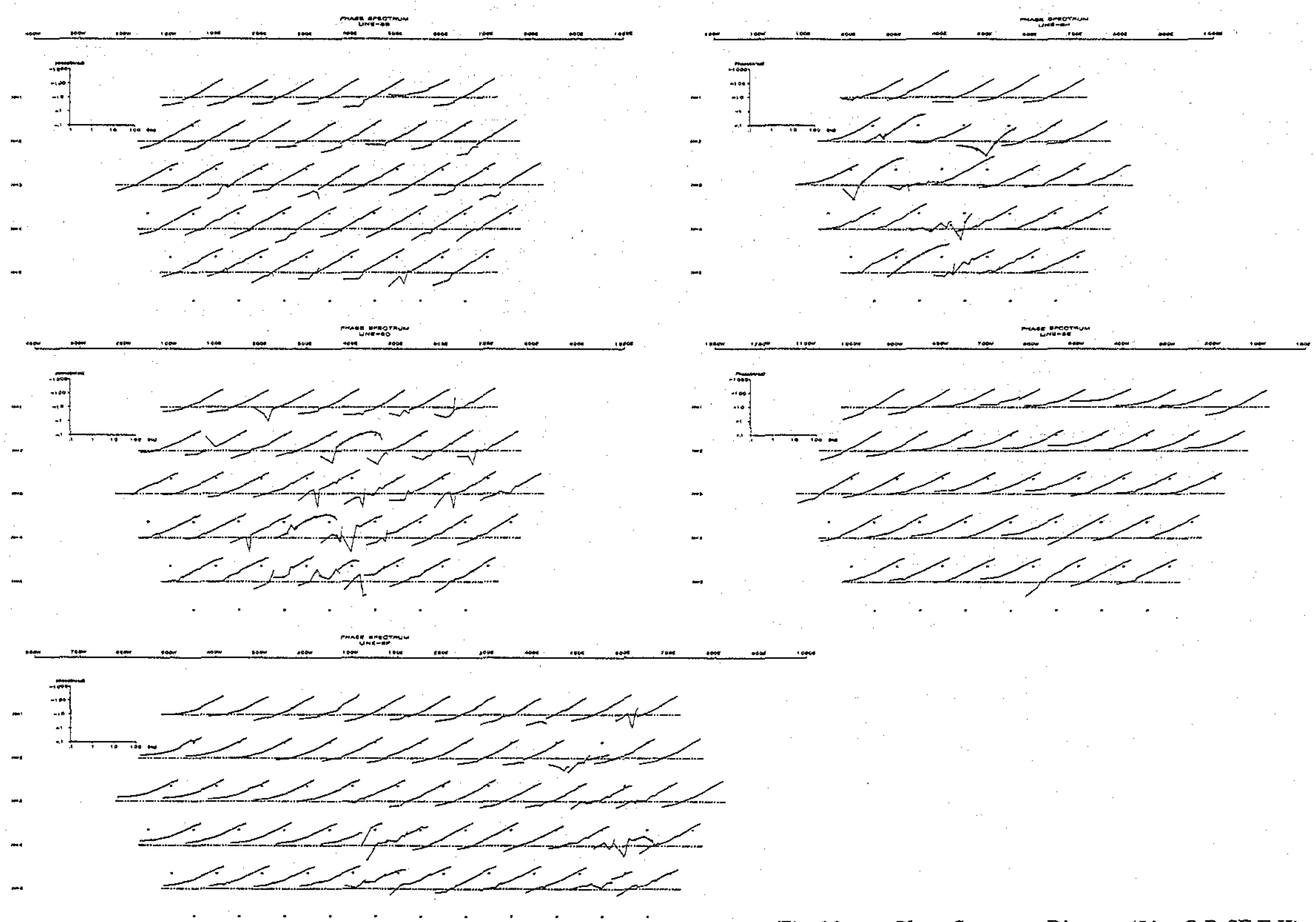


Fig. 39　　Phase Spectrum Diagram (Line-B,D,SE,F,H)

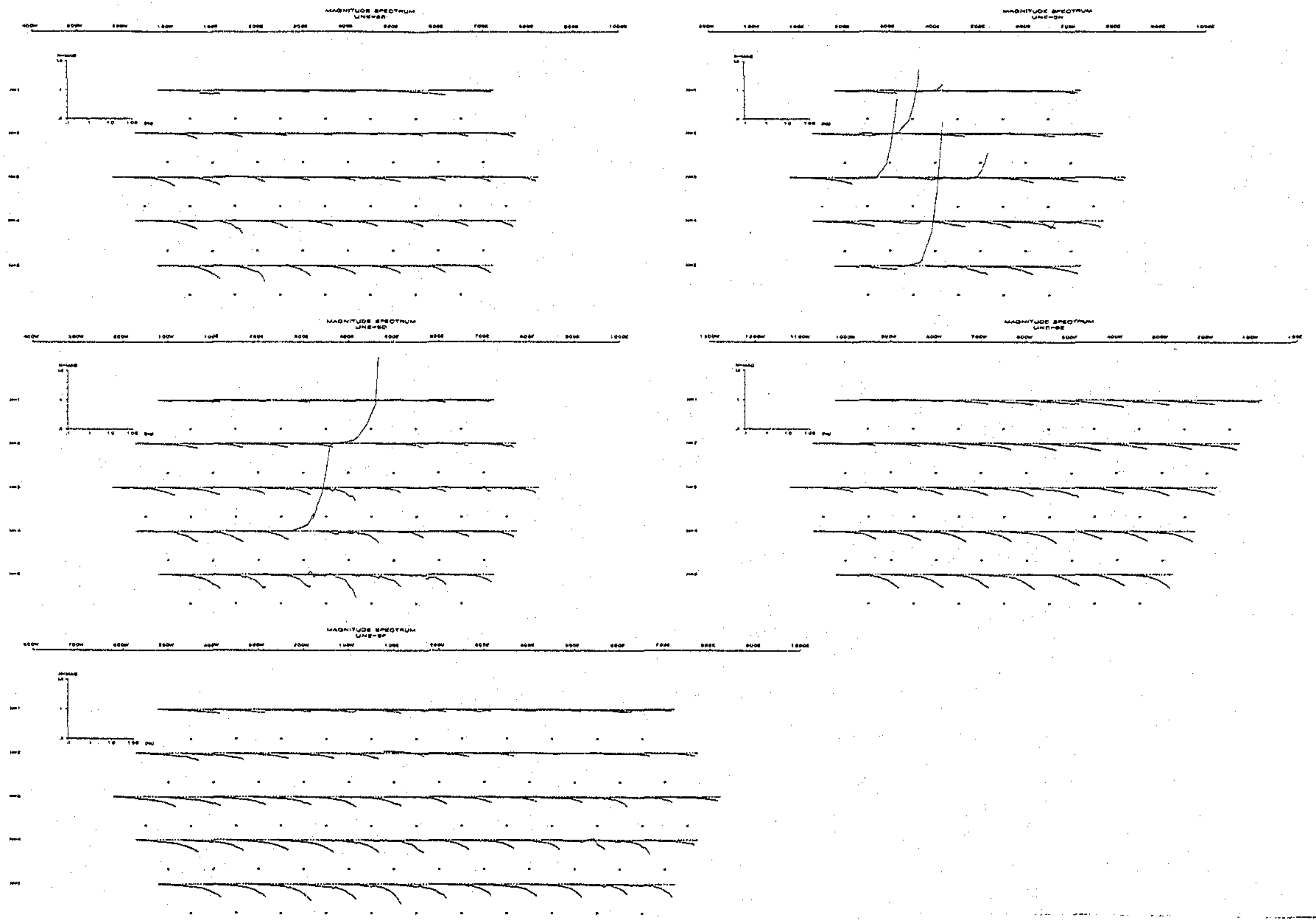


Fig. 40 Magnitude Spectrum Diagram (Line-B,D,SE,F,H)

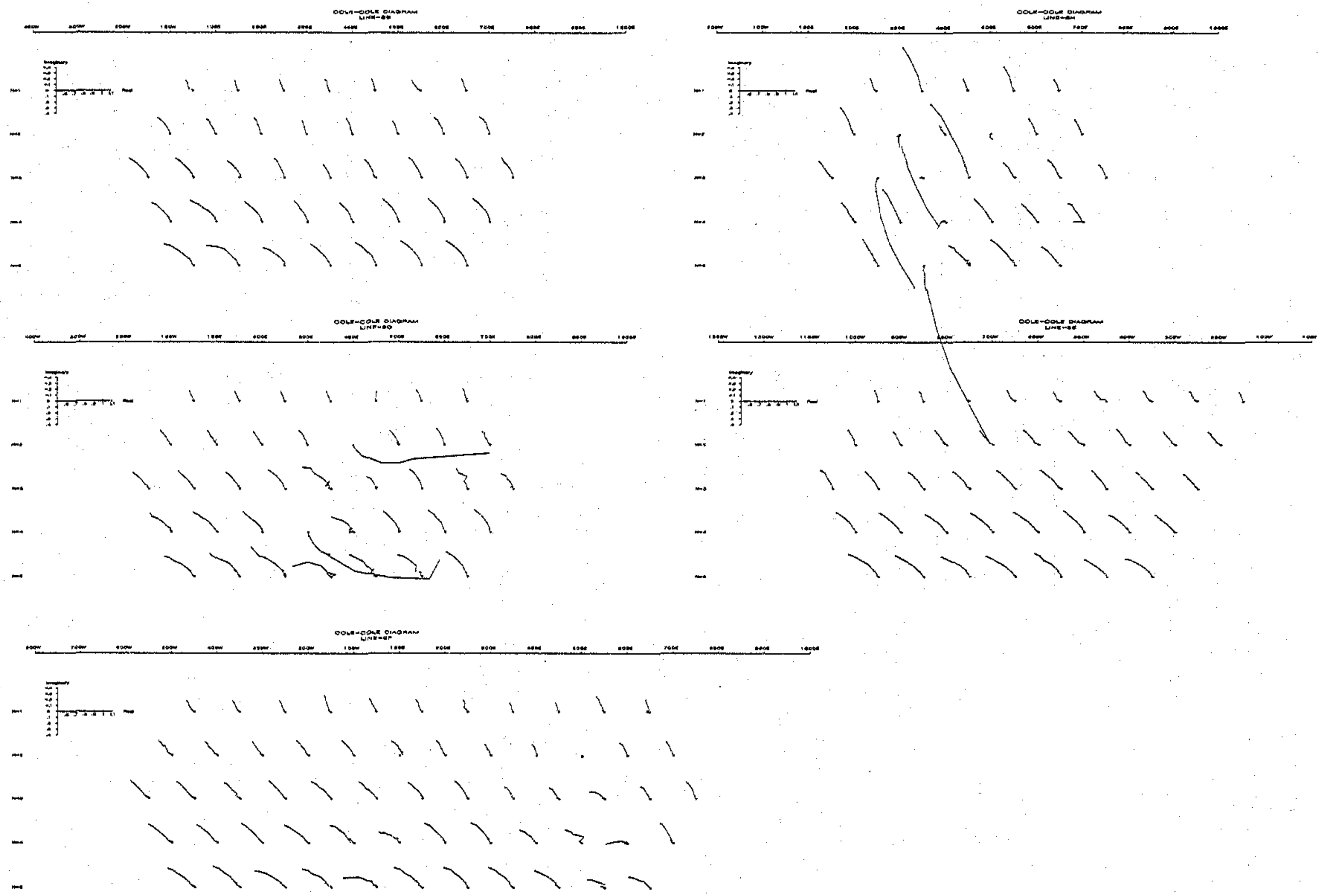


Fig. 41 Cole-Cole Diagram (Line-b,D,SE,F,H)

Magnitude spectrum decrease steeply to the west of 300W rather than to the east. Some coupling effects are seen at the depth of n = 4 to 5.

IP effect being so small at the shallower depth, showed no significant difference in the Cole-Cole map, however EM coupling effects are seen at the depth of n = 4 to 5 as the resistivity is very low.

Line-H

A strong negative coupling at the deeper zone below n = 2 in 300E and 500E suggests a strong resistivity contrast around here. The other data show almost same indications as a small IP anomaly type.

A real part in high frequency zone is comparatively small in Cole-Cole map since resistivity on this line is a little higher than the other lines.

2–2–4 Discussion

The resistivity underground structure in the A area were studied using the results of previous CSAMT survey. The A-1 low resistivity zone at the west of Mamut mine was assumed to be caused by the alteration associated with mineralization.

IP and SIP surveys were carried out in the A-1 low resistivity zone in order to clarify the nature of the low resistivity zone and to check the possibility of the existence of sulfide minerals, which is a good indicator of the mineralization.

(1) Resistivities derived from IP/SIP survey in the area show a common feature with that from the previous CSAMT survey. The IP/SIP resistivity contrast within the Pinosuk Formation is not remarkable, but some difference of resistivities within it could be observed.

Pinosuk Formation is distributed in the whole area. According to the drilling result of the MJM–9 hole, its thickness is 273 m and it is divided into two layers, namely, upper and lower layers. The former is very loose and porous and its thickness is 50 m to 60 m, and the latter is compact.

Although it was assumed that the thickness of the Pinosuk Formation is 50 m to 60 m in the previous CSAMT survey, the formation derived from IP/SIP survey seems to correspond to the upper Pinosuk Formation.

According to the survey results of this IP/SIP survey, high resistivities of more than 60 ohm-m are predominantly distributed except for the low resistivity zone of less than 40ohm-m at the shallower depth of n = 1 and n = 2, with resistivity increasing its value with depth.

Assuming the resistivities of upper Pinosuk Formation, lower Pinosuk Formation and other rocks to be of less than 50ohm-m, of 50 to 70ohm-m and of more than 70ohm-m, respectively, the existence of a resistivity discontinuity with a NE-SW trend running through the central part of the IP/SIP survey area is suggested.

A high resistivity zone of more than 70ohm-m is distributed near the ground surface in the western half of the area, and increases its depth toward southeast. Pinosuk Formation may have a thickness of about 150 m at the southeastern part of the area and may increase its thickness toward northeast.

According to the results of the model calculation, high resistivity rocks, corresponding to peridotite, are distributed near the surface along the Bambangan Creek in the central part of the area, and increase its depth towards both eastern and western banks. The low resistivity layer, corresponding to the Pinosuk Formation, decreases its depth toward south, that is, about 230 m, 200 m, 190 m and 120 m at Lines D, E, F and H, respectively. A moderate layer, corresponding to compact upper-Pinosuk layer and sandstone, is distributed widely in the eastern part of the area.

Therefore, it is thought that the A-1 low resistivity zone, assumed to be due to the alteration associated with the mineralization according to the results of CSAMT method, may be caused only by the upper Pinosuk layer.

In the resistivity zone of less than 60ohm-m, spectral types show similar pattern with those in low resistivity zone, that is, the phase increases monotonically with frequency in the Cole-Cole diagram.

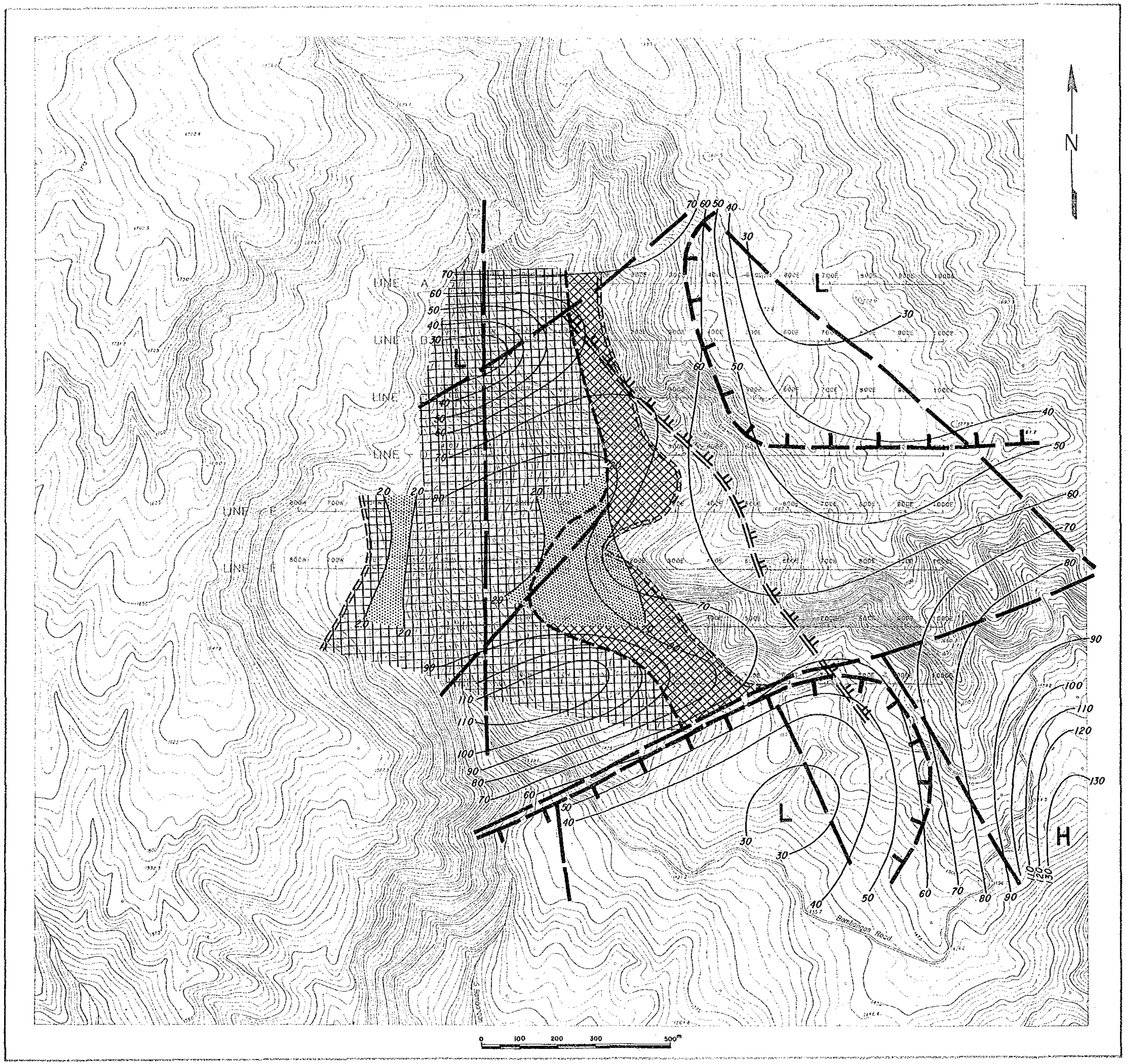
(2) There is no interesting IP anomalies in the area except for one remarkable IP anomaly observed in a high resistivity zone of more than 70ohm-m at the west bank of Bambangan Creek (near 500W of Lines E and F) and several local and weak anomalies caused by EM coupling and/or noise at the depth in the resistivity zone of less than 60chm-m.

The IP anomaly at the west bank of the Bambangan Creek showed a with PFE of 3.0 to 4.0%. This anomaly may be caused by a west-dipping anomalous source below 500W of Line E, and may extend towards north and south.

(3) It was necessary to check the relation between a remarkable IP anomalous source near 500W of Line E and the Mamut ore deposit, so that in-situ SIP survey was carried out at the Mamut mine. From this survey, two kinds of spectral types were observed; one shows a flat pattern between 0.125 Hz and 32 Hz and detected in the high-grade ore zone, and other shows monotonic decrease of phase with frequency between 0.125 Hz and 3 Hz and detected in the low-grade ore zone.

An IP anomaly near 500W of Line E shows a similar spectral type as the latter one, but magnitudes are different each other. This difference may be due to the type and size of its anomalous source and the content of the sulfide minerals.

Therefore, it can be concluded that there is no existence of similar orebody as Mamut ore deposit near 500W of Line E but there exists a dyke-like anomalous source in the sulfide dissemination.



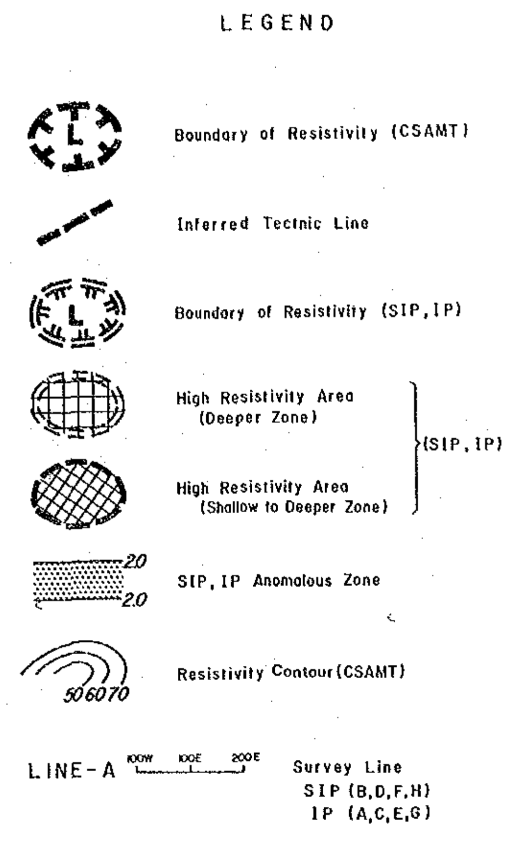


Fig. 42 Geophysical Interpretation Map of "A" Area

Chapter 3 Drilling

3–1 Drilling Method and Machine

3–1–1 Drilling Method

Regarding casing process, 4 inches casing pipe is put into Overburden (surface soil). After drilling by using HQ-WL, the same rods are inserted as the casing pipe, after this drilling work has started by the hole size of NQ-WL and then BQ-WL.

Firstly, MJM-1 hole was drilled by this programme, however, there were many boulders and the collapsible zone in the ground, so it was very difficult to insert the casing pipe. Therefore, the casing pipe were inserted, rotating swivel head to settle the metal shoe bit. It was difficult to rotate 4 inches casing pipe and HQ-WL rod. If we had forced to rotate them, the engine might immediate stop, finally HW-WL rods were inserted to 20.10 meter.

After this, during NQ-WL drillings, at the depth of 31.80 meter, the hole encountered the fractured zone having the high water pressure, so we tried to force to drill further using HQ-WL rod (as casing pipe) again, however, immediately after this at the depth of 11.00 meter the rods were broken.

Although we tried to use every possible way, it was finally in failure to recover the HQ-WL rods. It was decided that the new hole (as MJM-1') should be drilled using new method as follows;

Firstly, for the portion of overburden, HW casing pipe insert with rotation. Secondly, inserting NW casing pipe with diamond shoe and then drill by NQ-WL.

In another words, extending the hole by NW casing pipe with diamond shoe and then insert NW casing pipe, i.e., repeat to insert and extend the hole using NW casing pipe.

When it can not put NW casing pipe forward, it shall be started to drill by NQ-WL.

If the hole encounters the fractured zone within the depth of the hole where BW casing pipe be inserted, we will take measure to apply the cementation method.

For the drilling work, bentonite mud water method has been applied, and in addition this mud water mixed with CMC mud oil and mud fluid ("Libonite") when encountered in the shear zone or Pinosuk Gravels.

3–1–2 Drilling Machine and Consumed Materials

The drilling machines were a set of Tone Boring TGM-5 and a set of TGM-2C (the drilling capacity is 510 meters in NQ size and 660 meters in BQ size).

Although it had been planned to drill three holes using only a set of TGM-2C drilling ma-

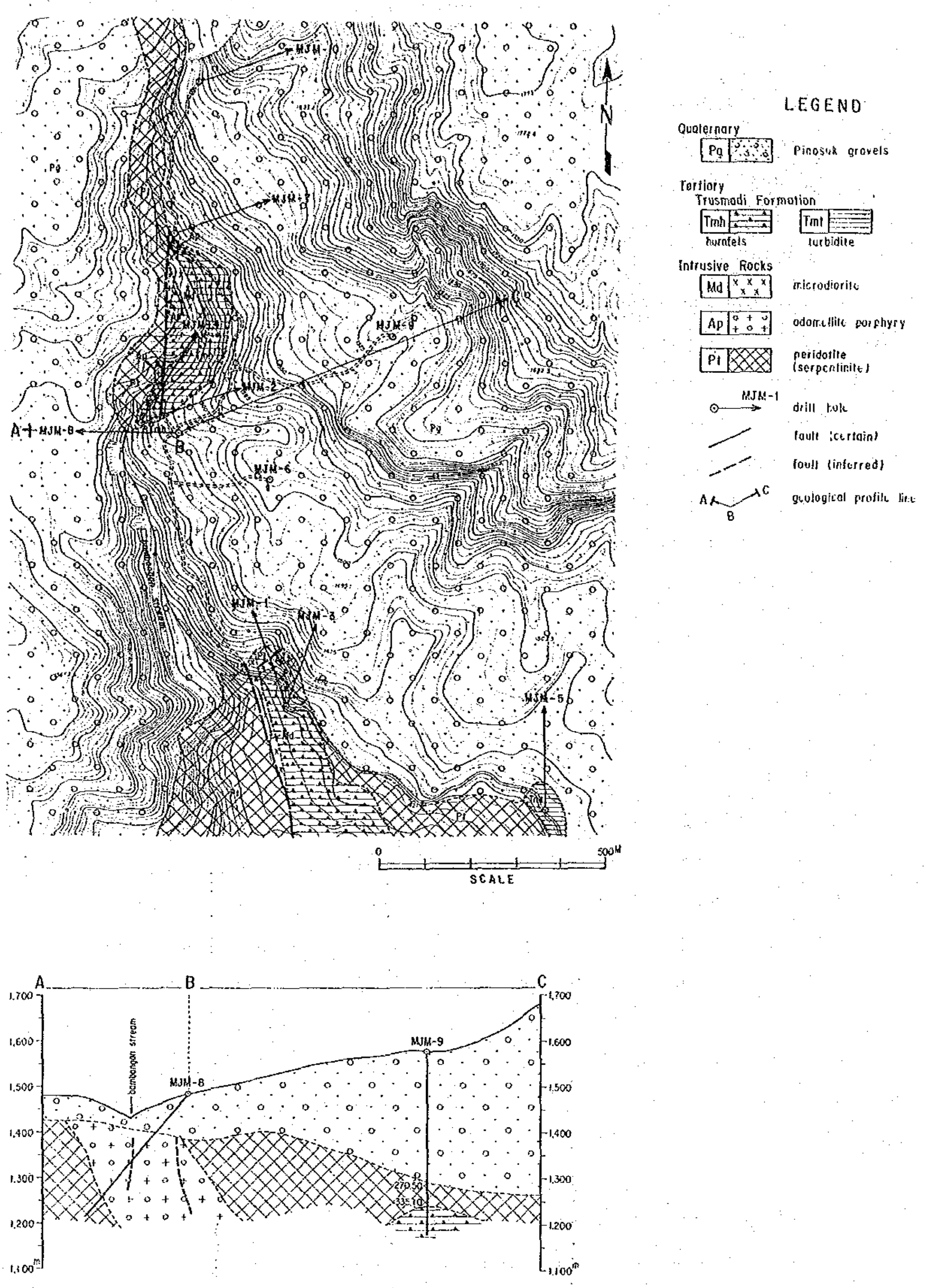


Fig. 43 Location Map of Drill Hole

Table 6–1 Specifications of Drilling Machine

Drilling Machine TGM – 2C	1 set
Specifications:	
Capacity	640 m ~ 660 m (BQWL)
Dimension LxWxH(mm)	2,430x990x1,520
Hoisting capacity	2,200Kg
Spindle speed (r.p.m)	Forward 80,200,300,400
Engine	"KE – 250" "F3L–912"
Drilling pump "NAS – 3C"	1 set
Cylinder bore dia	75mm
Capacity	22, 130ℓ/min
Engine	"NS – 130C"
Water supply pump "NES – 100"	1 set
Capacity	100ℓ/min
Engine	"NS – 75"
Wire line hoist "WHS – 600"	1 set
Rope capacity	600m
Engine	Drilling machine's engine take off
Mud mixer "MLE – 100"	1 set
Capacity	125ℓ
Engine	"NS – 65"
Generator	YAMMAR Model "YSG – 2SN"

Drilling tools		MJM-1	MJM-3	MJM-6	MJM-7
Drilling rod	NQ-WL (3.0m)	70PCS	75PCS	84PCS	82PCS
	BQ-WL (3.0m)	117	117	117	117
	4B (1.0m)	55	–	–	–
Casing pipe	HW (1.0m)	–	9	9	19
	NW (0.5m)	–	–	1	–
	(1.0m)	2	44	58	44
	(3.0m)	10	–	–	–
	BW (3.0m)	–	75	84	82

Derrike	Hand made on the spot (wooden)

Table 6–2 Specifications of Drilling Machine

Drilling Machine TGM – 5	1 set
Specifications:	
Capacity	660m (BQ – WL)
Dimensions LxWxH(mm)	2,720x1,130x1,640
Hoisting capacity	2,200Kg
Spindle speed (r.p.m)	Forward 170,405,630,825
Engine	"F31 – 912"
Drilling pump NAS – 3T4	1 set
Cylinder bore dia	75mm
Capacity	22, 130ℓ/min
Engine	"TS155C"
Water supply pump "NES – 100"	1 set
Capacity	100ℓ/min
Engine	YAMMAR Model "NS – 65"
Wire line hoist "WHS – 600"	1 set
Rope capacity	600m
Engine	Drilling machine's engine power take off
Mud mixer "MCE – 100"	1 set
Capacity	125ℓ
Engine	YAMMAR "NSA40 – GK"
Generator	YAMMAR Model "YDG – 2000E"

Drilling tools

			MJM-2	MJM-4	MJM-5	MJM-8	MJM-9	MJM-10
Drilling rod	NQ-WL	(1.5m)	2PCS	_ PCS	_ PCS	_ PCS	_ PCS	_ PCS
		(3.0m)	69	65	101	85	87	87
	BQ-WL	(1.0m)	1	–	–	–	–	–
		(3.0m)	100	117	–	134	117	117
Casing pipe	4B	(0.5m)	–	1	–	–	–	–
		(1.0m)	–	5	3	–	–	–
	HW	(1.0m)	–	–	–	5	–	5
	NW	(0.5m)	–	–	–	1	–	
		(1.0m)	1	50	57	58	57	57
		(3.0m)	64	–	–	85	–	–
	BW	(3.0m)	–	65	–	–	87	87

Derrike	Hand made on the spot (wooden) or Model "DRP–9–5".

Table 7–1 Drilling Meterage by Diamond Bit

Item	Size of Bit	Type of Bit	Carats per Bit	Matrix	Stones per Carat	Water Way	Total bit Used
Diamond Bit	75.7mm	NQ-WL	30ct	E	25	4	7
	75.3mm	NQ-WL	30	E	25	4	11
	Total		540				18
	61.2mm	BQ-WL	20	E	25	4	6
	59.6mm	BQ-WL	20	E	25	4	9
	Total		300				15
Grand Total			*840				33

E : for ardinary rock
* : Total amount of Diamond Carat

Table 7–2 Drilling Meterage by Diamond Bit

Item	Size	Bit No.	Drilling Meterage by hole Unit: Meter											Total (m)
			MJM-1'	MJM-1	MJM-2	MJM-3	MJM-4	MJM-5	MJM-6	MJM-7	MJM-8	MJM-9	MJM-10	
		1851019	20.60	165.90						25.60				212.10
		1851020					162.90			4.00				166.90
		1851021			197.00		42.60			25.70				265.30
		1851022								73.90				73.90
		1851023		22.40	20.80									43.20
		1851024				122.50								122.50
		1851025								12.00			28.60	40.60
		1851026								58.90				58.90
		1851027				50.50		186.80						237.30
Dia-	NQ	1851070											116.70	116.70
mond		1851763								48.50				48.50
bit	WL	19218							129.00			11.50		140.50
		19219							159.60			52.90	15.40	227.90
		19221										178.60		178.60
		19222											92.90	92.90
		19223									37.20			37.20
		12065									116.60			116.60
		00051									72.80			72.80
		Total	20.60	188.30	217.80	173.00	205.50	186.80	288.60	248.60	226.60	243.00	253.60	2,252.40
Total			Drilled length/Bit (2,252.40/18)											125.13

Table 7 –3 Drilling Meterage by Diamond Bit

Item	Size	Bit No.	Drilling Meterage by hole Unit: Meter											Total (m)
			MJM-1'	MJM-1	MJM-2	MJM-3	MJM-4	MJM-5	MJM-6	MJM-7	MJM-8	MJM-9	MJM-10	
Dia-mond bit	BQ WL	175649		61.60										61.60
		175650		80.50										80.50
		175651					126.50							126.50
		175653											41.40	41.40
		175654				58.10				50.70				108.80
		175655											51.90	51.90
		175656						155.80						155.80
		175657				50.40								50.40
		175658			117.70									117.70
		19224										48.40		48.40
		19225								48.90				48.90
		19226										15.60		15.60
		19227									34.80			34.80
		19228										82.10		82.10
		19229									70.60			70.60
	Total			142.10	117.70	108.50	126.50	155.80		99.60	105.40	146.10	93.30	1,095.00
Total			Drilled length/Bit (2,252.40/18)					(1,095.00/15)						73.00
G - Total			Drilled length/Bit (NQ&BQ)					(3,347.40/33)						101.43

Table 8 Details of Consumed Materials

Description	Specifications	Unit	Quantity											Total
			MJM-1'	MJM-1	MJM-2	MJM-3	MJM-4	MJM-5	MJM-6	MJM-7	MJM-8	MJM-9	MJM-10	
Light Oil		ℓ	520	2,480	2,065	1,290	2,145	1,155	1,420	6,265	2,180	3,910	2,710	26,140
Bentnite		Kg	875	7,250	4,700	1,525	5,675	3,525	3,900	13,925	4,300	3,025	3,200	51,900
Libonite		〃	–	260	280	175	1,570	870	425	961	250	295	360	5,446
C.M.C		〃	70	180	125	90	222	164	128	303	90	102	110	1,584
Cement		〃	200	320	120	480	250	400	250	500	800	350	500	4,170
Diamond Bit	NQ WL	Pc	1	2	2	2	2	1	2	7	3	3	3	28
〃	BQ WL	〃	–	2	1	2	1	1	–	2	2	3	2	16
〃	NW	〃	–	1	1	1	1	1	1	2	1	1	1	11
〃	HW	〃	–	–	1	–	1	–	–	1	1	1	1	6
Diamond Reamer	NQ WL	〃	1	1	1	2	1	1	2	5	2	2	3	21
〃	BQ WL	〃	–	1	1	1	1	1	–	1	1	2	1	10
Casing Crown	PQ	〃	2	–	–	–	–	–	–	–	–	–	–	2
〃	HQ	〃	3	–	–	–	–	–	–	–	–	–	–	3
Core barrel Assy	NQ WL	set	1	1	1	1	1	1	1	3	1	2	1	14
Core barrel Assy	BQ WL	〃	–	1	1	1	1	1	–	2	1	1	2	11
Inner tube	NQ WL	Pc	1	1	1	1	2	1	1	2	1	2	2	15
Inner tube	BQ WL	〃	–	1	1	1	2	1	–	3	1	3	2	15
Core lifter	NQ WL	〃	1	3	4	3	4	3	2	5	2	4	4	35
Core lifter	BQ WL	〃	–	2	3	4	5	4	–	6	3	5	4	36
Core lifter case	NQ WL	〃	1	2	2	3	4	2	2	5	2	3	4	30
Core lifter case	BQ WL	〃	–	2	2	2	2	3	–	4	3	3	4	25

Table 9–1 Timetable of Drilling Work

Hole No.	Drilling			shift		Working man		Working time						G. Total
	Bit size	Drilling	Core length	Drilling	Total	Engineer	Worker	Drilling	Other Working	Recovering	Total	Removing	Road con-structing and others	
		m	m	shift	shift	man	man	h	h	h	h	h	h	h
MJM-1'	PQ	2.50	0	1	17	36	95	3°30′	9°10′	0°00′	12°40′	120°00′	8°00′	140°40′
	HQ	8.70	0	2	2	4	10	7°00′	18°30′	0°00′	25°30′			25°30′
	NQ	20.60	14.30	12	15	32	65	27°50′	54°00′	40°00′	121°50′	0°00′		121°50′
	Total	31.80	14.30	15	34	72	170	38°20′	81°40′	40°00′	160°00′	120°00′	8°00′	288°00′
MJM-1	NW	19.90	0	3	21	60	260	9°00′	18°00′	0°00′	27°00′	8°00′	0°00′	35°00′
	NQ	188.30	178.10	24	31	54	150	123°20′	160°10′	93°00′	376°30′			376°30′
	BQ	142.10	141.20	31	33	54	190	101°50′	191°40′	56°00′	349°30′	14°00′		363°30′
	Total	350.30	319.30	58	85	168	600	234°10′	369°50′	149°00′	753°00′	22°00′	0°00′	775°00′
MJM-2	NW	15.50	0	2	17	71	255	7°30′	14°00′	0°00′	21°30′	127°00′	156°00′	304°30′
	NQ	217.80	214.40	29	29	47	136	189°00′	155°30′	0°00′	344°30′			344°30′
	BQ	117.70	117.00	24	29	44	185	53°50′	196°10′	0°00′	250°00′	27°00′		277°00′
	Total	351.00	331.40	55	75	162	576	250°20′	365°40′	0°00′	616°00′	154°00′	156°00′	926°00′
MJM-3	NW	19.00	0	4	9	24	60	18°40′	13°20′	0°00′	32°00′	46°00′	24°00′	102°00′
	NQ	173.00	169.50	11	17	27	70	82°10′	71°40′	36°00′	189°50′			189°50′
	BQ	108.50	108.20	17	18	32	75	64°40′	98°30′	11°00′	174°10′	18°00′		192°10′
	Total	300.50	277.70	32	44	83	205	165°30′	183°30′	47°00′	369°00′	64°00′	24°00′	484°00′
MJM-4	HW	9.00	0	3	11	22	126	13°00′	8°10′	0°00′	21°10′	70°00′	0°00′	91°10′
	NW	10.00	0	1	1	2	7	12°10′	8°00′	0°00′	20°10′			20°10′
	NQ	205.50	192.90	26	26	43	148	160°10′	131°20′	0°00′	291°30′			291°30′
	BQ	126.50	109.50	22	29	54	235	93°45′	244°45′	0°00′	338°30′	18°00′		356°30′
	Total	351.00	300.70	52	67	121	516	279°05′	392°15′	0°00′	671°20′	88°00′	0°00′	759°20′
MJM-5	4″	5.50	0	2	14	28	165	8°00′	8°00′	3°00′	19°00′	110°00′	0°00′	129°00′
	NW	2.50	0	1	3	6	15	6°00′	10°00′	8°00′	24°00′			24°00′
	NQ	186.80	181.20	18	18	41	150	108°20′	98°30′	42°20′	249°10′			249°10′
	BQ	155.80	150.20	22	29	51	118	116°10′	143°00′	0°00′	259°10′	18°00′		277°10′
	Total	350.60	331.40	43	64	126	448	238°30′	259°30′	53°20′	551°20′	128°00′	0°00′	679°20′

Table 9–2 Timetable of Drilling Work

Hole No.	Drilling			shift		Working man		Working time							G. Total
	Bit size	Drilling	Core length	Drilling	Total	Engineer	Worker	Drilling	Other Working	Recovering	Total	Removing	Road con-structing and others	
		m	m	shift	shift	man	man	h	h	h	h	h	h	h
JMJ-6	4"	3.00	0	1	11	37	122	5°10′	6°50′	0°00′	12°00′	77°00′	64°00′	153°00′
	NW	11.00	0	2	2	6	18	15°30′	19°30′		35°00′			35°00′
	NQ	288.60	256.20	28	32	64	129	198°40′	161°50′		360°30′	10°00′		370°30′
	Total	302.60	256.20	31	45	107	269	219°20′	188°10′	0°00′	407°30′	87°00′	64°00′	588°30′
MJM-7	HW	2.00	0	1	26	78	363	7°50′	7°20′		15°10′	196°00′	90°00′	301°10′
	NQ	248.60	146.30	70	80	160	403	327°10′	530°00′	26°00′	883°10′			883°10′
	BQ	99.60	76.80	29	33	57	144	99°10′	268°20′		367°30′	0°00′		367°30′
	Total	350.20	223.10	100	139	295	910	434°10′	805°40′	26°00′	1,265°50′	196°00′	90°00′	1,551°50′
MJM-8	HW	19.00	0	1	14	42	143	4°00′	5°00′	0°00′	9°00′	158°00′	8°00′	175°00′
	NQ	226.60	207.60	20	20	32	81	126°30′	112°10′		238°40′			238°40′
	BQ	105.40	84.00	13	21	43	95	69°20′	106°20′		175°40′	20°00′		195°40′
	Total	351.00	291.60	34	55	117	319	199°50′	223°30′	0°00′	423°20′	178°00′	8°00′	601°20′
MJM-9	HW	5.00	0	1	34	114	241	4°00′	23°00′	0°00′	27°00′	224°00′	64°00′	315°00′
	NW	7.00	0	1	1	3	2	5°00′	25°00′		30°00′			30°00′
	NQ	243.00	199.30	26	26	39	88	163°10′	130°20′		293°30′	0°00′		293°30′
	BQ	146.10	108.20	29	33	57	168	148°30′	220°00′		368°30′			368°30′
	Total	401.10	307.50	57	94	213	499	320°40′	398°20′	0°00′	719°00′	224°00′	64°00′	1,007°00′
MJM-10	HW	5.00	0	1	12	36	178	5°20′	6°30′	0°00′	11°50′	88°00′	56°00′	155°50′
	NQ	253.60	230.30	49	49	57	143	250°20′	201°00′		451°20′			451°20′
	BQ	93.30	85.40	14	14	54	139	91°10′	109°20′		200°30′	75°00′		275°30′
	Total	351.90	315.70	75	75	147	460	346°50′	316°50′	0°00′	663°40′	163°00′	56°00′	882°40′

Table 10-1 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	22. 9.1985~ 2.10.1985	11	11 days	0 days	34 man	90 man
	Drilling	3.10.1985~12.10.1985	10	drilling 6	0	18	38
				recovering 4	0	11	24
	Removing	13.10.1985~15.10.1985	3	3	0	9	18
	Total	22. 9.1985~15.10.1985	24	24	0	72	170

Drilling length				
	Length planed	350.00 m	Surface soil Overburden Quaternary	11.20 m
	Increase or Decrease in length	-318.20 m	Core length	14.30 m
	Length drilled	31.80	Core recovery	80 %

Core recovery of 100m hole		
Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	45	
100 ~ 200		
200 ~		

working hours		h	%	%
	Drilling	38°20'	24	13
	Other working	81°40'	51	29
	Recovering	40°00'	25	14
	Total	160°00'	100	56
	Reassemblage	96°00'		33
	Dismantlement	24°00'		8
	Water transportation			
	Road construction and others	8°00'		3
	G. Total	288°00'		100

Efficiency of Drilling	
Total m/work period(m/day)	31.8m/10days (3.18m/day)
Total m/total shift(m/shift)	31.8m/15shift (2.12m/shift)

Drilling length/bit(each sized bit)			
Bit size	PQ	HQ	NQ
Drilled length	2.50 m	8.70 m	20.60 m
Core length	0	0	14.30

Casing pipe inserted	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
	PQ	2.5	7.9	0
	HQ	20.1	63.2	0

Table 10–2 Summary Record of Drilling Work

		Survey Period: Period	days	work day (days)	off day (days)	total man day: Engineer (man)	total man day: worker (man)
Operation	Preparation	16.10.1985~ 2.11.1985	18	18	0	51	221
	Drilling	3.11.1985~ 7.12.1985	35	drilling 31	0	99	311
				recovering 4	0	12	36
	Removing	8.12.1985~10.12.1985	3	3	0	6	32
	Total	16.10.1985~10.12.1985	56	56	0	168	600

Drilling length	Length planed	350.00 m	Surface soil Overburden Quaternary	19.90 m
	Increase or Decrease in length	+0.30 m	Core length	319.30 m
	Length drilled	350.30	Core recovery	97 %

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	67	
100 ~ 200	100	85
200 ~ 300	100	90
300 ~ 350.3	99	91

		h	%	%
working hours	Drilling	234°10′	31	25
	Other working	369°50′	49	40
	Recovering	149°00′	20	16
	Total	753°00′	100	81
	Reassemblage	8°00′		1
	Dismantlement	14°00′		2
	Water transportation			
	Road construction and others	156°00′		16
	G. Total	931°00′		100

Efficiency of Drilling

Total m/work period(m/day)	350.30m/35days (10.00m/day)
Total m/total shift(m/shift)	350.30m/58shift (6.00m/shift)

Drilling length/bit(each sized bit)

Bit size	NW	NQ	BQ
Drilled length	19.90 m	188.30 m	142.10 m
Core length	0	178.10	141.20

	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
Casing pipe inserted	NW	29.0	8.3	
	BW	208.2	59.4	

Table 10–3 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	11.12.1985~25.12.1985	15	15 days	0 days	61 man	149 man
	Drilling	26.12.1985~23. 1.1986	29	drilling 29	0	98	403
				recovering 0	0	0	0
	Removing	24. 1.1986~28. 1.1986	5	5	0	3	24
	Total	11.12.1985~28. 1.1986	49	49	0	162	576

Drilling length	Length planed	350.00 m	Surface soil Overburden Quaternary	15.50 m
	Increase or Decrease in length	+1.00 m	Core length	331.40 m
	Length drilled	351.00	Core recovery	99 %

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	81	
100 ~ 200	90	94
200 ~ 300	91	94
300 ~ 351	99	94

working hours	Drilling	250°20′ h	41 %	27 %
	Other working	365°40′	59	39
	Recovering			
	Total	616°00′	100	66
	Reassemblage	127°00′		13
	Dismantlement	27°00′		3
	Water transportation			
	Road construction and others	156°00′		18
	G. Total	926°00′		100

Efficiency of Drilling

Total m/work period(m/day)	351.00m/29days (12.10m/day)
Total m/total shift(m/shift)	351.00m/55shift (6.38m/shift)

Drilling length/bit(each sized bit)

Bit size	NW	NQ	BQ
Drilled length	15.50 m	217.80 m	117.70 m
Core length	0	214.40	117.00

	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
Casing pipe inserted	HX	4.0	1.1	100
	NW	39.0	11.1	100
	BW	233.3	66.5	100

Table 10-4 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	29.12.1985~ 2. 1.1986	5	5 days	0 days	15 man	36 man
	Drilling	3. 1.1986~22. 1.1986	20	drilling 18	0	53	130
				recovering 2	0	6	18
	Removing	23. 1.1986~25. 1.1986	3	3	0	9	21
	Total	29.12.1985~25. 1.1986	28	28	0	83	205

Drilling length				
Length planed	300.00 m	Surface soil Overburden Quaternary	19.00 m
Increase or Decrease in length	+0.50 m	Core length	277.70 m
Length drilled	300.50	Core recovery	99 %

Core recovery of 100m hole		
Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	78.1	
100 ~ 200	98.9	88.7
200 ~ 300.5	101.5	92.4

working hours			
Drilling	165°30′ h	42 %	34 %
Other working	183°30′	46	38
Recovering	47°00′	12	10
Total	396°00′	100	82
Reassemblage	46°00′		9
Dismantlement	18°00′		4
Water transportation			
Road construction and others	24°00′		4
G. Total	484°00′		100

Efficiency of Drilling	
Total m/work period(m/day)	300.50m/20days (15.00m/day)
Total m/total shift(m/shift)	300.50m/32shift (9.39m/shift)

Drilling length/bit(each sized bit)			
Bit size	NW	NQ	BQ
Drilled length	19.00 m	173.00 m	108.50 m
Core length	0	169.50	108.20

Casing pipe inserted			
Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
NW	31.0	10.3	100
BW	192.0	63.9	100

Table 10–5 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	9. 2.1986~16. 2.1986	8	8 days	0 days	17 man	106 man
	Drilling	17. 2.1986~21. 3.1986	33	drilling 33	0	98	380
				recovering 0	0	0	0
	Removing	22. 3.1986~27. 3.1986	6	6	0	6	30
	Total	9. 2.1986~27. 3.1986	47	47	0	121	516

Drilling length				
Length planed	350.00 m	Surface soil Overburden Quaternary	19.00 m
Increase or Decrease in length	+1.00 m	Core length	302.40 m
Length drilled	351.00	Core recovery	91 %

Core recovery of 100m hole		
Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	99	
100 ~ 200	86	92
200 ~ 300	93	92
300 ~ 351	81	91

working hours	h	%	%
Drilling	279°05′	42	37
Other working	392°15′	58	52
Recovering			
Total	671°20′	100	89
Reassemblage	70°00′		9
Dismantlement	18°00′		2
Water transportation			
Road construction and others			
G. Total	759°20′		100

Efficiency of Drilling	
Total m/work period(m/day)	351.00m/33days (10.63m/day)
Total m/total shift(m/shift)	351.00m/52shift (6.75m/shift)

Drilling length/bit(each sized bit)			
Bit size	HW	NW	NQ
Drilled length	9.00 m	10.00 m	205.50 m
Core length	0	0	192.90
Bit size	BQ		
Drilled length	126.50 m		
Core length	109.50		

Casing pipe inserted: Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
HW	9.0	2.6	100
NW	44.00	12.5	97.7
BW	224.5	64.0	86.8

Table 10–6 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	26. 1.1986~ 6. 2.1986	12	days 12	days 0	man 24	man 148
	Drilling	7. 2.1986~11. 3.1986	33	drilling 26	0	90	268
				recovering 2	5	6	16
	Removing	12. 3.1986~13. 3.1986	2	2	0	6	16
	Total	26. 1.1986~13. 3.1986	47	42	5	126	448

Drilling length				
	Length planed	m 350.00	Surface soil Overburden Quaternary	m 8.00
	Increase or Decrease in length	m +0.60	Core length	m 331.40
	Length drilled	350.60	Core recovery	% 97

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	94	
100 ~ 200	99	97
200 ~ 300	97	97
300 ~ 350.6	95	97

working hours		h	%	%
	Drilling	238°30′	43	35
	Other working	259°30′	47	38
	Recovering	53°20′	10	8
	Total	551°20′	100	81
	Reassemblage	110°00′		16
	Dismantlement	18°00′		3
	Water transportation			
	Road construction and others			
	G. Total	679°20′		100

Efficiency of Drilling

Total m/work period(m/day)	350.60m/33days (10.62m/day)
Total m/total shift(m/shift)	350.60m/43shift (8.15m/shift)

Drilling length/bit(each sized bit)

Bit size	4″	NW	NQ	BQ
Drilled length	m 5.50	m 2.50	m 186.80	m 155.80
Core length	0	0	181.20	150.20

Casing pipe inserted	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
	4″	5.5	1.6	100
	NW	50.0	14.3	100
	BW	194.8	55.6	100

Table 10–7 Summary Record of Drilling Work

		Survey Period: Period	days	work day (days)	off day (days)	total man day: Engineer (man)	total man day: worker (man)
Operation	Preparation	14. 3.1986~24. 3.1986	11	11	0	32	112
	Drilling	25. 3.1986~ 9. 4.1986	16	drilling 16	0	72	113
				recovering 0	0	0	0
	Removing	10. 4.1986~12. 4.1986	3	3	0	3	24
	Total	14. 3.1986~12. 4.1986	30	30	0	107	269

Drilling length				
Length planed	300.00 m	Surface soil Overburden Quaternary	14.00 m
Increase or Decrease in length	+2.60 m	Core length	256.20 m
Length drilled	302.60	Core recovery	89 %

Core recovery of 100m hole: Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	75	
100 ~ 200	93	85
200 ~ 300	97	89
300 ~ 302.6	96	89

working hours	h	%	%
Drilling	219°20′	54	39
Other working	188°10′	46	34
Recovering			
Total	407°30′	100	73
Reassemblage	77°00′		14
Dismantlement	10°00′		2
Water transportation			
Road construction and others	64°00′		11
G. Total	558°30′		100

Efficiency of Drilling	
Total m/work period(m/day)	302.60m/16days (18.91m/day)
Total m/total shift(m/shift)	302.60m/31shift (9.76m/shift)

Drilling length/bit(each sized bit): Bit size	4″	NW	NQ
Drilled length	3.00 m	11.00 m	288.60 m
Core length	0	0	256.20

Casing pipe inserted: Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
4″	3.0	1.0	100
NW	57.0	18.8	100

Table 10–8 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	28. 3.1986~21. 4.1986	25	25 days	0 days	75 man	350 man
	Drilling	22. 4.1986~24. 6.1986	64	drilling 57	0	187	496
				recovering 7	0	21	24
	Removing	25. 6.1986~28. 6.1986	4	4	0	12	40
	Total	28. 3.1986~28. 6.1986	93	93	0	295	910

Drilling length				
	Length planed	350.00 m	Surface soil Overburden Quaternary	2.00 m
	Increase or Decrease in length	+0.20 m	Core length	223.10 m
	Length drilled	350.20	Core recovery	72 %

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	69	
100 ~ 200	62	57
200 ~ 300	72	62
300 ~ 350.2	76	64

working hours		h	%	%
	Drilling	434°10′	34	27
	Other working	805°40′	64	52
	Recovering	26°00′	2	2
	Total	1,265°50′	100	81
	Reassemblage	196°00′		13
	Dismantlement			
	Water transportation			
	Road construction and others	90°00′		6
	G. Total	1,551°50′		100

Efficiency of Drilling

Total m/work period(m/day)	350.20m/64days (5.47m/day)
Total m/total shift(m/shift)	350.20m/100shift (3.50m/shift)

Drilling length/bit(each sized bit)

Bit size	HW	NQ	BQ
Drilled length	2.00 m	248.60 m	99.60 m
Core length	0	146.30	76.80

Casing pipe inserted	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
	HW	7.00	2.0	100
	NW	58.50	16.7	100
	BW	250.60	71.6	100

Table 10–9 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	26. 6.1986~11. 7.1986	13	13 days	0 days	39 man	132 man
	Drilling	12. 7.1986~29. 7.1986	18	drilling 18	0	72	173
				recovering 0	0	0	0
	Removing	30. 7.1986~ 3. 8.1986	5	5	0	6	14
	Total	26. 6.1986~ 3. 8.1986	36	36	0	117	319

Drilling length	Length planed	350.00 m	Surface soil Overburden Quaternary	19.00 m
	Increase or Decrease in length	+1.00 m	Core length	291.60 m
	Length drilled	351.00	Core recovery	88 %

working hours	Drilling	199°50′ h	47 %	33 %
	Other working	223°30′	53	37
	Recovering			
	Total	423°20′	100	70
	Reassemblage	158°00′		26
	Dismantlement	20°00′		3
	Water transportation			
	Road construction and others	8°00′		1
	G. Total	601°20′		100

Casing pipe inserted				
Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
HW	19.00	5.4	100
NW	44.00	12.5	100
BW	245.60	70.0	82.9

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	81	
100 ~ 200	97	90
200 ~ 300	89	89
300 ~ 351	80	88

Efficiency of Drilling

Total m/work period(m/day)	351.00m/18days (19.50m/day)
Total m/total shift(m/shift)	351.00m/34shift (10.32m/shift)

Drilling length/bit(each sized bit)

Bit size	NW	NQ	BQ
Drilled length	19.00 m	226.60 m	105.40 m
Core length	0	207.60	84.00

Table 10–10 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	13. 4.1986~15. 5.1986	33	33 days	0 days	111 man	238 man
	Drilling	16. 5.1986~13. 6.1986	29	drilling 29	0	87	209
				recovering 0	0	0	0
	Removing	14. 6.1986~18. 6.1986	5	5	0	15	52
	Total	13. 4.1986~18. 6.1986	67	67	0	213	499

Drilling length	Length planed	400.00 m	Surface soil Overburden Quaternary	12.00 m
	Increase or Decrease in length	+1.10 m	Core length	307.50 m
	Length drilled	401.10	Core recovery	79 %

Core recovery of 100m hole		
Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	76	
100 ~ 200	80	78
200 ~ 300	94	84
300 ~ 401.1	66	79

		h	%	%
working hours	Drilling	320°40'	44	32
	Other working	398°20'	56	40
	Recovering			
	Total	719°00'	100	72
	Reassemblage	224°00'		22
	Dismantlement			
	Water transportation			
	Road construction and others	64°00'		6
	G. Total	1,007°00'		100

Efficiency of Drilling	
Total m/work period(m/day)	401.10m/29days (13.83m/day)
Total m/total shift(m/shift)	401.10m/57shift (7.03m/shift)

Drilling length/bit(each sized bit)				
Bit size	HW	NW	NQ	BQ
Drilled length	5.00 m	7.00 m	243.00 m	146.10 m
Core length	0	0	199.30	108.20

	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
Casing pipe inserted	HW	5.0	1.2	100
	NW	58.5	14.6	100
	BW	255.0	63.6	63.5

Table 10–11 Summary Record of Drilling Work

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	19. 6.1986~26. 6.1986	11	11 days	0 days	33 man	170 man
	Drilling	30. 6.1986~27. 7.1986	28	drilling 28	0	98	242
				recovering 0	0	0	0
	Removing	28. 7.1986~ 2. 8.1986	6	6	0	16	48
	Total	19. 6.1986~ 2. 8.1986	45	45	0	147	460

Drilling length		m		m
	Length planed	350.00	Surface soil Overburden Quaternary	5.00
	Increase or Decrease in length	+1.90	Core length	315.70
	Length drilled	351.90	Core recovery	91 %

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	83	
100 ~ 200	98	91
200 ~ 300	92	91
300 ~ 351.9	91	91

Working hours		h	%	%
	Drilling	346°50′	52	39
	Other working	316°50′	48	36
	Recovering			
	Total	663°40′	100	75
	Reassemblage	88°00′		10
	Dismantlement	75°00′		8
	Water transportation			
	Road construction and others	56°00′		7
	G. Total	882°40′		100

Efficiency of Drilling

Total m/work period(m/day)	351.90m/28days (12.56m/day)
Total m/total shift(m/shift)	351.90m/54shift (6.51m/shift)

Drilling length/bit(each sized bit)

Bit size	NW	NQ	BQ
Drilled length	5.00 m	253.60 m	93.30 m
Core length	0	230.30	85.40

Casing pipe inserted	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
	HW	5.00	1.4	100
	NW	57.00	16.2	100
	BW	258.60	73.5	58

chine, it was so delayed to finish the hole MJM-1. Therefore, it was arranged to use another TGM-5 drilling machine, afterwards two drilling machines were used.

Specifications of drilling machines and pumps, diamond bits and the details of consumed materials such as bentonite, light oil etc. are shown in Tables 6 and 8.

Most of mud materials and other consumed materials were brought from Japan, however wood, light oil, cement and others were prepared from local source.

3–1–3 Form of Works

For the preparations of drilling site, removings and dismantlements of drilling machine, one shift working per day was applied, however, the drilling work was done by two shifts with twelve hours per shift. The number of personnels for drilling work were five, consisting of one Japanese engineer, one counter part of Malaysian geological survey and local employees.

Result of drilling works are shown in Table 9, summary record of drilling results in Table 10, progress record of diamond drilling in Fig. 44.

3–4 Transportation of Machines, Equipments and Materials, and Road Constructions

Machines, mud materials and parts of engine were shipped from Japan and unloaded at Kota Kinabalu port, and then transported to the drilling site of MJM-1 hole by heavy trucks via Mamut Mine.

The ship sailed from Yokohama port on 26th August, however, coming across a typhoon on the way, so delayed to arrive at Kata Kinabalu on 18th September.

These machines and other materials arrived at drilling site on 22nd September. From the next day, the derrick tower and preparation for drilling work were started. At the same time, the road construction from MJM-1 to MJM-2 and land readjustments were also started. Then after, all road constructions for the drill site were made using buldozer.

For the transportation of drilling machine and/or heavy materials, a buldozer was used with riding on a sled for machines, pumps and mixers.

This transportation work sometimes met difficulties of cut of wire and running idle of catapillar when passing on the steep hill and soft muddy ground.

The total length of road construction is 2,400 meter.

Those accessories and materials for TGM-5 left Yokohama port on 5th December, and arrived at Kata Kinabalu on 20th December.

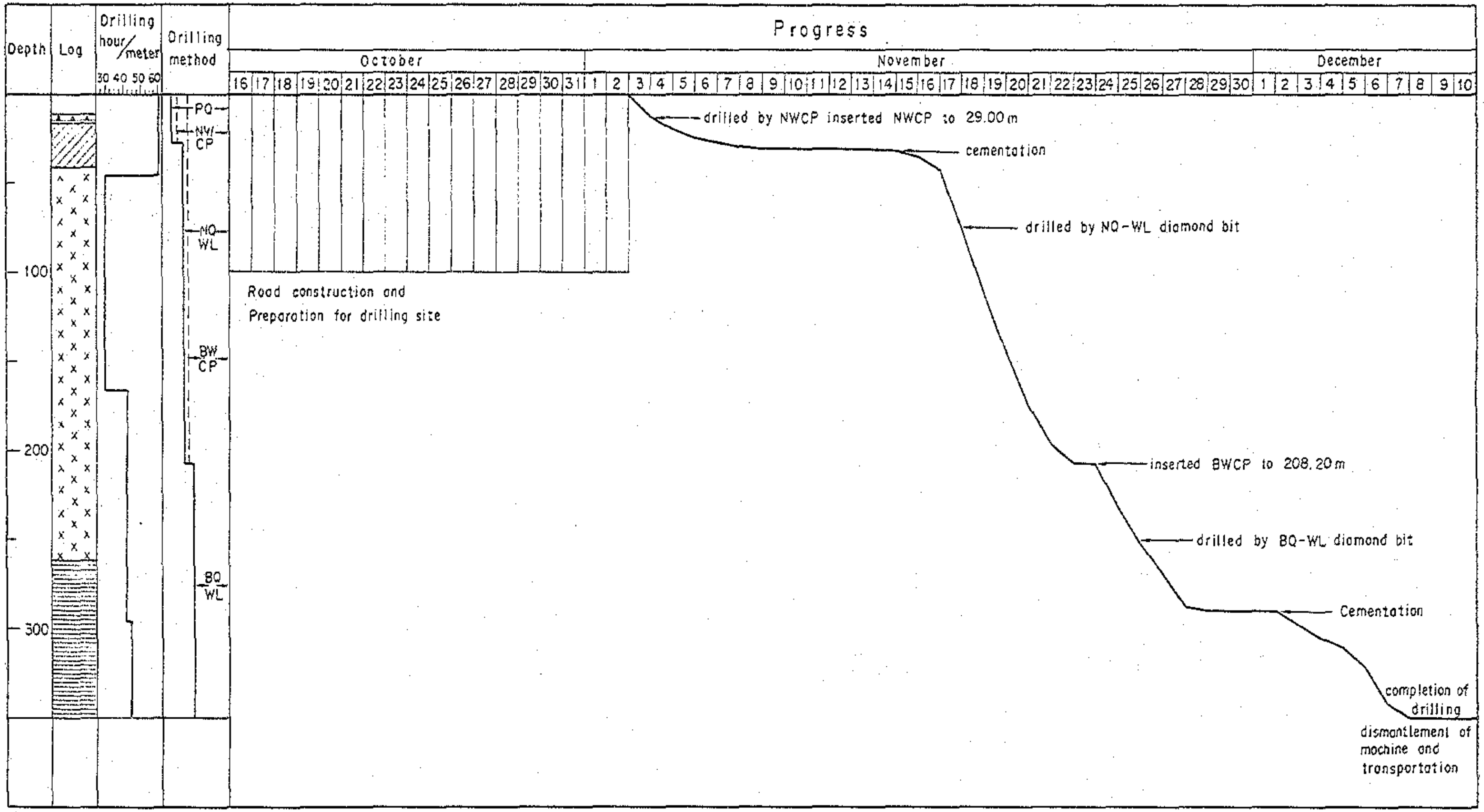


Fig. 44–1 Progress Record of Drilling (MJM–1)

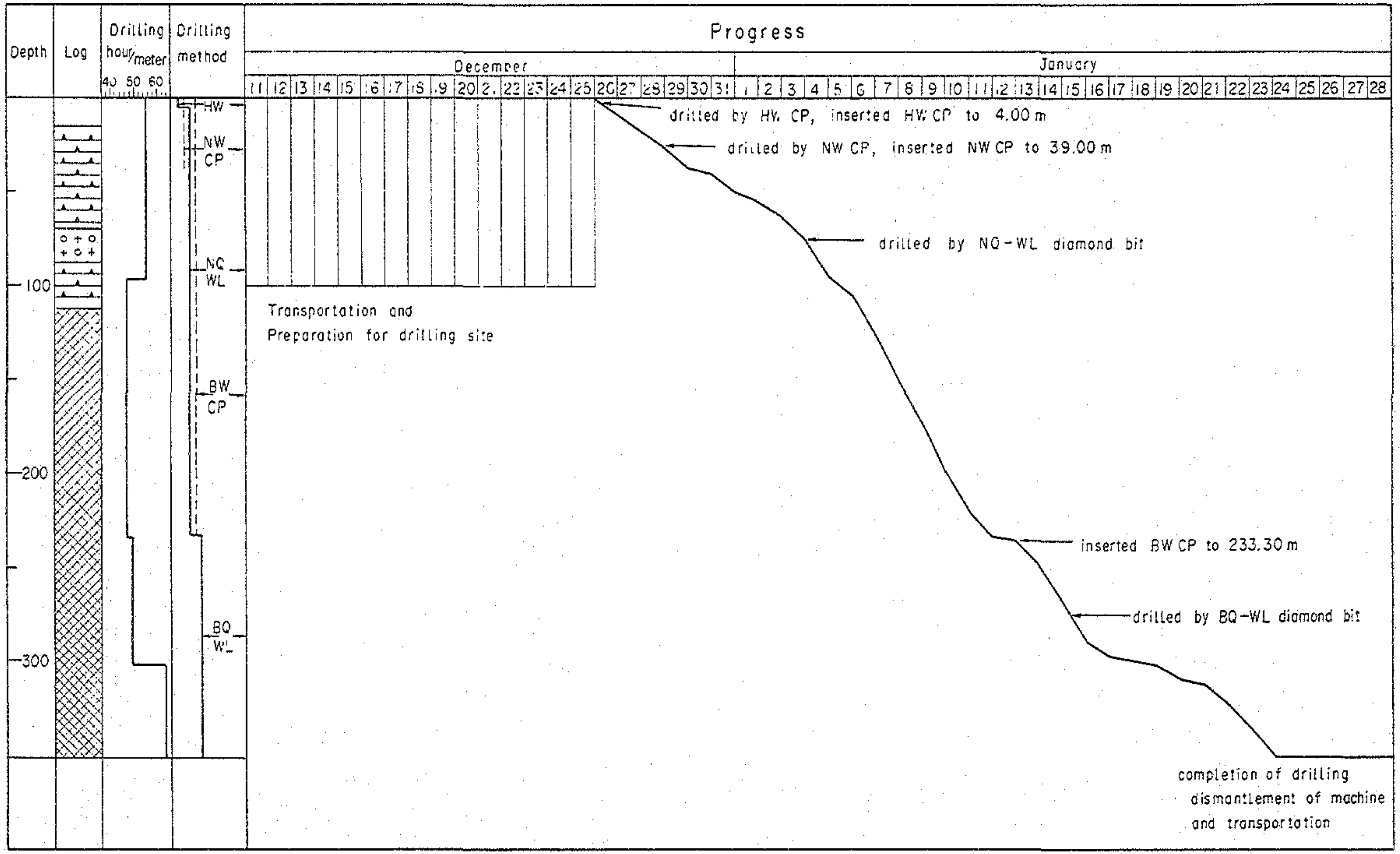


Fig. 44-2 Progress Record of Drilling (MJM-2)

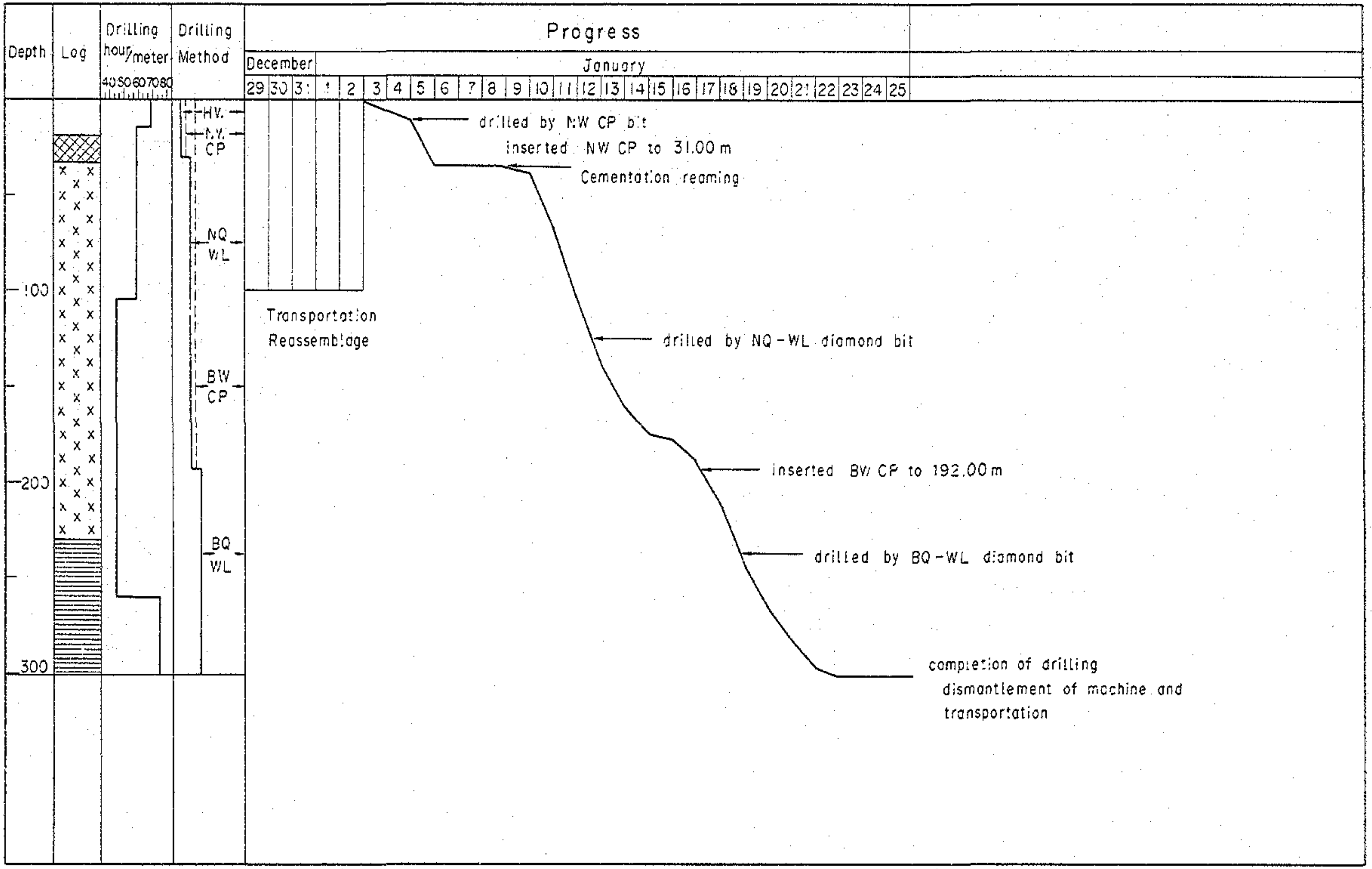


Fig. 44–3 Progress Record of Drilling (MJM–3)

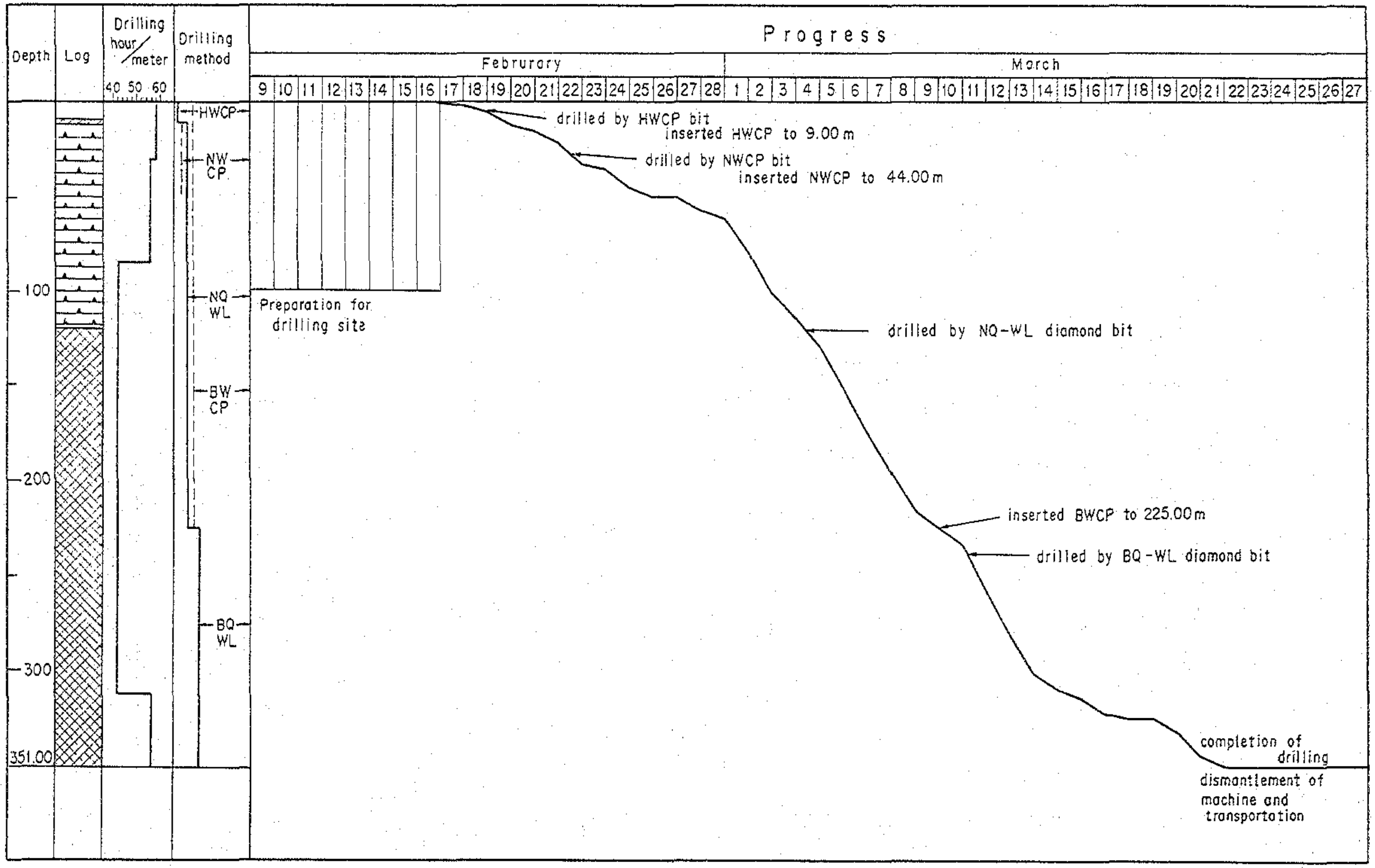


Fig. 44–4 Progress Record of Drilling (MJM–4)

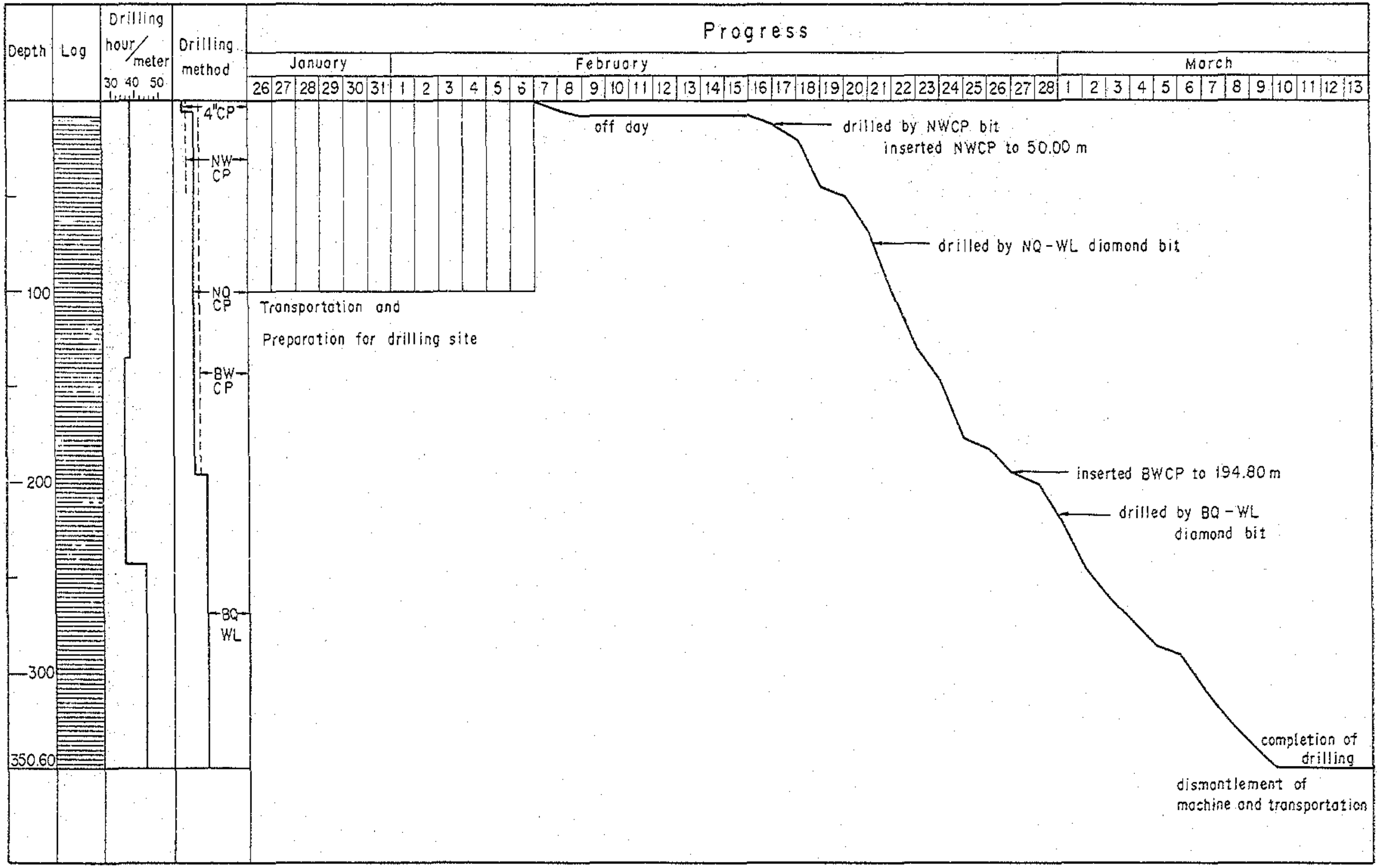


Fig. 44–5 Progress Record of Drilling (MJM–5)

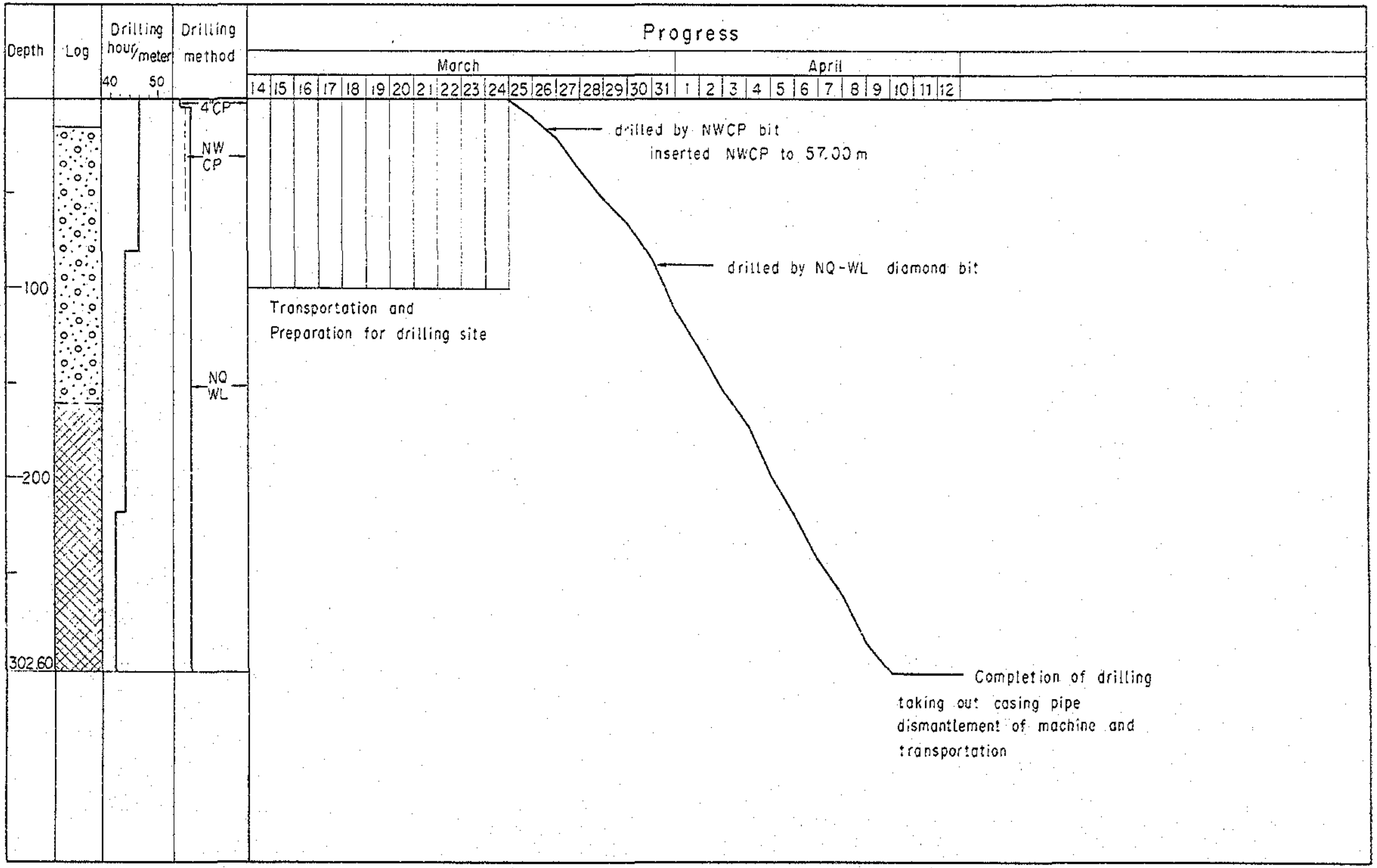


Fig. 44–6 Progress Record of Drilling (MJM–6)

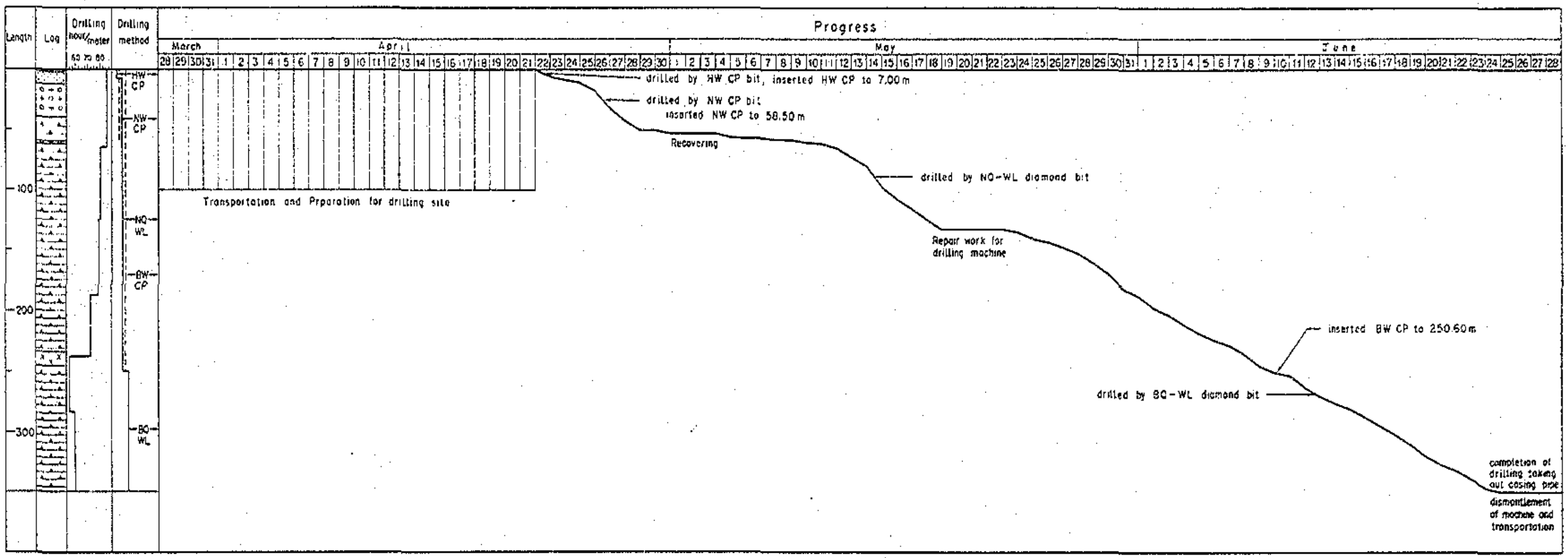


Fig. 44–7 Progress Record of Drilling (MJM–7)

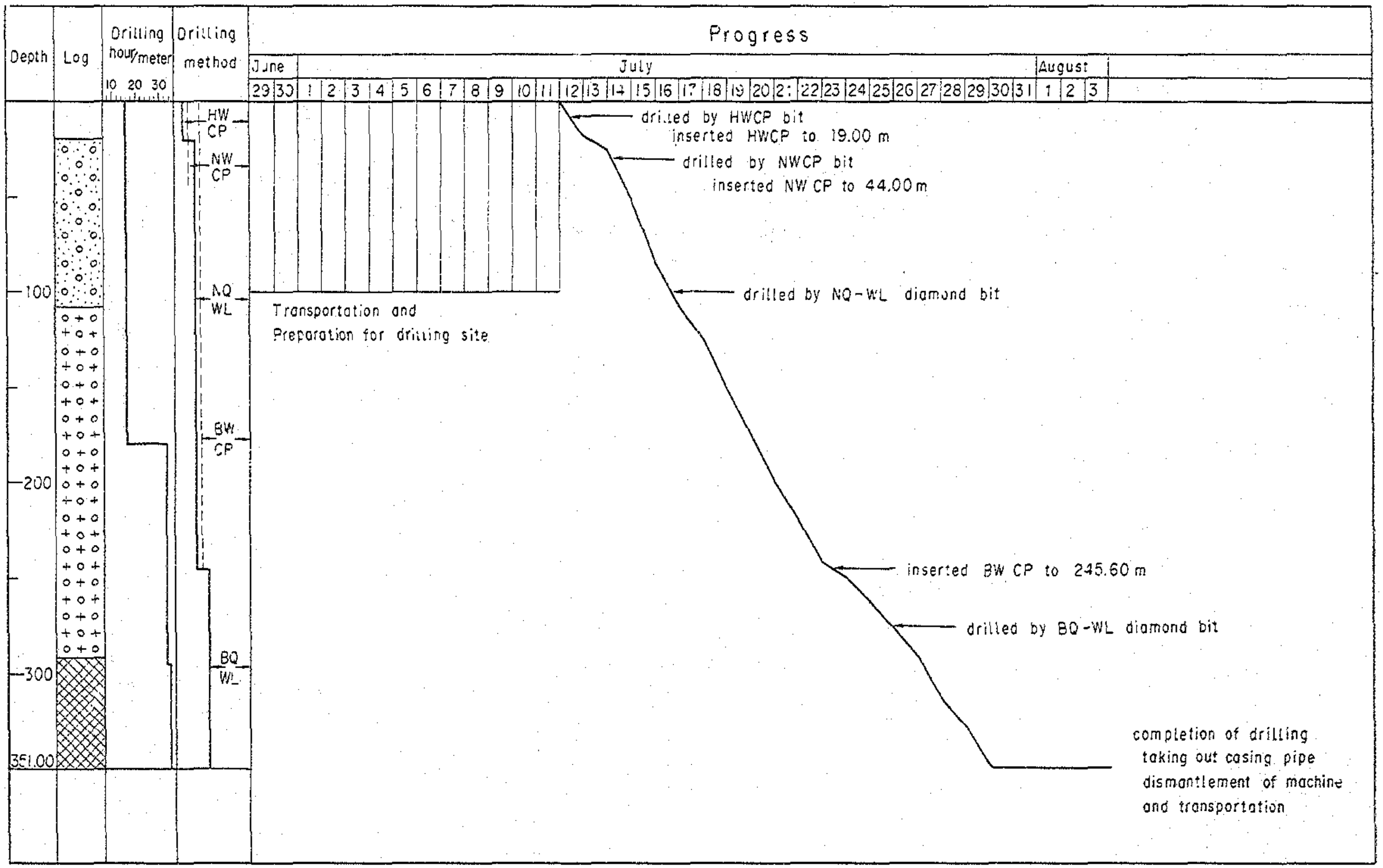


Fig. 44–8 Progress Record of Drilling (MJM–8)

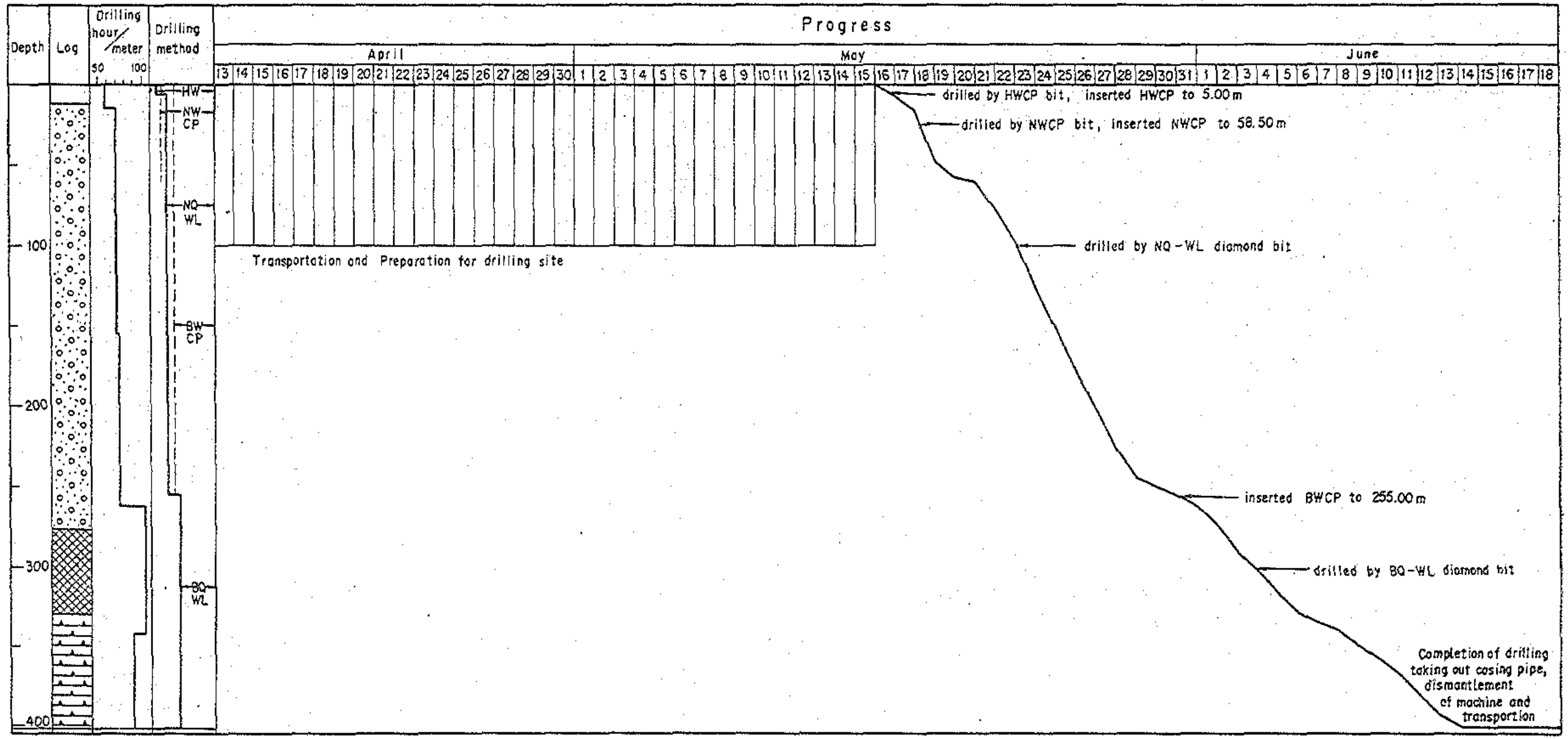


Fig. 44–9 Progress Record of Drilling (MJM–9)

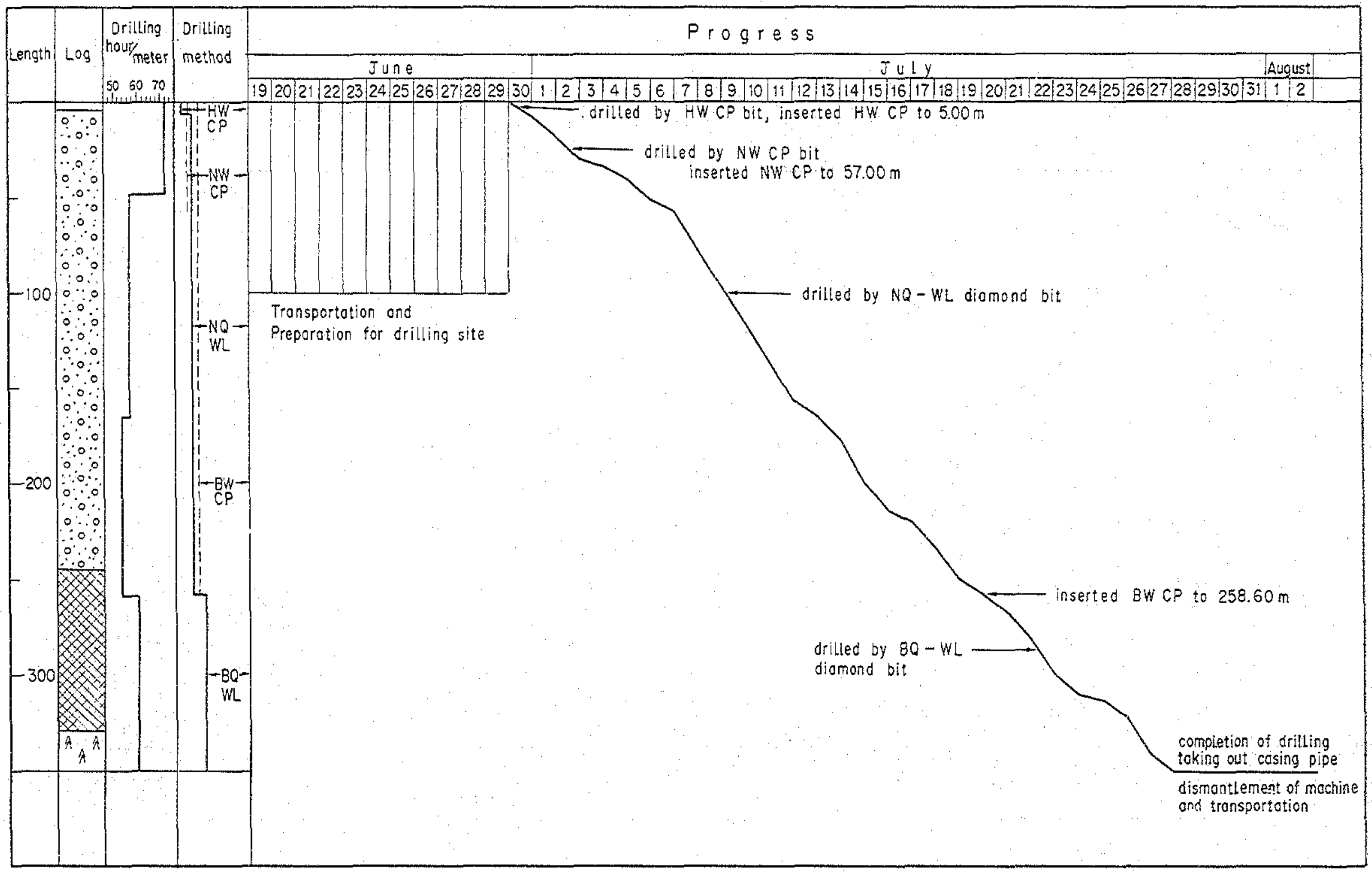


Fig. 44–10 Progress Record of Drilling (MJM–10)

3–1–5 Water Supply

Water for drilling work was obtained from a creek near Bambangan water intake for the holes of MJM-1 and MJM-3 with a line of plastic pipe.

For the other holes, the water is obtained from upstream of creek by spontaneous flow. Delivery hose with its diameter of 1½ inches was used for supply of water.

3–1–6 Dismantlement

After the drilling work, machines and equipments was gathered in the area around the drill site of MJM-8 hole, and the generators and the engine for water pump etc. were collected to the base camp in Ranau.

All cores were put in core box, transfered to Sabah office, Malaysian Geological Survey.

3–1–7 Deviation of Drilling Holes

Azimuth and inclination of some holes such as MJM-7, 8 and 10 were measured.

The results are as follows.

MJM-7	58° –46° at 310 m depth
	(designed angle : 70° –50°)
MJM-8	272° –35° at 351 m depth
	(designed angle : 270° –50°)
MJM-10	70° –35° at 357.90 m depth
	(designed angle : 70°–50°)

3–2 Result of Drilling

The results of survey performed along the Bambangan Creek in "a" area where ten holes with its proposed length of 3,450 m in total are as follows;

The locations of drill site are shown in Fig. 43, the core loggings of ten holes are to be referred in Fig. 45, the profile of each hole is in Fig. 47 and schematic geological section in "a" area is in Fig. 48.

3–2–1 Geology

(1) Drilling Hole MJM-1 (350° –50°,350.30 m)

The hole was designed to confirm the possibilities of the continuation of mineralization below 100 m from the surface. The mineralization zone of disseminated copper oxide minerals is distributed in sheared zone along the boundary between adamellite porphyry and serpentinite on the middle of the cliff along the Bambangan Creek.

Geology of the hole is as follows;

From the surface to 40.8 m is hornfels and serpentinite, then garnet-microdiorite to 263.3 m, which is suffered strong weathering, then turbidite layers as geosynclinal and flysh type sediments belong to Trusmadi Formation to the bottom of the hole. The turbidite consists of subangular to rounded pebble size siltstone and mudstone with the same matrix.

The alterations are rather weak. Calcitization, silicification and chloritization are common in garnet-microdiorite. Partially magnetic dots can be detected but pyrites are rare.

The argillization is more abundant than calcitization in turbidite, however it can be recognized as the alteration before sedimentation.

Very rare fine pyrites in lenticular shape occurred at the depth of 298.9 m.

(2) Drilling Hole MJM-2 (70° −50°, 351.00 m)

This hole was designed to find the mineralized zone expected underneath of the Pinosuk Gravels which widely distributed in the shape of elevated terrace between Mamut open pit and Bambangan Creek. In western side of the Pinosuk Gravels, there is an outcrop of the mineralized sheared zone, where the hole MJM-1 was drilled. The location of MJM-2 is situated 700 m north from JMJ-1 on the western flank of Pinosuk Gravels terrain.

The geology of the hole is as follows;

From surface to 69.04 m is biotite-hornfels then adamellite-porphyry and from 93.20 m to 112.70 m is hornfels and then serpentinized peridotite to the bottom of the hole.

The alterations are silicification, calcitization, serpentinization, biotitization and chloritization etc.

The pyritizations may indicate the process of the mineralization, which also common in the peridotite.

The mineralization in the porphyry-copper type seems to be the same type as the Mamut ore deposit, having very rare chalcopyrites and molybdenites with common occurrence of pyrite in peridotite.

depth (width)	Au g/t	Cu %	Mo ppm
69.50m− 70.00m (0.50m)	0.12	0.182	4
142.80m−146.80m (4.00m)	0.16	0.030	4
167.90m−176.90m (5.00m)	0.26	0.031	10
182.20m−183.70m (1.50m)	0.22	0.029	23
186.80m−188.40m (1.10m)	0.13	0.033	203
198.20m−209.20m (11.00m)	0.10	0.014	35

depth (width)	Au g/t	Cu %	Mo ppm
212.50m–214.00m (1.50m)	0.07	0.080	12
226.10m–233.60m (7.50m)	0.23	0.017	13
214.70m–243.20m (1.50m)	0.12	0.013	10
290.60m–293.00m (2.40m)	0.21	0.095	6
296.40m–297.60m (1.20m)	0.19	0.091	6
299.80m–301.80m (4.00m)	0.18	0.089	5
309.90m–313.00m (3.10m)	0.09	0.052	3
322.20m–326.70m (4.50m)	0.19	0.169	10
335.00m–337.50m (2.50m)	0.25	0.061	6

The highest grade were obtained in the depth of 324.20–324.70m (0.50m) Cu : 0.635%.

(3) Drilling Hole MJM-3 (20° –50°, 300.50 m)

The purpose of MJM-1 was not only to find out the extention of the oxide copper mineralized zone below 100 m from surface, but also to confirm the possibilities of mineralization in the geochemical anomalies.

The geology of the hole is exactly the same as the geology in MJM-1 as follows;

From the surface to 31.6 m is serpentinite zone with some length of hornfels at the first portion (in no core zone), then encountering garnet-microdiorite and then the turbidite layers at 230.73 m until the bottom of the hole.

The alteration and mineralization is similar as those of MJM-1.

(4) Drilling Hole MJM-4 (30° –50°, 351.00 m)

The adamellite-porphyry has copper oxide mineralization in the exposure along west bank of Bambangan creek, however, it is very weak mineralized zone in the drilling hole MJM-2.

So this hole was designed to confirm the extension of mineralized adamellite-porphyry between above mentioned exposure and MJM-2 hole.

Geology of the hole is similar to those of MJM-2, as biotite-hornfels from surface to 121.20 m, then serpentinized peridotite to the bottom of the hole. No adamellite-porphyry was encountered.

The alterations are as follows;

weak silification through out of the hole, calcitization in some part, serpentinization, talc, biotitization and chloritization are observed in peridotite, weak pyritization is also accompanied in some part. For the mineralization, weak copper-molybdenum mineralizations were confirmed in the following parts.