Chapter 5. Geophysical survey

5-1 Physical properties of rocks and ore samples

5-1-1 The method of measurement

In order to discuss the method of geophysical survey, measurement of physical properties of rocks and ore minerals which were sampled at the outcrops and in the underground of the mines was carried out. The specimens were cut to the squares with about 6 cm side. Voltage measurement with 10 uA of transmitted current, 3 Hz and 0.3 Hz of frequencies to calculate relative resistivity. Platinum wire (0.4 mm diameter) was used as current and potential electrodes. Polarization ratio (PFE) was calculated using the following equation.

$$PFE=(\rho0.3 - \rho3)/\rho3 \times 100\ (\%)$$

where, $\rho0.3$ is relative resistivity in 0.3 Hz, $\rho3$ is relative resistivity in 3 Hz.

5-1-2 Results of Measurement

Resistivity and chargeability of each strata and rock facies are shown in Fig.II-5-1. The relationship between IP and relative resistivity in the specimens of rocks and ore minerals is shown in Fig.II-5-2.

1. Relative resistivity

Resistivity varies from 128 to 13,216 Ω·m. The resistivity of slate is the minimum, and it has the tendency of increasing from arose to conglomerate, through mafic rocks (dolerites, amphibolite, basalt), quartzite, quartz vein, sandstone, granite to dolomite.

Resistivity of the arose of the Deweras Group which is the main horizon occurring ore deposits is high whose value is from 3,000 to 7,000 Ω·m in the specimens which were mineralized by sulphides. The resistivity varies from 500 to 7,000 Ω·m in the specimens which are not mineralized. Therefore, mineralization does not make any effect to the resistivity. On the other hand, the resistivity in the specimens which are mineralized by oxides shows the tendency of relatively slightly low from 500 to 1,000 Ω·m.

The resistivity in dolerites and amphibolites which were mineralized by sulphides markedly varies from 700 to 6,000 Ω·m.

2. Chargeability

The chargeability in arkose which was mineralized by sulphides shows high IP from 5 to 18 % according to the grade of copper. However, the chargeability in arkose which was mineralized by oxides only shows less than 1 % of IP.

The chargeability in dolerite and amphibolite which were mineralized by sulphides shows high

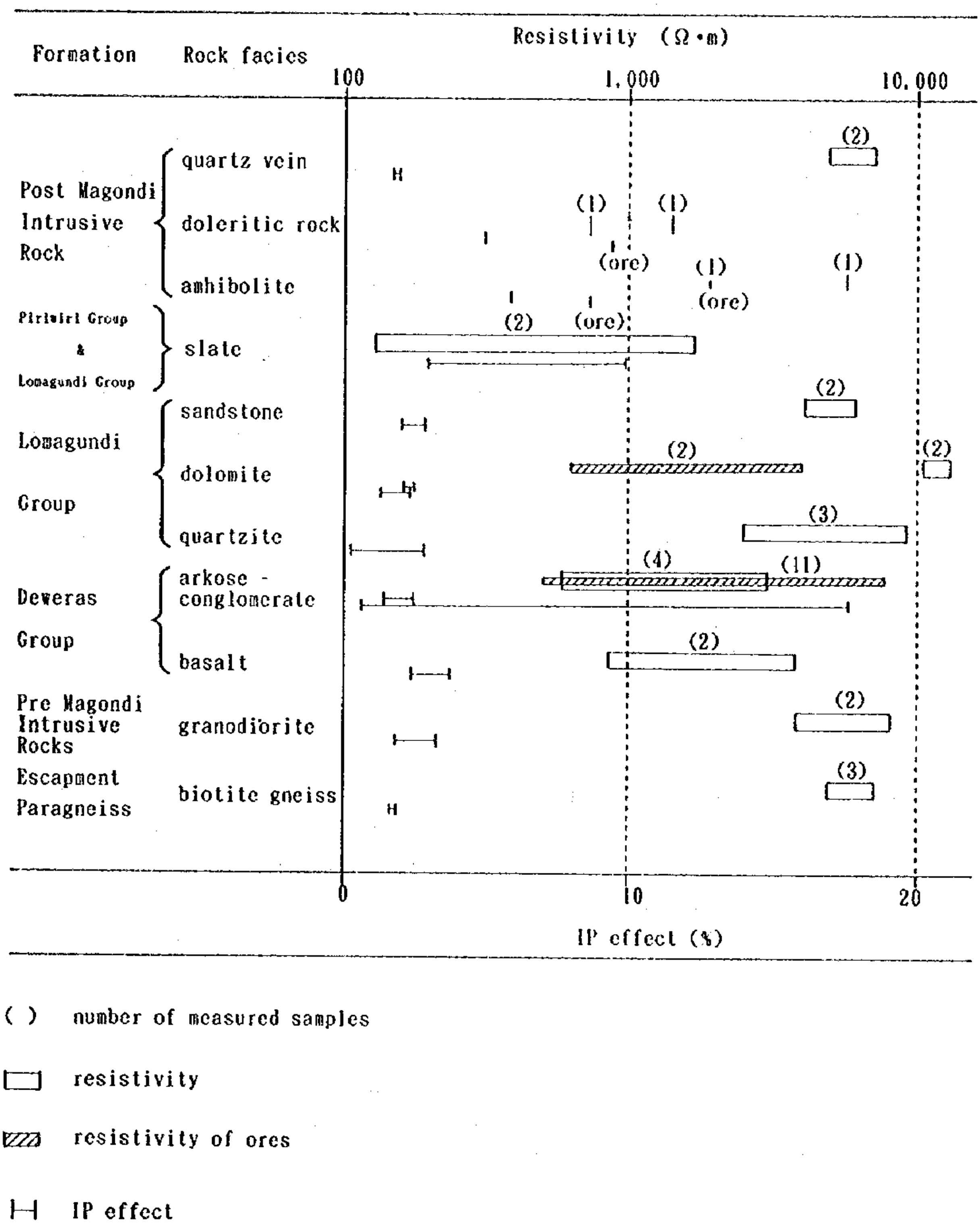

Fig.II-5-1 Apparent resistivities and IP of rock samples

IP from 4 to 10 % according to the grade of sulphide.

Graphitic slate shows high IP of approximate 10 %.

The other rocks show low IP of 1 to 3 %.

3. Spectral IP

The SIP measurement was carried out for the typical specimens after the measurement of relative resistivity and chargeability, and the examinations about spectral characteristics of ore minerals and rocks. the following facts can be pointed out.

In sulphide ore minerals, the phase difference is big and constant regardless of frequency.

In oxide ore minerals, the phase difference is small and constant regardless of frequency.

In dolerite and arose with little mineralization, the phase difference is small for low frequency, and the phase difference for high frequency constant is 2 or 3 times of that for low frequency.

As regards magnitude, some rocks shows the tendency of increasing or decreasing for high frequency, and some rocks shows constant. There is no obvious difference in relationship between magnitude and mineralization.

From the above facts, the following points must be noticed in case of application of geophysical survey in this area.

1) The arose of the Deweras Group which is the main horizon of ore deposit occurrence in this area shows high IP according to the progress of sulphide mineralization.

2) Resistivity markedly varied, and possibility of effect to the resistivity by sulphide mineralization is little.

3) Mineralized dolerite and amphibolite shows high IP according to progress of mineralization.

4) Although graphitic slate shows high IP of approximate 10 %, the distribution is not recognized within the Deweras Group which is the main horizon of the ore deposit occurrence. Therefore, the graphitic slate can not be interruption factor of IP survey.

5) Judging from the spectral characteristics, variety of the phase differences in ore minerals and rocks are observed.

5-1-3 Consideration

On the measurement of physical properties of rocks and ore samples, the chargeability method (e.g. IP survey) which detect the difference of the sulphide mineralization from the other is more expectative in case of application of geophysical prospecting in this area.

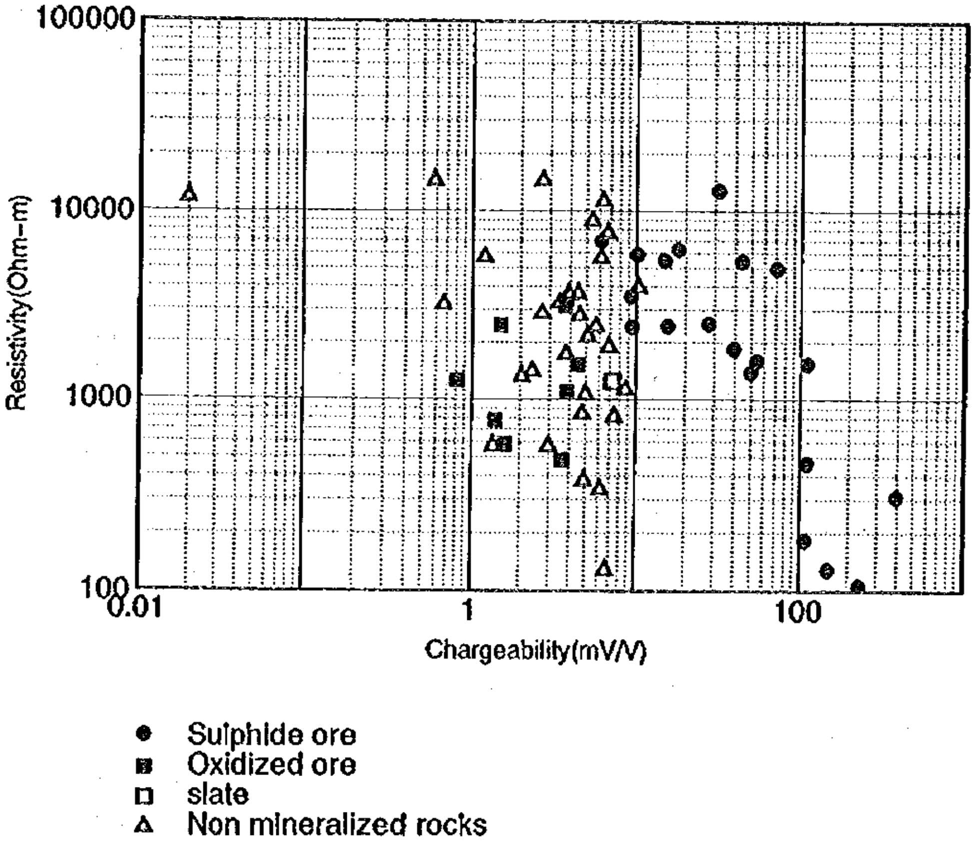

Fig.II-5-2 Relationship between IP and apparent resistivity of rock and ore samples

5-2 IP survey

5-2-1 Contents of the survey

Geophysical electrical methods of prospecting were carried out using IP method in two stages. One was to set up the survey lines on the geochemical anomalous places as reconnaissance. The other was to set up new additional survey lines parallel or extension to reconnaissance survey lines as a semi-detailed survey.

Specifications of the geophysical survey are shown in Table II-5-1. The index map of the survey area is shown in Fig.I-1-1.

Table II-5-1 Specification of the geophysical survey

	reconnaissance survey	semi-detailed survey
method	Induced polarization method(IP method)	
detection method	Time domain method	
electrode arrangements	dipole-dipole arrangement	
Separation of electrodes	a=200m	a=200m, a=100m
Coefficient of separation of electrode	n=1 ~ 4	
number of survey lines	21	12
Total length of survey lines	51.0km	23.2km
Measurement of physical properties(laboratory test) of rocks and ores	chargeability and resistivity 60 specimens	

5-2-2. Operation

1. Determination of survey lines and survey

After plotting the locations of Cu anomalous places(positioning by GPS) on the map, the lines were determined from the starting point, which was decided as the suitable point with bench mark such as crossing of road, river or power cable. The direction of the lines were decided to be at right angles to the strike of geology. The survey was carried out using pocket compass and esron tape.

The lines are shown in Fig.II-5-3.

2. Measuring method of IP phenomena

The intermittent electric current (on/off 2.0sec) was introduced into the earth through the current electrodes, and the primary potential difference(Vp) just before switching off the power and the secondary potential difference(Vs) just after was switching off the power is measured between another couple of potential electrodes.

Vs was measured in the time t(4msec ~ 14msec) after the power was switched off in this survey.

The concept of operation is shown in Fig.II-5-4. The concept of the method of measurement is shown in Fig.II-5-5 and the list of sampling time is shown Table in II-5-2.

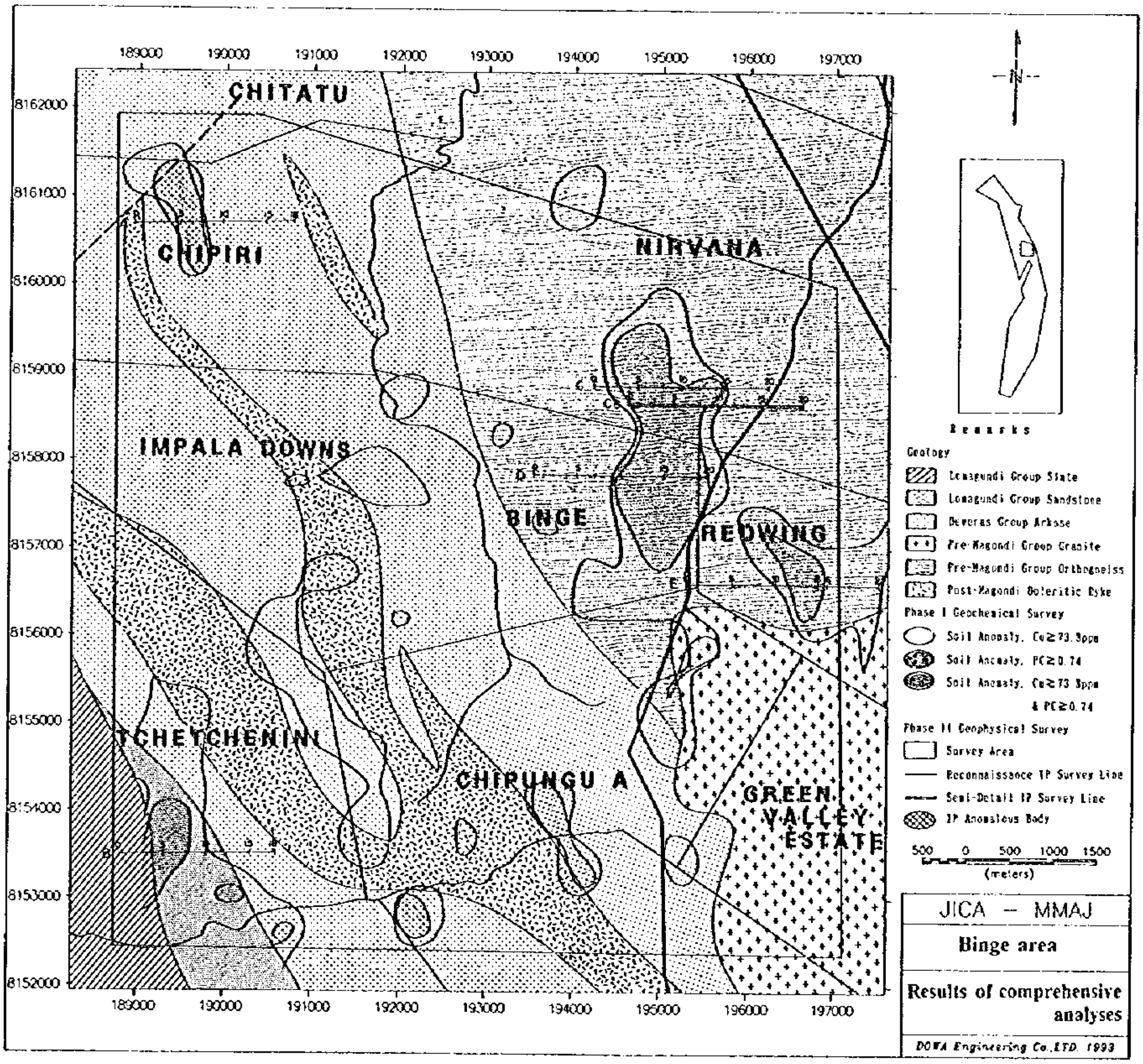

Fig.II-5-3 Locality of survey lines (Binge area)

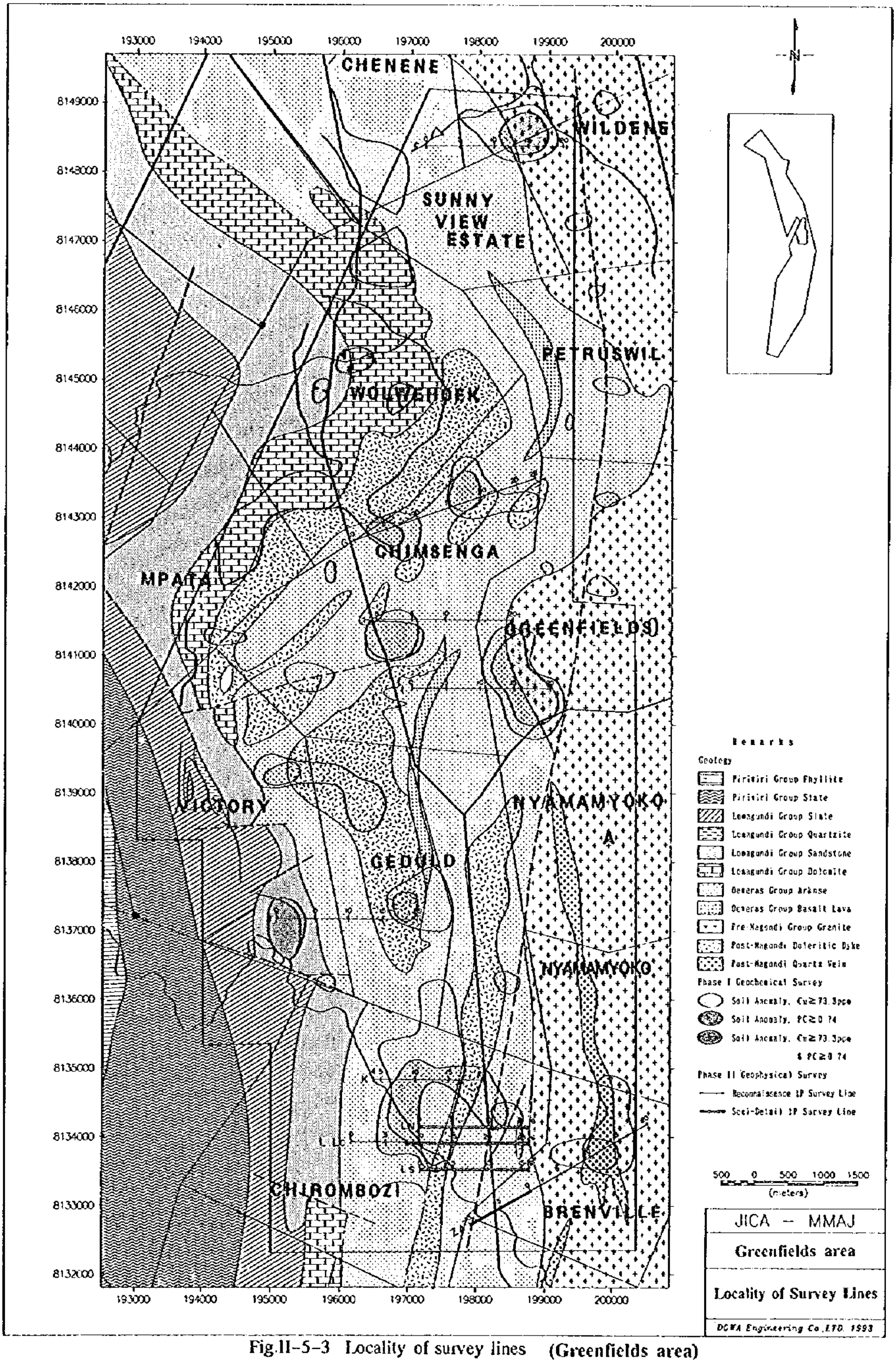

Fig.II-5-3 Locality of survey lines (Greenfields area)

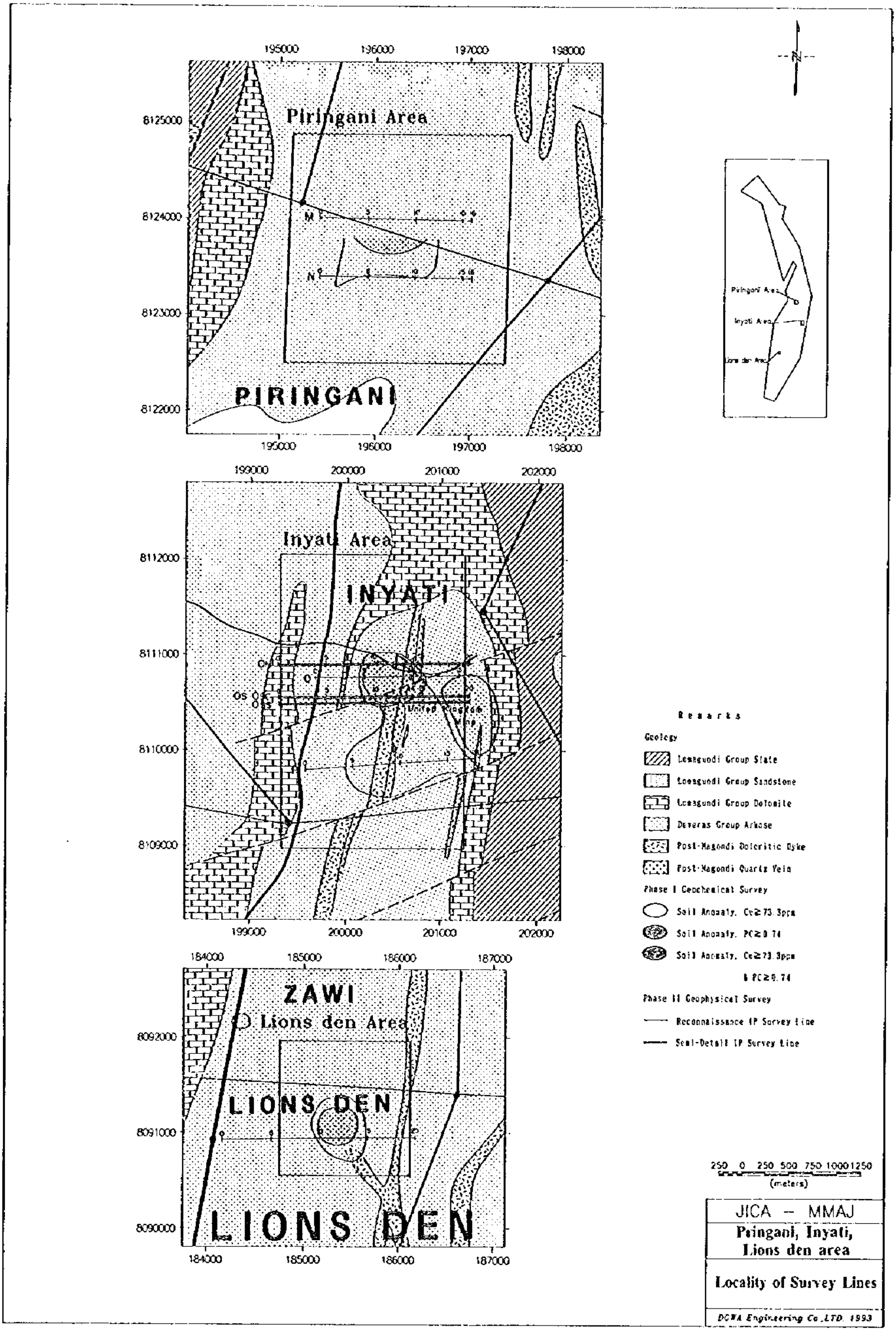

Fig.II-5-3 Locality of survey lines (Pringani, Inyati, Lions den area)

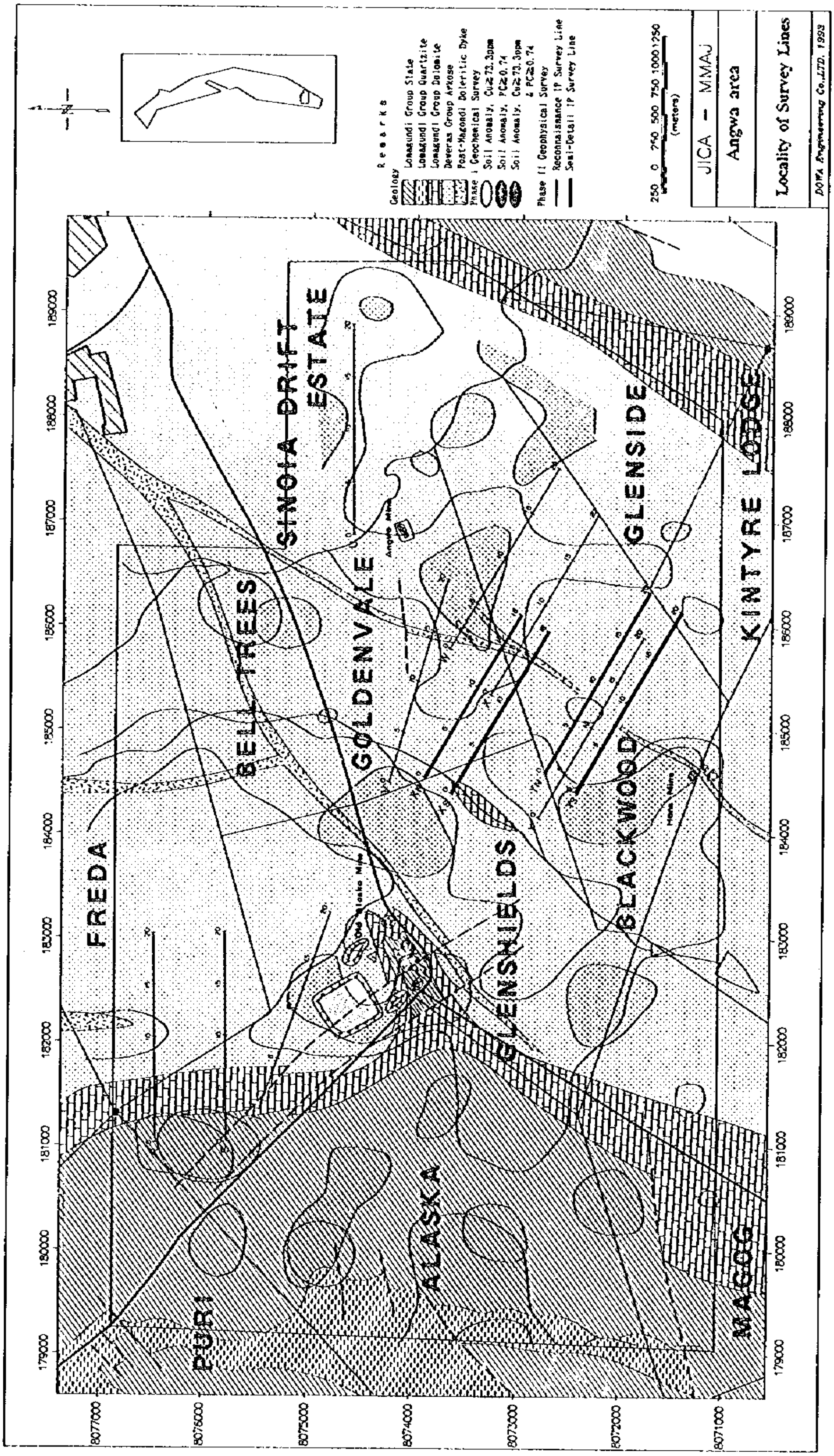

Fig.II-5-3 Locality of survey lines (Angwa area)

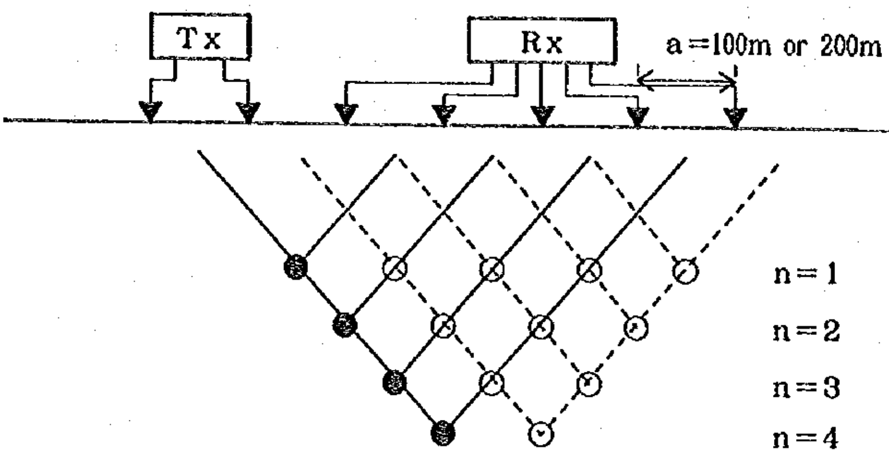

Fig.II-5-4 Concept of operation

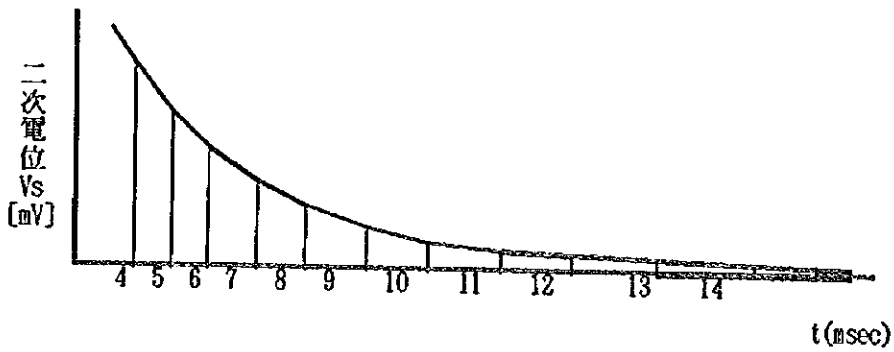

Fig.II-5-5 Concept of the method of measurement

TableII-5-2 List of sampling time

Slice #	4	5	6	7	8	9	10	11	12	13	14
Width (msec)	20	40	40	80	80	140	140	230	230	360	360
Mid-Point (")	60	90	130	190	270	380	520	705	935	1230	1590

3. Measurement of the physical properties of the rocks

IP measurements of 60 specimens of representative rocks and ores of this area were carried out in order to collect the fundamental data of the electrical characteristics of the rocks.

IP and resistivity measurements were carried out by the time-domain method after cutting four surfaces of each rock and dipping in tap water for a period of 1 day. The same receiver used in field was used in the this measurement.

5-2-3. Data processing

The analysis of this survey was carried out as a two dimensional problem, because the cross section with enough width(10km in horizontal × 3km in vertical) was chosen instead of cubic content.

The simulation analyses of resistivity and IP suspected section was carried out by 2.5 dimensional finite element method programs of Coggon(1971) and Rijo(1977). In these analyses, several ten times of repetition was made by conversational mode of model input and amendment until the completion of approximation to suspected section.

5-3. Results of survey

5-3-1. Result of reconnaissance

The characteristics of resistivity and IP distribution of each line are summarized and shown in TableII-5-3.

TableII-5-3 List of the result of reconnaissance

line	Resistivity	IP value	characteristic of distribution
A	500 ~ 5,000	1.8 ~ 6.1	generally low IP
B	64 ~ 1,400	1.8 ~ 9.6	distinct IP anomaly on stations No.2 to No.10
C	319 ~ 3,024	2.4 ~ 8.2	distinct IP anomalies on stations No.2 to No.14
D	119 ~ 2,860	4.7 ~ 8.8	generally indistinct
E	130 ~ 3,135	1.0 ~ 5.0	generally low IP
F	422 ~ 3,105	0.2 ~ 5.8	generally indistinct
G	196 ~ 1,055	2.1 ~ 6.6	generally low IP
H	147 ~ 580	2.9 ~ 4.9	generally low IP
I	342 ~ 4,182	3.3 ~ 7.7	IP anomaly in the shallow the station No.2
J	240 ~ 825	3.6 ~ 5.6	generally indistinct
K	175 ~ 1,054	2.6 ~ 5.3	generally low IP
L	198 ~ 1,051	2.2 ~ 10.6	detected an IP anomaly on stations No.14 to No.20
Za	394 ~ 4,615	2.3 ~ 9.0	detected an IP anomaly on stations No.0 to No.4
M	92 ~ 715	4.4 ~ 5.9	weak IP anomaly, widening towards the deep part
N	140 ~ 573	3.5 ~ 5.9	weak IP anomaly on the stations No.10 to No.12
O	169 ~ 1,433	0.8 ~ 7.8	distinct IP anomaly widening towards the deep part
P	149 ~ 2,367	2.3 ~ 5.2	generally low IP
Q	132 ~ 769	2.6 ~ 6.6	weak IP anomaly on the stations No.4 to No.14
R	172 ~ 1,236	3.1 ~ 5.8	weak IP anomaly in the deep part the No.6 station
S	142 ~ 4,730	3.8 ~ 6.7	weak IP anomaly in the deep part the No.6 station
T	230 ~ 753	2.8 ~ 4.2	generally low IP
U	217 ~ 1,499	2.3 ~ 5.5	generally low IP
V	413 ~ 2,684	2.4 ~ 6.0	generally indistinct
W	145 ~ 1,519	2.7 ~ 6.3	weak IP anomalies on the stations No.4 and No.12
X	221 ~ 1,600	3.0 ~ 8.8	detected an IP anomaly on the stations No.0 to No.6
Y	374 ~ 2,270	3.0 ~ 9.6	distinct anomaly on the stations No.12 to No.16

5-3-2. Results of semi-detailed survey

1. Provisional resistivity and IP cross sections of semi-detailed survey

The lines were determined in semi-detailed survey from IP anomalous zones which were detected by reconnaissance survey of the lines C, L, O, X, Y and Za which were presumed to have detected IP anomalies shown in Fig.II-5-3. The electrode separation survey 100m to detect the source of IP anomalies of the shallow IP anomalies.

The Binge site

C and Cs line

Cs line was set up 150m south of C line.

Tendencies of low resistivity/low IP and high resistivity/high IP are shown on each line, and all the IP patterns correlate.

The IP anomalous pattern of the eastern side of Cs line is weak.

The Greenfields site

Ln, Lc, L and Ls line

The line L was extended 600m to the east.The line Ln and the line Ls were set up 200m to the north and 400m to the south of the line L, respectively. The line Lc is on the line L, and the electrodes separation is 100m.

The distribution of IP anomalies of the eastern part by the extension of line L and setting 100m electrodes separation was analyzed. Comparing the IP anomaly patterns by 200m and 100m electrodes separation in the same depth, the IP anomaly pattern by 100m electrodes separation shows more complex patterns than by 200m electrodes separation. This means that 100m electrodes separation shows distinct sensitivity for IP anomaly. The IP anomaly shows complex shape from the shallow part to the deep part under the stations No.12 to No.22.

An indistinct IP anomaly(6.8mV) was detected under the stations No.7 to No.10 in Ln line.

An indistinct IP anomaly(5.2mV) was detected near the surface of the stations No.8 to No.12 in Ls line. The anomaly is less distinct than in the Ln survey line.

Za line

This line was extended 1km to the west.

The IP anomalous zone is widely distributed in the western side. The anomalous pattern shows distinct shape which widens towards the deeper part. The IP anomaly which is located in the station No.0 corresponds to arkose. The eastern part of the station No.4 is the distribution area of the basement granite.

The Inyati site

On, O, Os, Osc, Oss line

Osc survey line with 100m electrodes separation was set up on the Os survey line.

On survey line, Os survey line and Oss survey line were set up 400m north, 200m south and 250m south of O survey line, respectively.

The IP anomaly of the anomalous zone in On line which is the same pattern in O section is weaker than that of O section.

There is distinct IP pattern of the shallow part in Os and Osc section.

The IP anomaly pattern by 100m electrodes separation shows more clear pattern near the surface of the station of No.8 to No.9 in Osc line.

There are IP anomalies in Os and Oss lines however, it suggests that IP anomaly decreases in Oss line which is the south of Os section.

The Angwa site

Xn, X, Xs line

Xn and Xs survey lines were set 150m north and 150m south of X survey line, respectively.

All the lines show the tendency of high resistivity and high IP anomaly.

The Ip anomalies are distributed in the west end of Xn, X line, and centre part of in Xs line, respectively.

The Ip anomalies in all the lines are recognized in the area comprising arkose.

Yn, Y, Ys line

Yn and Ys survey lines were set 150m north and 150m south of Y survey line, respectively.

All the lines show the tendency of high resistivity and high IP anomaly.

The distinct IP anomaly of the deeper part are distributed in the station No.10 to No.14 in Ys line.

The IP anomaly in Ys section is more distinct than that in Y section. All the anomalies are recognized in the comprising area of arkose.

The characteristics of IP anomalies are summarized in TableII-5-4.

Tablell-5-4. List of the results of semi-detailed survey

Survey line	Characteristics of IP anomaly
C, Cs	No increase of IP anomaly of the deep part to the east in the station No.8 in the Cs survey line
Ln, Lc, L, Ls	Distinct pattern which wides to the deeper part of the anomaly is recognized in the station No.16 to No.19 in L(Lc) survey line. IP anomaly in each survey line suggests the continuity from the north to the south, however, the anomaly decreases in the direction of north and the south of (L,Lc)survey line.
Za	Large scale pattern which widens to the deeper part with the centre of No.0 station is recognized.
On, O, Osc, Os, Oss	Distinct pattern which widens to the deeper part of the anomaly is recognized in station No.9 of Os survey line. IP anomaly shows maximum in Os survey line and slightly decreases in the Oss survey line. Indistinct IP anomalies are recognized in O and On survey lines. Successive IP distribution with the general trend of north to south is recognized.
Xn, X, Xs	Successive distribution of IP anomalies in the direction of north to south is generally shown, however, the IP value is low.
Yn, Y, Ys	Distinct IP anomalies are recognized in the deep part. IP anomaly of the deep part is more distinct and shallower towards the south.

5-3-3. Results of data processing

Distinct IP anomalous patterns were shown in the Binge site (B, C, Cs survey lines), the Greenfields site(L, Za survey lines), the Inyati site(O, Os, Oss survey lines) and the Angwa site(Y,Ys survey lines). In addition to the lines, comparatively distinct IP anomalous zones were detected in Xn, X and Xs lines of the Angwa site.

There are characteristically two kinds of high IP anomalous zones with low resistivity and high resistivity. High IP/low resistivity zones are distributed in B, O and L survey lines, and high IP/high resistivity zones are distributed in C, Za and Y survey lines.

On the other hand samples with sulphide mineralization show a chargeability more than 10mV/V separated clearly from rock samples. Ores show low resistivity and high chargeability according to the extend of mineralization. Relationship between mineralization and physical properties of low to high resistivity, high chargeability are evident.

Sectional analysis of simulation model was carried out by 2.5 dimensional finite element method for apparent resistivity/chargeability of provisional sections of 6 survey lines of B, C, L, O, Za and Ys which were selected within IP anomalous zones by reconnaissance and semi-detailed prospecting.

(1) B survey line

By the results of simulation analysis, two different resistivity layers are presumed. The resistivity of the surface layer is low(25 to 300Ω·m) and that of the lower layer is high(3,000 Ω·m). Although the structure which is composed of such two layers is considered to be the anomalous pattern with two IP anomalies of the shallow and deep part of the underground, the IP anomaly is considered to reflect the graphitic slate of the western margin and the low IP of sandstone in the stations No.8 to No.10.

(2) C survey line

The structure of resistivity distribution is considered to be composed of 130 to 180, 750 and 4,000 Ω·m resistivity zones in descending order by simulation analysis. IP anomaly pattern of the deep part is considered to reflect a high resistivity body(4,000 Ω·m, 20mV/V) which is widely distributed in the deep part.

(3) L survey line

This IP anomaly is considered to reflect a small anomalous body(70mV/V) by simulation analysis. The existence of a small mineralization zone is indicated by the geological condition, IP anomalous pattern and the peculiar value of the analysis.

Almost the same IP anomaly in the Lc survey line was detected in the Ln survey line. Although this anomalous zone suggests the continuation along the direction of strike from north to south, the IP value is low. This IP anomalous zone is presumed to be indistinct in the northern and the southern side of the L survey line.

(4) Za survey line

This IP anomaly is presumed to be a flat shaped high IP anomalous body (300mV/V) by simulation analysis. The discovery of new ore deposit is expected in this area by geological condition, IP anomalous pattern and peculiar value of analysis.

(5) Os survey line

The IP anomaly was analyzed as a comparatively small body.

This IP anomalous body is considered to be a mineralization zone by geological conditions, IP anomalous pattern and singularity(150mV/V), however, increase to the deeper part is not expected. Although the scale of the anomalous body is the largest in the Os survey line, the scale is presumed to be smaller in the north and the south side of the Os survey line.

(6) Ys survey line

The flat shaped high IP anomalous body with an inclination to the west is presumed to be of a depth of more than 200m by simulation analysis. High IP anomaly in the deep part is considered to be the reflection of a mineralization zone.

Simulated results are shown Fig.II-5-6.
Summary of geophysical survey is as follows.

TableII-5-5 Summary of geophysical survey

Line	Resistivity structure	Resistivity(Ω·m)	IP(mV/V)	IP anomalous body	Depth(m)	Geology
B	2 layers	1'st layer 25~300 2'nd layer 3,000	2.5~10 4.5	-	-	slate, Sandstone, arkose
C	3 layers	1'st layer 150~180 2'nd layer 750 3'rd layer 4,000	1~7 4~7 12~20	-	-	gneiss
L	West portion -low East portion -high	West portion 85~450 East portion 3,000	1~10 2.8	70mV/V (small steep plate)	<50	arkose ~ granite boundary
Za	Centre part -low	Centre portion 200~500 End portion 3,000	0.5~4.5 4.5	300mV/V (flat plate)	200~350	arkose ~ granite boundary
O	2 layers	1'st layer 80~500 2'nd layer 4,000	1~2 3	150mV/V (small steep plate)	<150	Quartz Vein
Ys	3 layers	1'st layer 150~300 2'nd layer 750 3'rd layer 2,500	3~9 1~8 2~6	200mV/V (steep plate)	250<	arkose

An IP anomaly caused by mineralization in this area is considered to be shown in chargeability of 50mV/V to several hundred mV/V. On the other hand, some cases of no IP anomaly with widening shape towards the deep part and high IP but low chargeability (less than 50mV/V) are not caused by mineralization but by the influences of geology.(e.g. Line Band C)

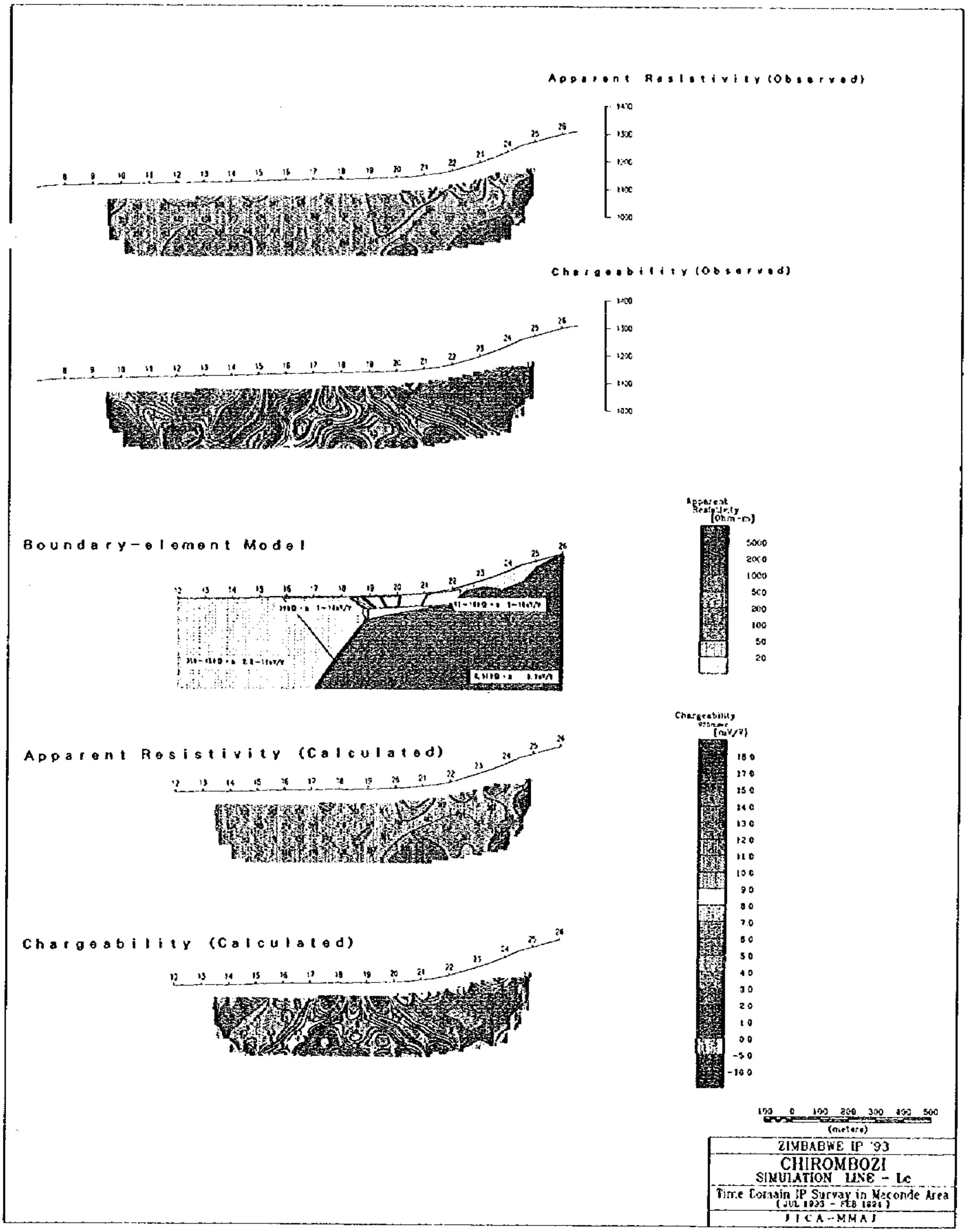

Fig.II-5-6 Section of simulated results (L line)

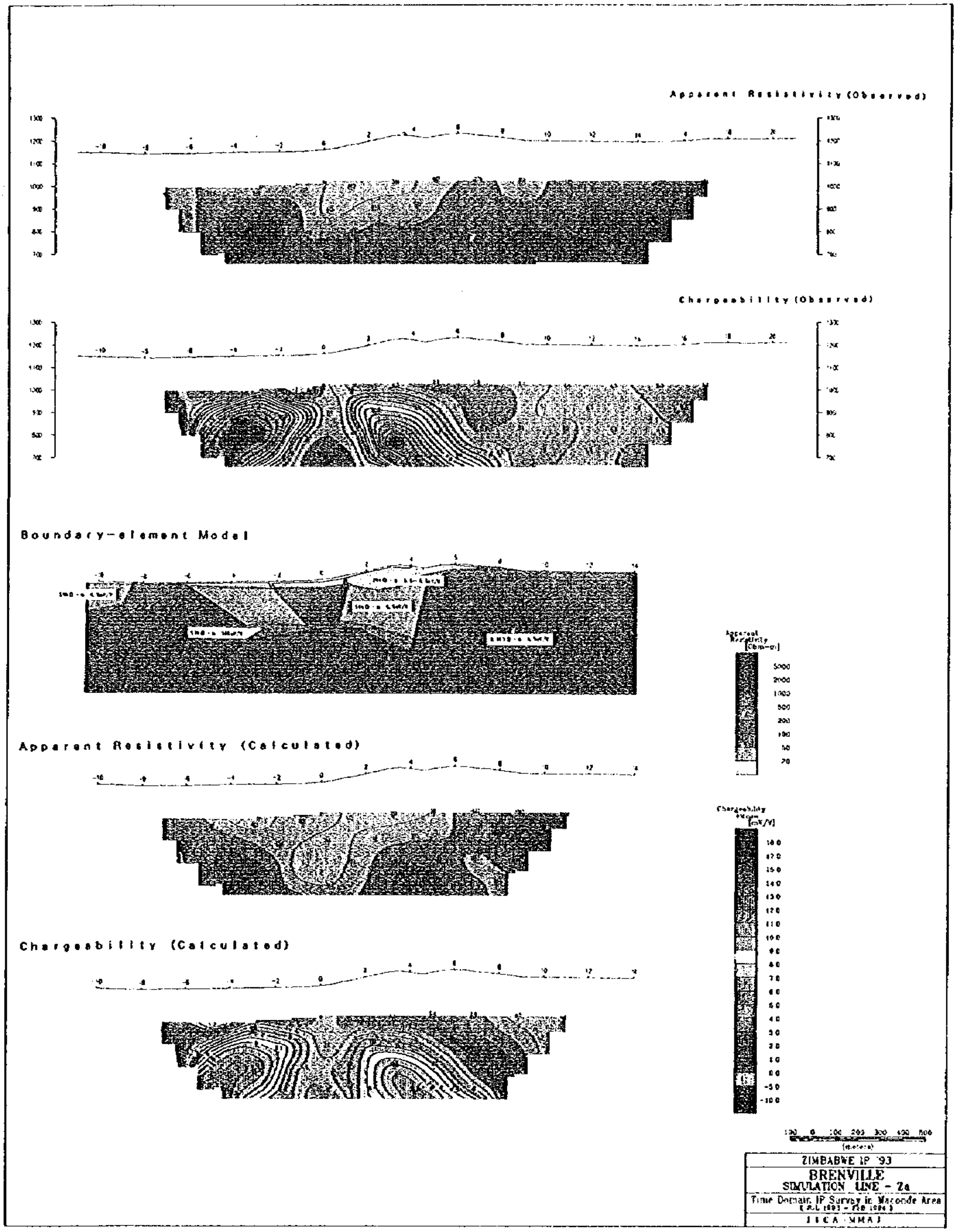

Fig.II-5-6 Section of simulated results (Za line)

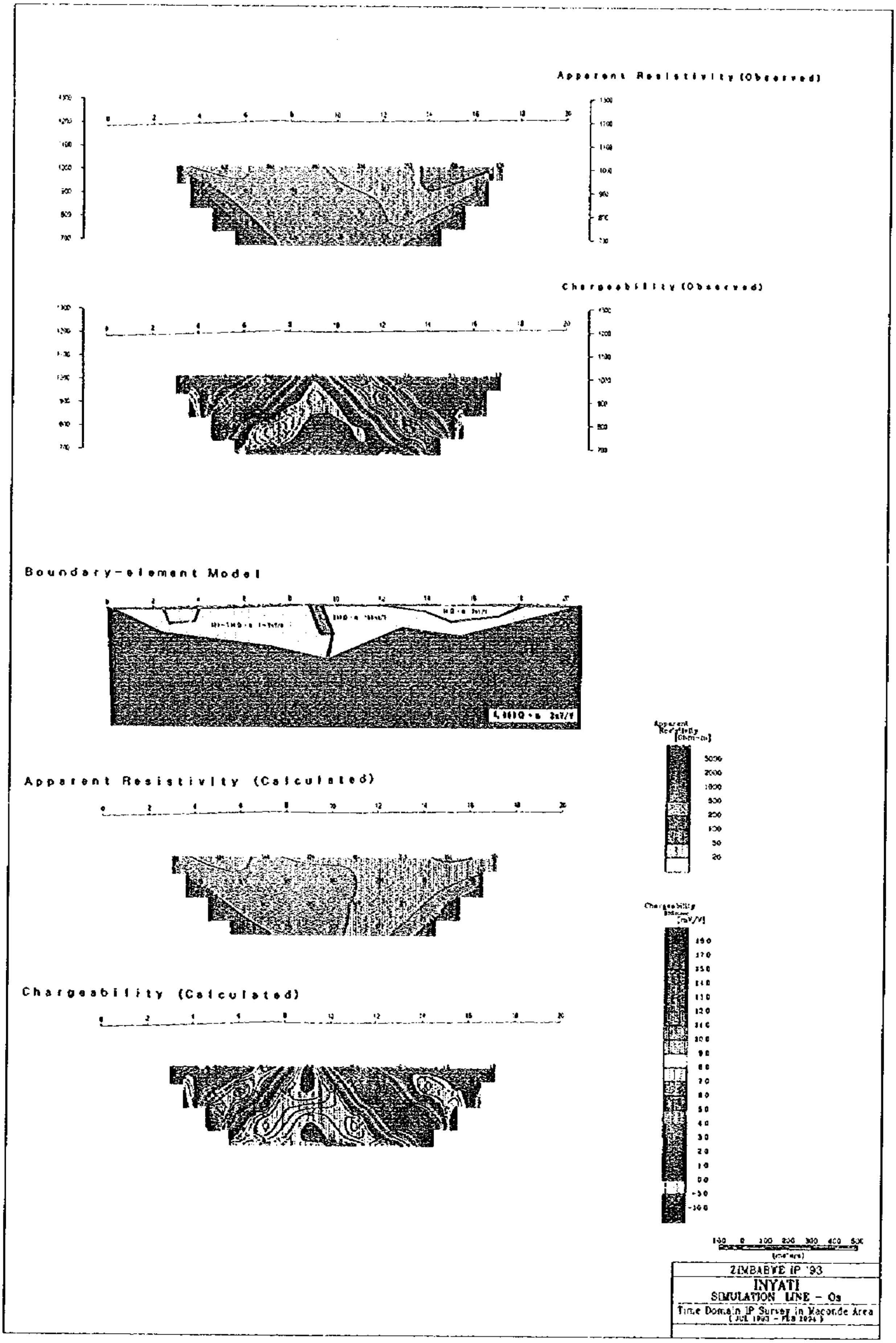

Fig.II-5-6 Section of simulated results (Os line)

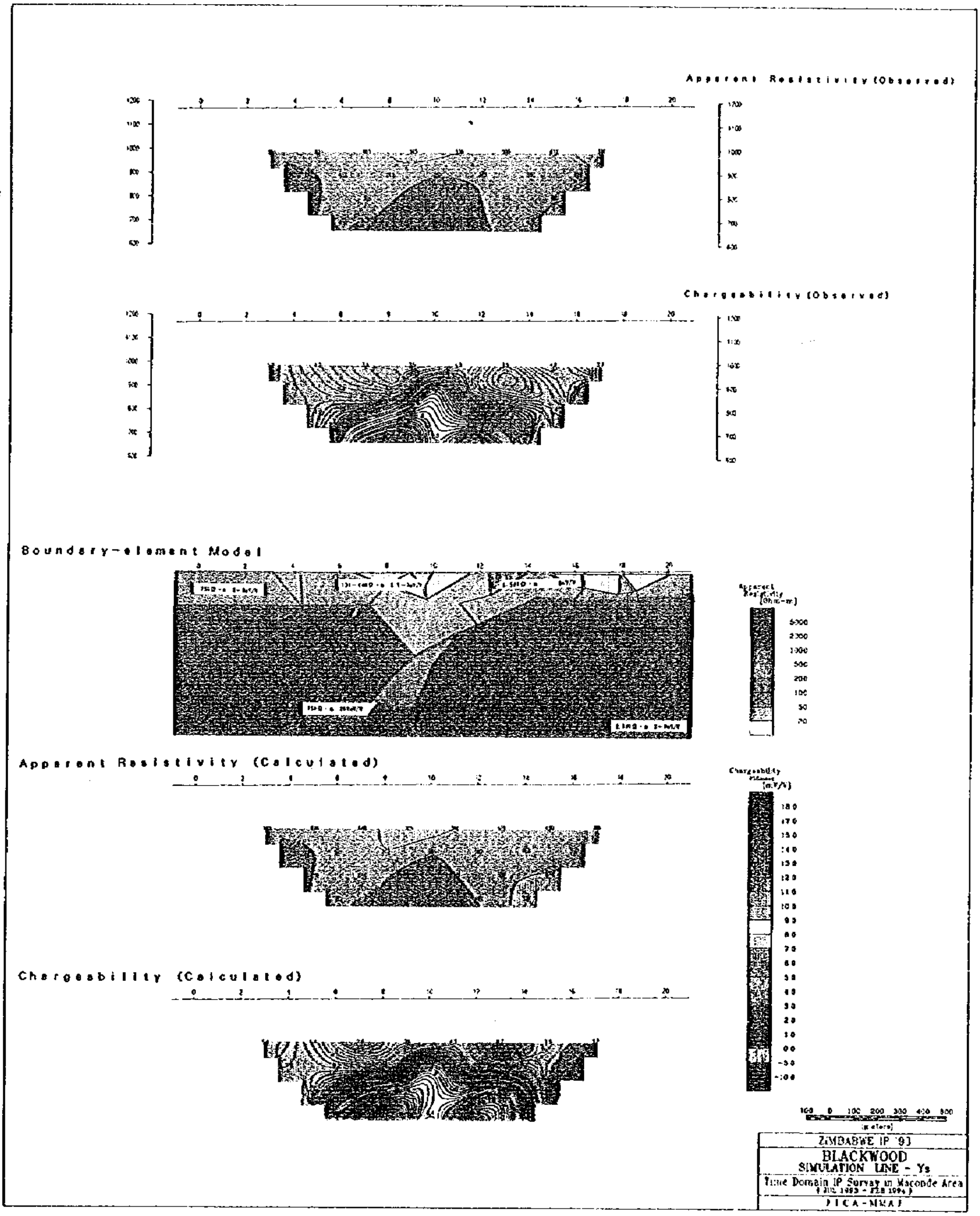

Fig.II-5-6 Section of simulated results (Ys line)

Chapter 6 The drilling survey

6-1 Purpose and outline of drilling survey

Based on results of Phase I and Phase II surveys, the drilling survey was carried out in order to find out new ore deposits. The drilling survey consists of ten drill holes, total length of 4,057.50 metres.

The target zones for drilling survey and conducted drilling holes are summarized as follows:

1) Greenfields area (Chirombozi farm) : MJZM-1
2) Greenfields area (Brenville farm) : MJZM-2,3,4
3) Inyati area (Inyati farm) : MJZM-5
4) Angwa area (Blackwood farm) : MJZM-6,7,8,9,10

Each drilling sites are shown in FigII-6-1.

6-2 Result of the survey

6-2-1 Geology and mineralization

Drilling sites are shown in Fig.II-6-1. Drilling sections are shown in Fig.II-6-2 to Fig.II-6-6.

The summary of each hole is as follows :

1. Greenfields area

(1) MJZM-1 (202.60m)

The bed rock appears after the soil portion at 15.20 metres.

The geology of this hole mainly consists of arkose, and fine grain basaltic tuff is accompanied in shallow portion of 30.5m to 44.0m, 51.4m to 61.0m, 65.3m to 79.8m. Dolomite and dolomitic sand stone are also accompanied in bottom portions of 156.8m to 164.5m, 170.7m to 174.0m, 187.3m to 191.5m.

In and around the fine basaltic tuff portion is changed to muscovite schist by strong folding and metamorphism.

Dip shows a steep inclination of 50 to 70 degrees.

The results of microscopic observation of thin sections of rocks are as follows :

The sample at 55m is a fine grain basaltic tuff, originally, and a calcite-muscovite-quartz schist under the microscope. Large quantities of calcite, muscovite and quartz, small quantities of plagioclase and opaque minerals and extremely small quantities of tourmaline were observed.

The sample at 100m is a top portion of arkose with grading originally and changed to calcite-muscovite-quartz semischist under metamorphism. Large quantities of muscovite and quartz, medium quantities of plagioclase and calcite, small quantities of potash feldspar and opaque minerals and extremely small quantities of apatite and zircon were observed.

The sample at 118m is a bottom portion of arkose with grading originally and a micaceous arkose under the microscope. Large quantities of muscovite, quartz and plagioclase, medium

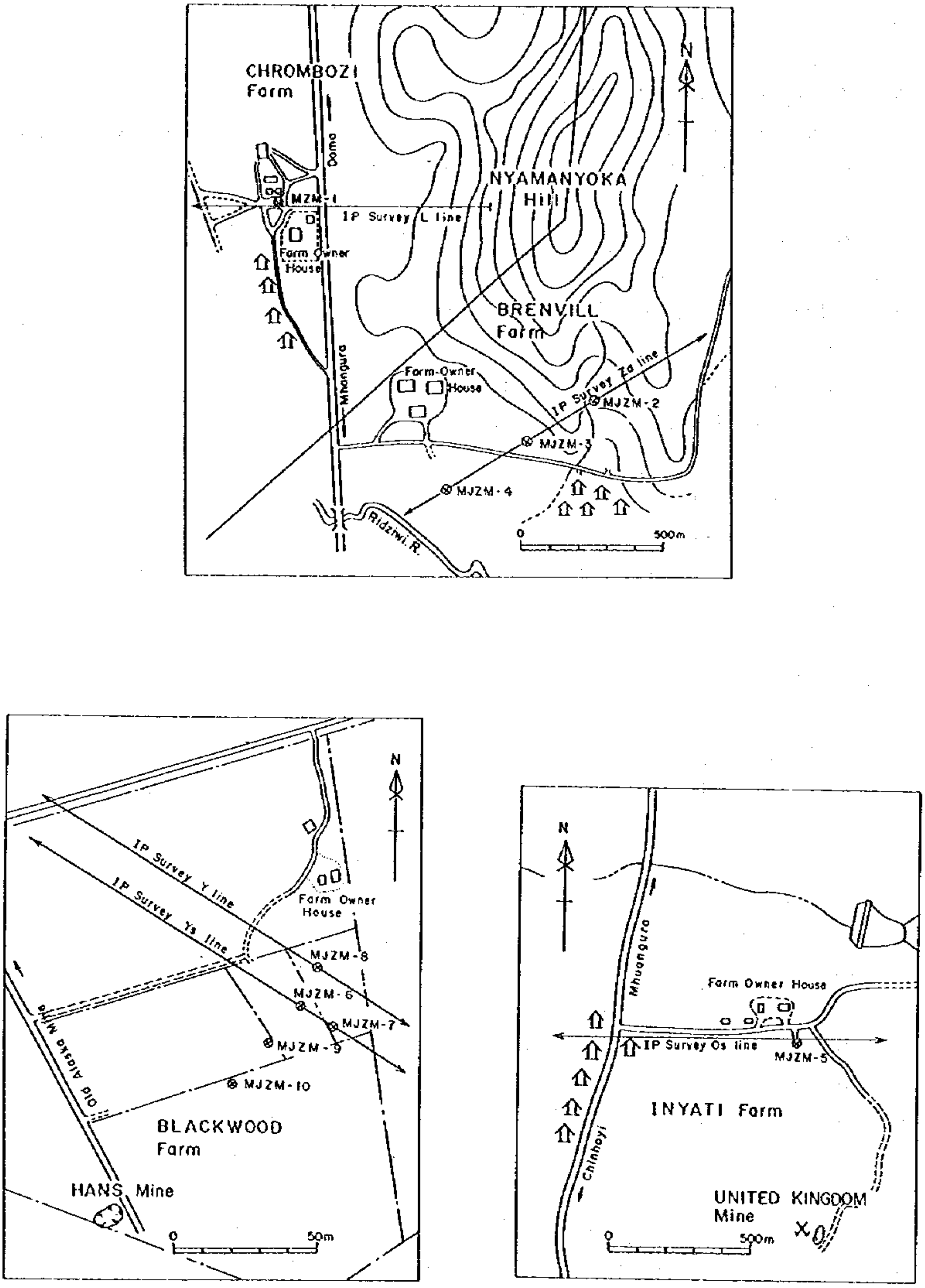

Fig.II-6-1 Locality of drilling sites

quantities of potash feldspar and calcite, small quantities of opaque mineral (pyrite?) and extremely small quantity of apatite and zircon were observed. Weak mineralization of Magnetite was recognized in arkose at 44.0m to 64.0m and 196.8m to 199.8m.

The results of microscopic observation of polished sections of ores are as follows :

Samples at 44.3m, 64.46m, 198.70m accompanied small quantities of euhedral or irregular shaped Magnetite and Maghemite, Hematite as a weathering product from magnetite, extremely small quantities of columnar pyrite and irregular shaped sphalerite were observed.

The results of chemical analysis of ores are as follows:

Gold shows near or less than the detection limit (0.01ppm). Silver is all under the 1ppm. Copper is all under the 10ppm. Nickel shows a maximum of 120ppm. Cobalt shows a maximum of 17ppm. Iron shows 1 to 3%. No encouraging analysis results were obtained. A maximum 1,221ppb content of Platinum in one sample (49m to 50m) is remarkable.

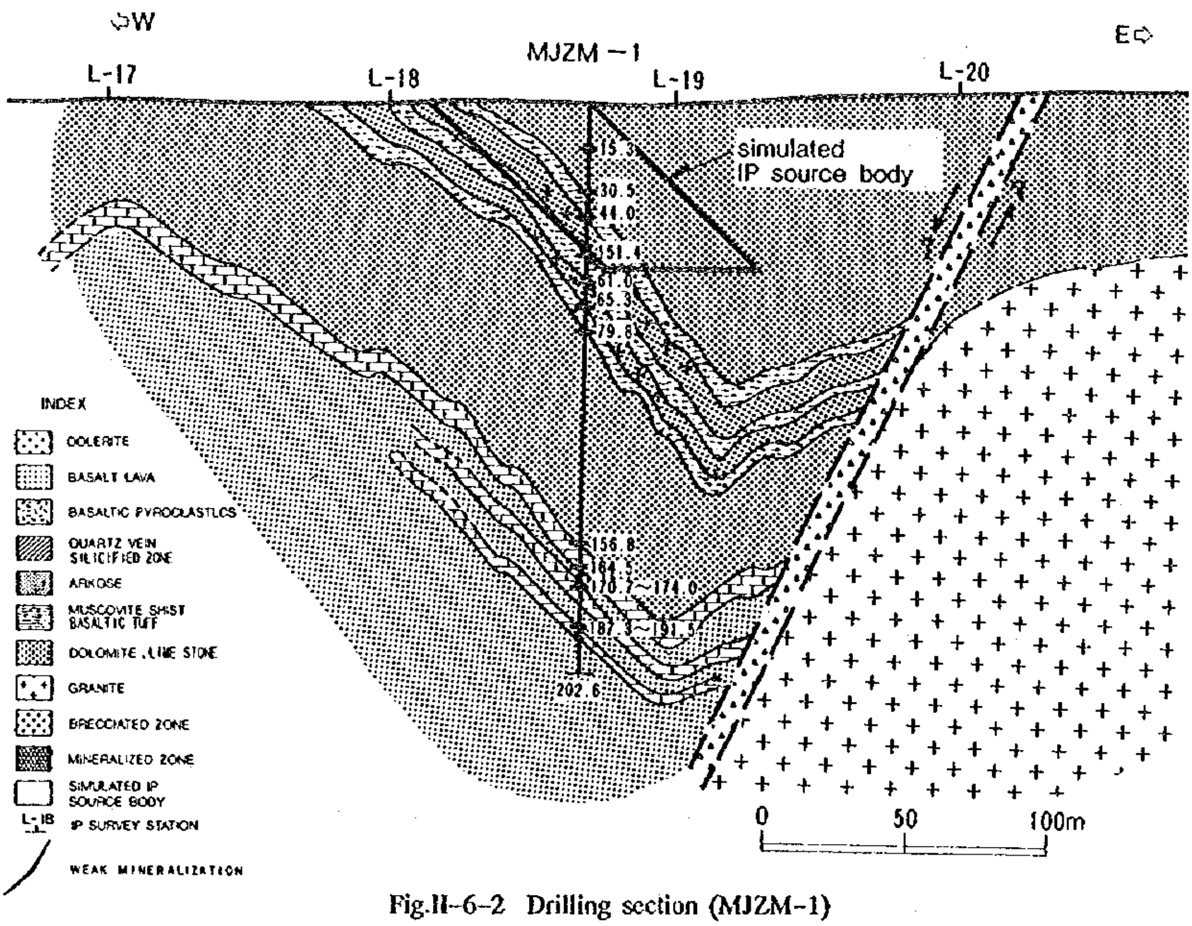

Fig.II-6-2 Drilling section (MJZM-1)

(2) MJZM-2 (400.60m)

The geology of this hole consist of granite, and quartz vein in section 74.87m to 77.80m, and dolerite dyke in sections 252.40m to 254.30m, 255.60m to 257.77m, 268.61m to 306.00m, 350.10m to 352.40m are accompanied.

A strong fractured zone was recognized from 160m to 342m, and strong silicified zone with banded quartz vein is accompanied from 40m to 333m especially.

Mineralization of large quantities of hematite and chlorite and small to extremely small quantity of pyrite were recognized in silicified and fractured zone.

The results of microscopic observation of polished sections of ores are as follows :

Sample at 210.10m is a banded quartz vein, medium quantity of euhedral Maghemite with Hematite, small quantity of columnar hematite, and extremely small quantity of euhedral pyrite were observed.

The results of chemical analysis of ores are as follows :

Gold shows a maximum of 0.12ppm. Silver shows a little high content in silicified zone but is all under the 1ppm. Copper a shows of maximum 55ppm. Nickel shows a maximum of 89ppm. Cobalt shows a maximum of 15ppm, Iron shows 0.6 to 8.73%. Platinum shows a maximum of 878ppb. No encouraging analysis results were obtained.

(3) MJZM-3 (400.60m)

The bed rock appears after the red soil portion at 6.00 metres.

The geology of this hole consists of granite, and quartz vein at 72.30m, 132.55m, 133.80m to 138.60m, 178.48m, 187.50m, 198.09m, 211.90m, 214.10m, 336.70m to 338.00m, 387.00m to 394.00m and dolerite dyke at 22.28m to 22.58m, 27.00m to 42.90m, 82.84m to 91.30m, 251.70m to 252.10m 287.90m to 291.55m, 342.90m to 351.10m, 374.30m to 383.00m are accompanied.

Weak fractured zone was recognized from 49.00m to 82.84m, and boundary portion of dolerite.

Mineralization of extremely small quantity of pyrite was recognized in and around the dolerite dyke portion.

No encouraging mineralization was obtained.

(4) MJZM-4 (301.70m)

The geology of this hole consists of granite, and quartz vein at 1.78m to 3.39m, 116.30m (W=30cm) and dolerite dyke at 27.20m to 47.75m, 86.10m to 89.00m, 103.30m to 154.30m, 192.10m to 209.60m, 293.40m to 296.70m, 299.70m to bottom of hole are accompanied.

No fractured zone was recognized. Very weak quartz-chlorite vein was recognized in 79.85m to 115.00m.

Only weak mineralization of extremely small quantity of pyrite was recognized from and around the dolerite dyke portion.

No encouraging mineralization was obtained.

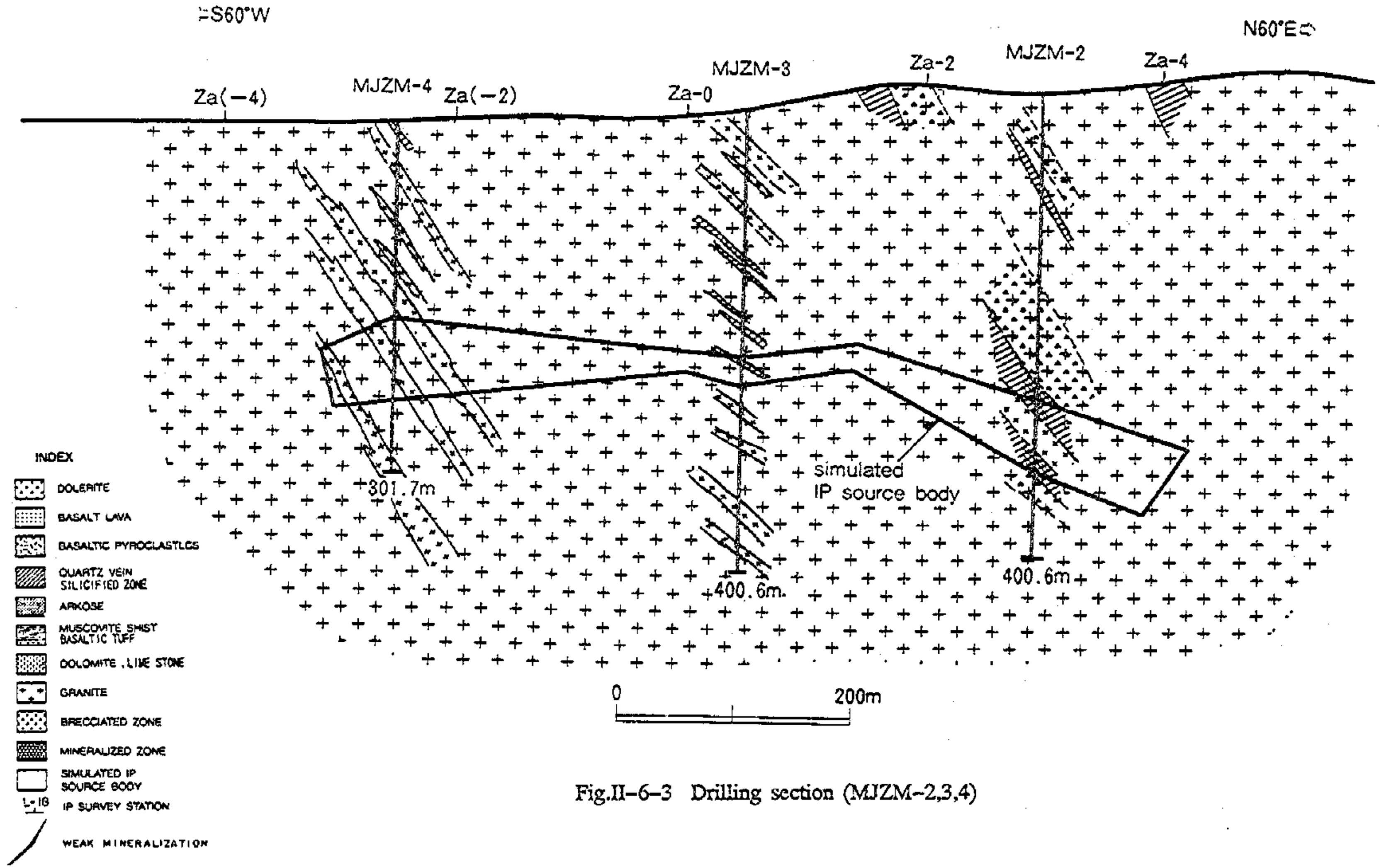

Fig.II-6-3 Drilling section (MJZM-2,3,4)

2. Inyati area

(1) MJZM-5 (200.00m)

The bed rock appears after the red brown soil portion at 7.55 metres.

7.55m to 17.95m : Limestone. It shows white to milky white color, and is compact, hard, no foliated.

17.95m to 25.00m : Basaltic tuff or muscovite schist. It shows green color, micro folding structure, and accompanied small quartz vein (segregation?).

25.00m to 43.12m : Intrusive dolerite. It shows deep green color, and is compact and hard. Small vein of quartz, calcite, magnetite and hematite was recognized.

43.12m to 48.40m : Green colored basaltic tuff or muscovite schist.

48.40m to 88.30m : Deep green colored, compact and hard intrusive dolerite. It accompanied a small vein of quartz, calcite, magnetite and tourmaline. Amygdaloidal structure of calcite and chlorite is observed in some places.

88.30m to 90.70m : Green colored basaltic tuff or muscovite schist. It shows micro folding structure, and accompanied many quartz, chalcopyrite, pyrite vein along a filiation.

90.70m to 94.50m : Conglomerate. It consists of subround and several kinds of fragments like granite, arkose, mudstone and dolerite.

94.50m to bottom of hole : Arkose is observed. Many quartz vein are accompanied in 95.60m to 99.50m, 128.53m, 166.20m, 188.50m, 196.00m to 197.20m. This arkose has several kind of facies like grading portion, red color portion with hematite, and green color portion with chlorite.

The results of microscopic observation of thin section of rocks are as follows :

The sample at 15m is a limestone. Large quantity of calcite and small quantity of quartz were observed. Calcite is fine grain and saccharoidal generally.

The sample at 19.50m is a calcite, chlorite rock. Calcite and chlorite show coarse grain patch like texture. Matrix mainly consists of medium to small quantity of quartz, extremely small quantity of plagioclase. Small to extremely small quantity of tourmaline, sericite and opaque mineral were also observed.

The sample at 30m, 40m, 50m and 70m are altered dolerite. These show ophitic texture. Large quantities of plagioclase and tremolite, medium quantity of sphene were accompanied, and chlorite, epidote, calcite and quartz were produced by alteration.

The sample at 45m is a calcite, quartz, plagioclase, epidote semi schist. Large quantities of plagioclase and lepidoblastic chlorite, medium quantity of quartz, small vein of quartz and iron minerals, and small quantities of tremolite, epidote and sphene were accompanied.

The sample at 90m is a quartz-calcite-chlorite semi schist. Large quantities of quartz and lepidoblastic chlorite, small vein of calcite, and small quantities of plagioclase, lepidoblastic sericite, chalcopyrite and pyrite were accompanied.

Mineralization of small vein of chalcopyrite and pyrite is recognized from 88.3m to 90.7m.

The results of microscopic observation of polished sections of ores are as follows :

Sample at 89.30m is a calcite, quartz vein. Small quantity of irregular shaped chalcopyrite, extremely small amounts of sphalerite and bornite were observed.

Sample at 54.950m is a vein occurring in the dolerite, and mainly consist of magnetite.

The results of chemical analysis of ores are as follows :

Mineralization of this hole is recognized by naked eye, silver shows a maximum of 4.7ppm, copper shows a maximum of 4,490ppm (=0.45%). Others are not remarkable.

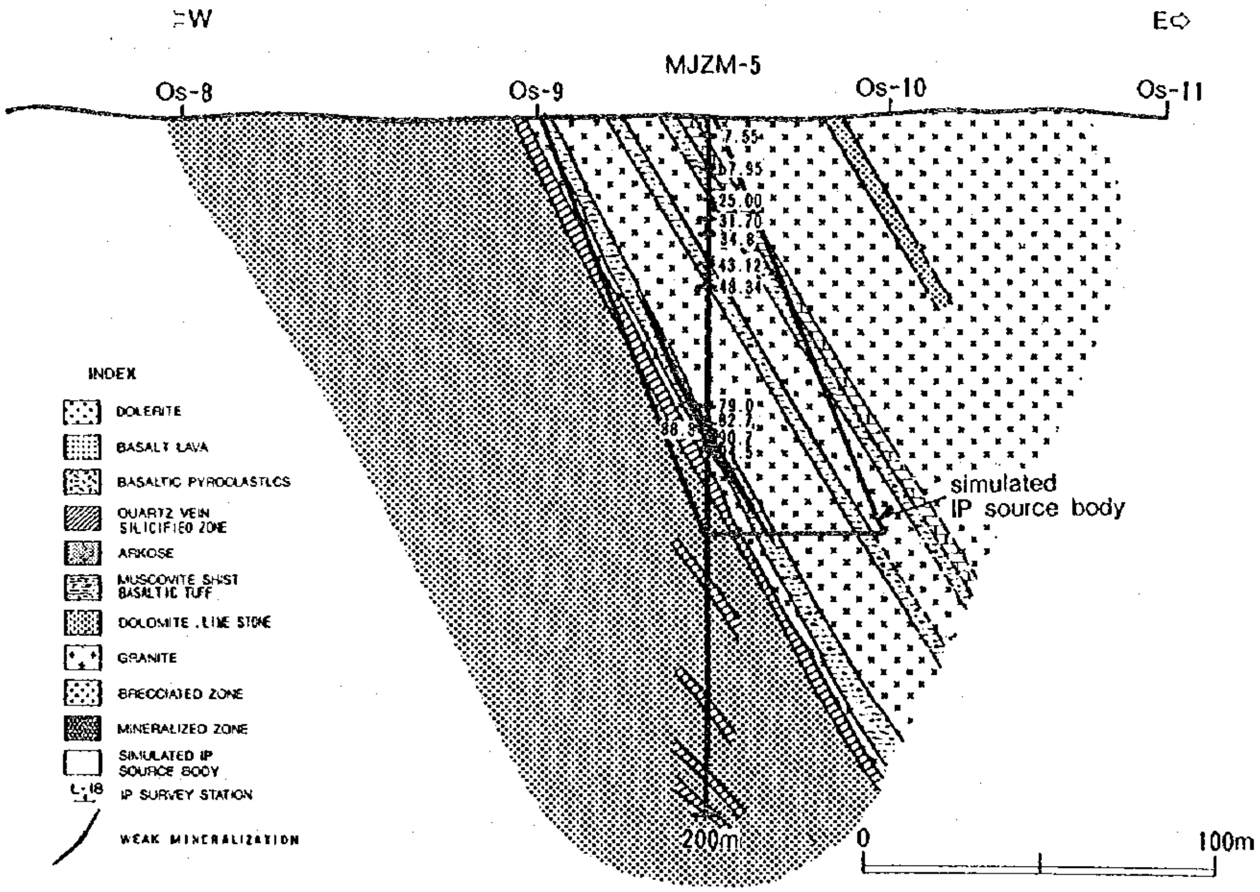

Fig.II-6-4 Drilling section (MJZM-5)

3. Angwa area

(1) MJZM-6 (600.00m)

The bed rock appears after the brown soil portion at 7.15 metres.

7.15m to 493.00m : Intrusive dolerite. Basaltic pyroclastics were accompanied in sections 48.00m to 78.08m, 83.89m to 88.18m, 143.00m to 154.60m, 365.50m to 461.70m. Basaltic lava like portion is recognized at around 120.7m. This is sheet like intrusive rock, and formed by repeated intrusive activity.

493.00m to 513.10m : Medium grain arkose. It shows pink color, and chlorite spot is accompanied.

513.10m to 529.50mm : Fine grain green colored basaltic tuff. Small quantity of pink colored sandy portion is accompanied.

529.50m to 540.53mm : Alternation of pink colored arkose and fine grain green colored basaltic tuff.

540.53m to 578.30m : Intrusive dolerite similar to upper portion.

578.30m to 588.00m : Green colored fine grain basaltic tuff. It shows pale green to deep green color. Pink colored hematite portion is observed.

588.00m to bottom of hole : medium to fine grain arkose. It shows clear cross bedding. Fine grain green colored basaltic tuff is accompanied.

Weak mineralization of hematite and magnetite are recognized on top portion of arkose. Remarkable copper mineralization was not encountered.

The results of chemical analysis of ores are as follows :

Gold shows less than the detection limit. Silver is all under the 1ppm. Copper shows a maximum of 81ppm, Nickel shows a maximum of 141ppm. Cobalt shows a maximum of 42ppm, iron shows 1 to 9%. Platinum shows maximum 530ppb. No encouraging analysis results were obtained. Difference of contents of copper, cobalt, iron, platinum are recognized according to host rocks.

(2) MJZM-7 (600.00m)

0m to 122.35m : Basaltic lava. It shows auto brecciate structure and amygdaloidal texture of quartz and calcite. Pyrite dissemination is recognized in and around a small quartz veins.

122.35m to 265.74m : Basaltic pyroclastics. It shows green to deep green color. Several sizes and large quantities of subround fragments are accompanied in matrix. Small quantities of accidental fragments like granite, arkose, mudstone are also recognized. Fine grain tuffs are observed in some places. This is formed by repeated volcanic activity.

265.74m to bottom of hole : Arkose. Basaltic tuff is accompanied from 370.00m to 413.80m. Many quartz veins were observed in upper potion of arkose. Mineralization of pyrite and chalcopyrite is recognized in and around the quartz vein. Repeated grading structure and cross bedding were observed in under portion of arkose. Remarkable mineralization is not recognized but only small quartz vein recognized in under portion of arkose

The results of microscopic observation of thin sections of rocks are as follows :

The samples at 40m, 65m are altered basalt. Large quantities of plagioclase, mica and intersertal texture were observed. Large quantity of chlorite, medium quantity of calcite, small quantities of epidote and quartz, euhedral pyrite were produced by alteration.

The samples at 150m, 160m are basaltic pyroclastics. Large quantity of calcite, medium to small quantities of quartz, plagioclase, potash feldspar, columnar mica, nematoblastic muscovite and lepidoblastic chlorite and extremely small quantities of apatite and opaque mineral were also observed.

The samples at 245m, 275m, 300m, 375m, 390m, 410m, 440m, 450m are all arkose, and show several kinds of facies. Large quantity of quartz, large to medium quantities of plagioclase and calcite, medium to small quantities of potash feldspar, muscovite and chlorite and in some place extremely small quantities of mica, tourmaline, sphene, apatite and zircon sphene were accompanied.

The results of microscopic observation of polished sections of ores are as follows :

Sample at 48.50m is a mineralization in basalt lava. Small quantity of euhedral to irregular shaped pyrite, extremely small amount of irregular shaped corpuscular sphalerite were observed.

Sample at 272.9m is a mineralization with small quartz vein occurring in the arkose, large quantity of quartz, medium quantity of irregular shaped chalcopyrite, bornite, chalcocite, maghemite with small quantity of calcite and silicate minerals, small quantity of euhedral to irregular shaped pyrite, and extremely small quantity of irregular shaped corpuscular sphalerite were observed.

The results of chemical analysis of ores are as follows :

Gold shows less than the detection limit. Silver shows maximum 1.2ppm. Copper shows 366 and 117ppm in arkose just under the basaltic pyroclastics, this copper high content portion is similar to the ore horizon of Hans Mine. This hole seems to encounter an end portion of mineralized zone. Platinum shows maximum 942ppb. Others are not remarkable.

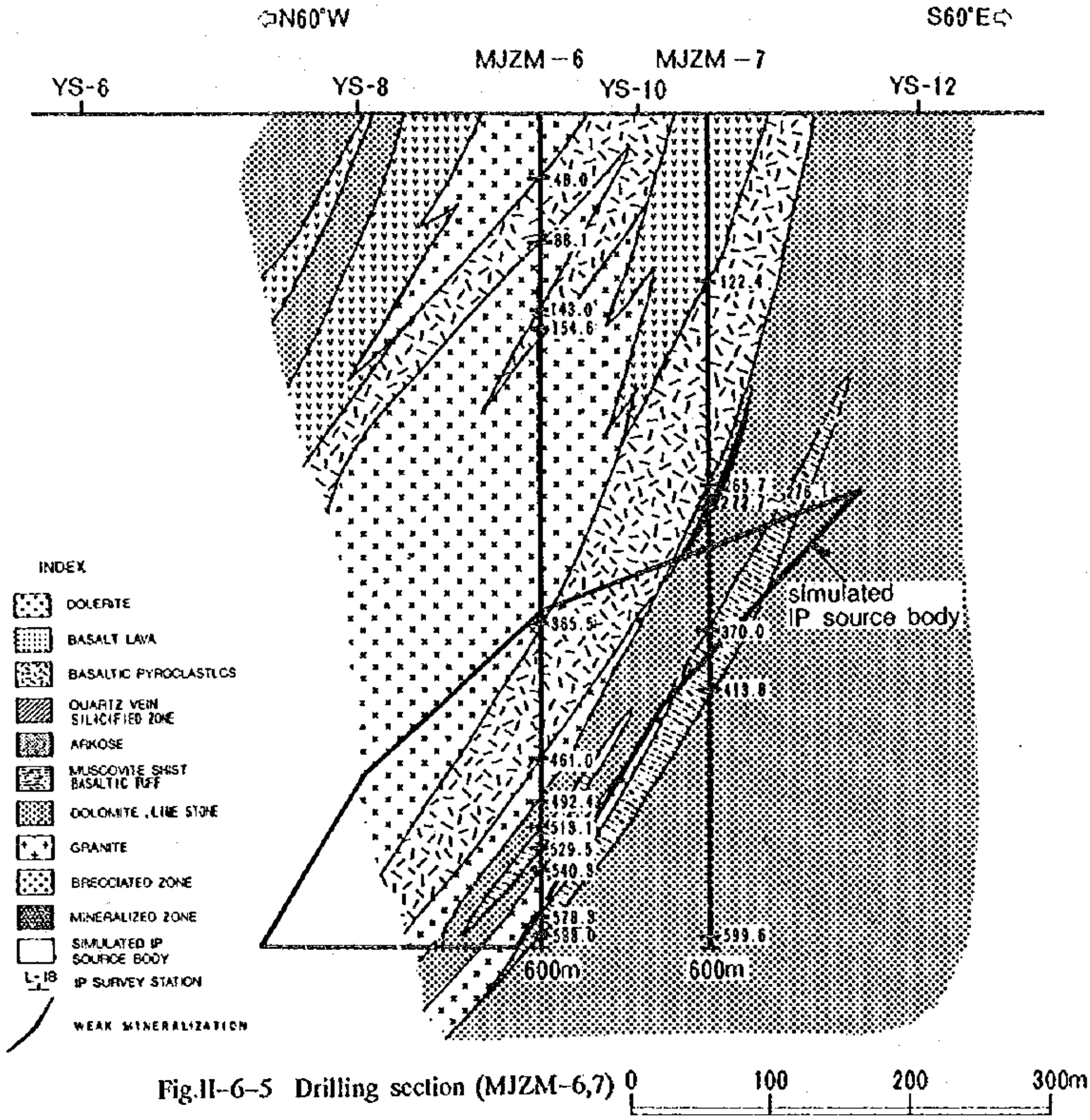

Fig.II-6-5 Drilling section (MJZM-6,7)

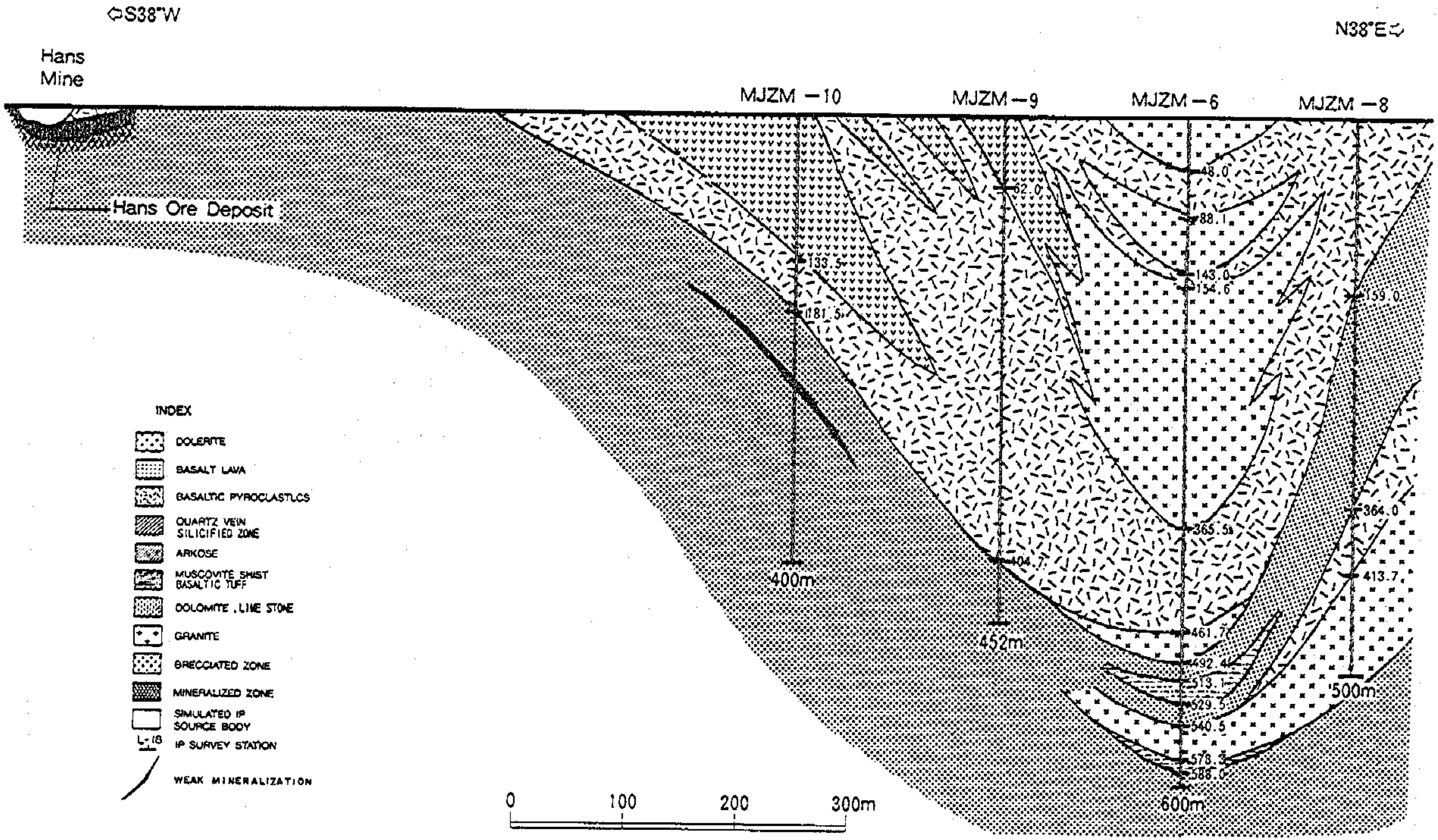

Fig.II–6–6 Drilling section (MJZM–6,8,9,10)

(3) MJZM-8 (500.00m)

0m to 159.00m : Basaltic pyroclastics. It shows green to deep green color. Several sizes and large quantities of subround fragments are accompanied in matrix. Size and quantity of fragments increase in under portion of pyroclastics.

159.00m to 364.00m : Arkose. Upper portion of arkose is pink to red colored homogeneous rock, and is rich in potash feldspar and hematite. Under portion is rich in chlorite. Red and green color portions occur alternately. Repeated grading is observed from 230m to 305m. Clear cross bedding is observed from 305m to 350m.

364.00m to 413.70m : Basaltic pyroclastics. It shows deep green to olive green color. Epidote by alteration is observed.

413.70m to bottom of hole : Intrusive dolerite. Very small vein of hematite and epidote is observed. Extremely small quantity of pyrite dissemination accompany in boundary portion.

Mineralization of hematite, magnetite, and extremely small quantity of pyrite is observed in the upper portion of arkose, but no remarkable copper mineralization is recognized.

The results of chemical analysis of ores are not remarkable.

(4) MJZM-9 (452.00m)

The bed rock appears after the yellow brown soil portion at 15.00 metres.

15.00m to 62.00m : Basaltic lava. It shows olive green to deep green color. Amygdaloidal texture and many small veins of calcite are observed.

62.00m to 404.70m : Basaltic pyroclastics is distinguished.

404.70m to bottom of hole : Arkose. Small vein of hematite and epidote was observed in some parts. Extremely small quantity of pyrite dissemination was recognized in boundary portion.

Mineralization of hematite, magnetite, and extremely small quantity of pyrite is observed in the upper portion of arkose, but no remarkable copper mineralization is recognized.

The results of chemical analysis of ores are not remarkable.

(5) MJZM-10 (400.00m)

The bed rock appears after the red brown to pale green soil portion at 19.30 metres.

19.30m to 132.30m : Basaltic lava. It shows green to deep green color. Amygdaloidal texture and typical auto brecciate structure are observed.

132.30m to 181.50m : Basaltic pyroclastics is distinguished.

181.50m to bottom of hole : Arkose continued. Upper portion of arkose is fine grain homogeneous rock. Pale red portion, purple color portion, and green color portion with chlorite and epidote occur alternately. Repeated grading is observed from 289.00m to 333.50m, and under 375.30m. Cross bedding is observed in 333.50m to 375.30m.

Mineralization of magnetite, pyrrhotite, hematite and extremely small quantity of bornite is observed in sections 201.73m to 207.73m, 215m to 226m, 255m to 267m. Copper mineralization is not so strong.

The results of chemical analysis of ores are as follows :

Silver shows a maximum of 5.13ppm from 204.73m to 206.23m. Copper shows a maximum of 1,867ppm in the same portion with silver high content. This copper high content portion is similar to the ore horizon of Hans Mine. This hole seems to encounter an end portion of a mineralized zone. Other elements are not remarkable.

6-3 Considerations

MJZM-1 was carried out to the anomalous body of geophysical survey line L, in order to pursue the mineralization northern extend from Mhangura Mine.

Weak mineralization of small quantities of Magnetite, maghemite, hematite, and extremely small quantity of pyrite and sphalerite was recognized in arkose from 44.0m to 64.0m. However, by the results of chemical analysis of cores, no encouraging analysis results were obtained.

MJZM-2.3,4 were carried out to the anomalous body of geophysical survey line Za. in order to pursue the mineralization northern extend from Mhangura Mine.

In MJZM-2, strong fractured zone was recognized from 160m to 342m, and strong silicified zone with banded quartz vein is accompanied from 240m to 333m especially.

Mineralization of large quantities of hematite and chlorite, small to extremely small quantity of pyrite was recognized in silicified and fractured zone.

By results of chemical analysis of cores, no encouraging analysis results were obtained.

In MJZM-3,4, only weak mineralization of extremely small quantity of pyrite was recognized in and around the dolerite dyke. No encouraging mineralization was obtained.

MJZM-5 was carried out on the anomalous body of geophysical survey line Os, in order to pursue the mineralization on the northern extent from United Kingdom Mine.

Mineralization is a small vein of chalcopyrite, sphalerite and Bornite accompanied with calcite quartz vein in quartz, calcite and chlorite schist. By the results of chemical analysis of cores, maximum 4.7ppm of silver and maximum 0.45% of copper are observed.

MJZM-6, 7, 8, 9, 10 was carried out on the anomalous body of geophysical survey line Y, Ys, and northeastern extension from United Kingdom Mine.

In MJZM-7, mineralization accompanies with small quartz vein. Chalcopyrite, bornite, chalcocite, pyrite, sphalerite and maghemite accompanied with small quantity of calcite and silicate minerals are observed in mineralized portion of arkose. By the results of chemical analysis of cores, copper shows maximum 366 to 117ppm in arkose just under the basaltic pyroclastics, however, this copper content is far from the ore condition expected in the similar ore horizon of Hans Mine. This hole seems have to encountered an end portion of a mineralized zone. Platinum shows maximum

942ppb. Others are not remarkable.

In MJZM-10, mineralization of magnetite, pyrrhotite, hematite and extremely small quantity of bornite is observed in sections 201.73m to 207.73m, 215m to 226m, 255m to 267m. By the results of chemical analysis of cores, silver shows maximum 5.13ppm in 204.73m to 206.23m. copper shows maximum 1,867ppm in same to silver high content portion. this copper high content portion is similar to the ore horizon of Hans Mine. this hole seems to have encountered an extension or end portion of mineralized zone.

MJZM-6,8,9 shows no remarkable mineralization and metal content.

Chemical analysis diagram of rock and ore samples are shown in Fig.II-6-7. to Fig.II-6-14.

Average copper content of crude ore in Alaska Mine and Mhangura Mine are 0.6% to 0.8% monthly, around 0.5% to 1.5% of copper ore may be mined. On the other hand, at least 2% of copper ore may be necessary for the beginning of development of new ore deposits. therefore, 1 to 3% of copper content may be necessary in drill hole.

By the results of drilling, weak mineralization was observed and around 0.5% of copper content may be obtained. However, high copper content ore that can be developed may be difficult to expect.

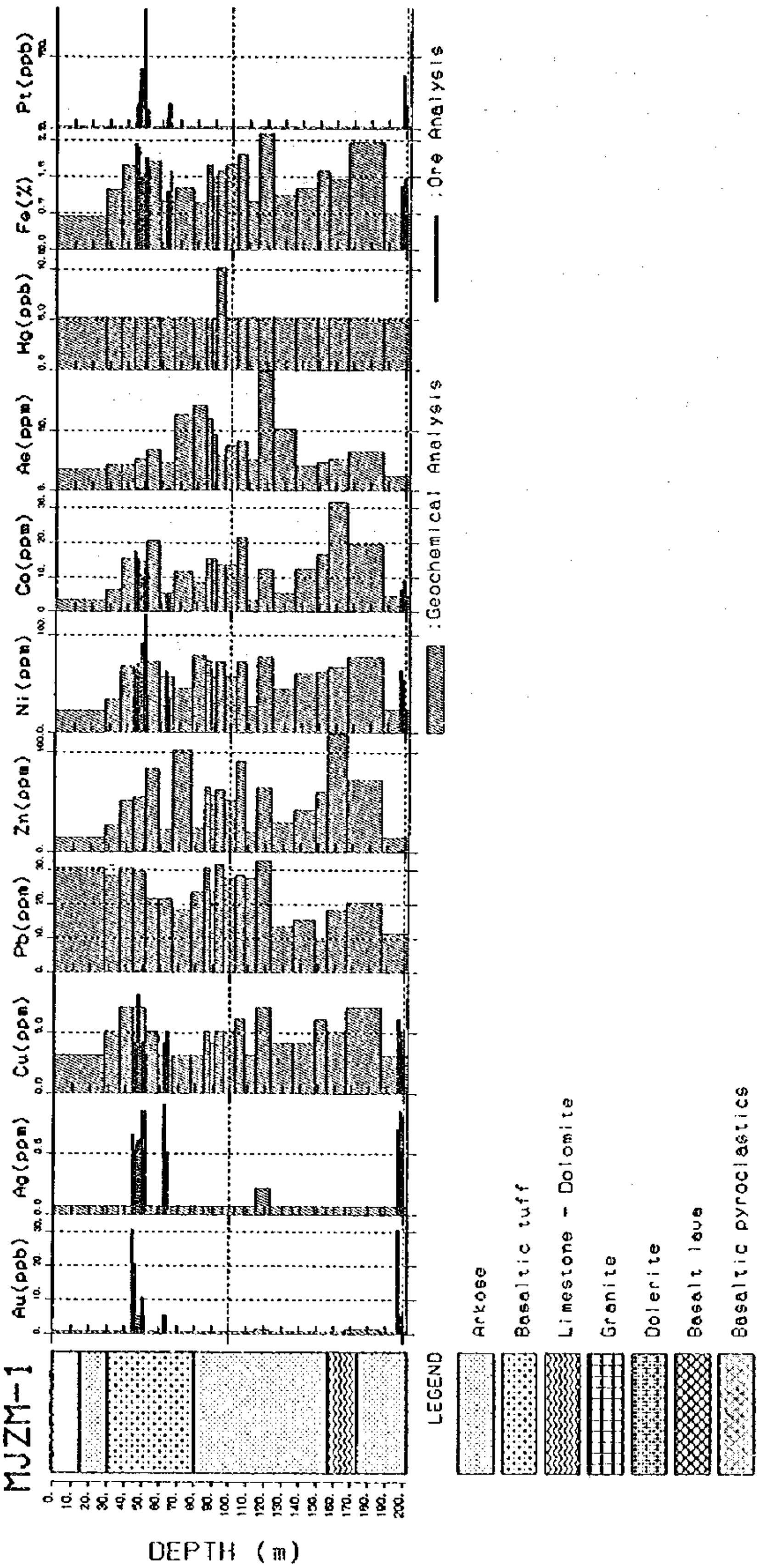

Fig.II-6-7 Chemical analysis diagram of rock and ore samples (MJZM-1)

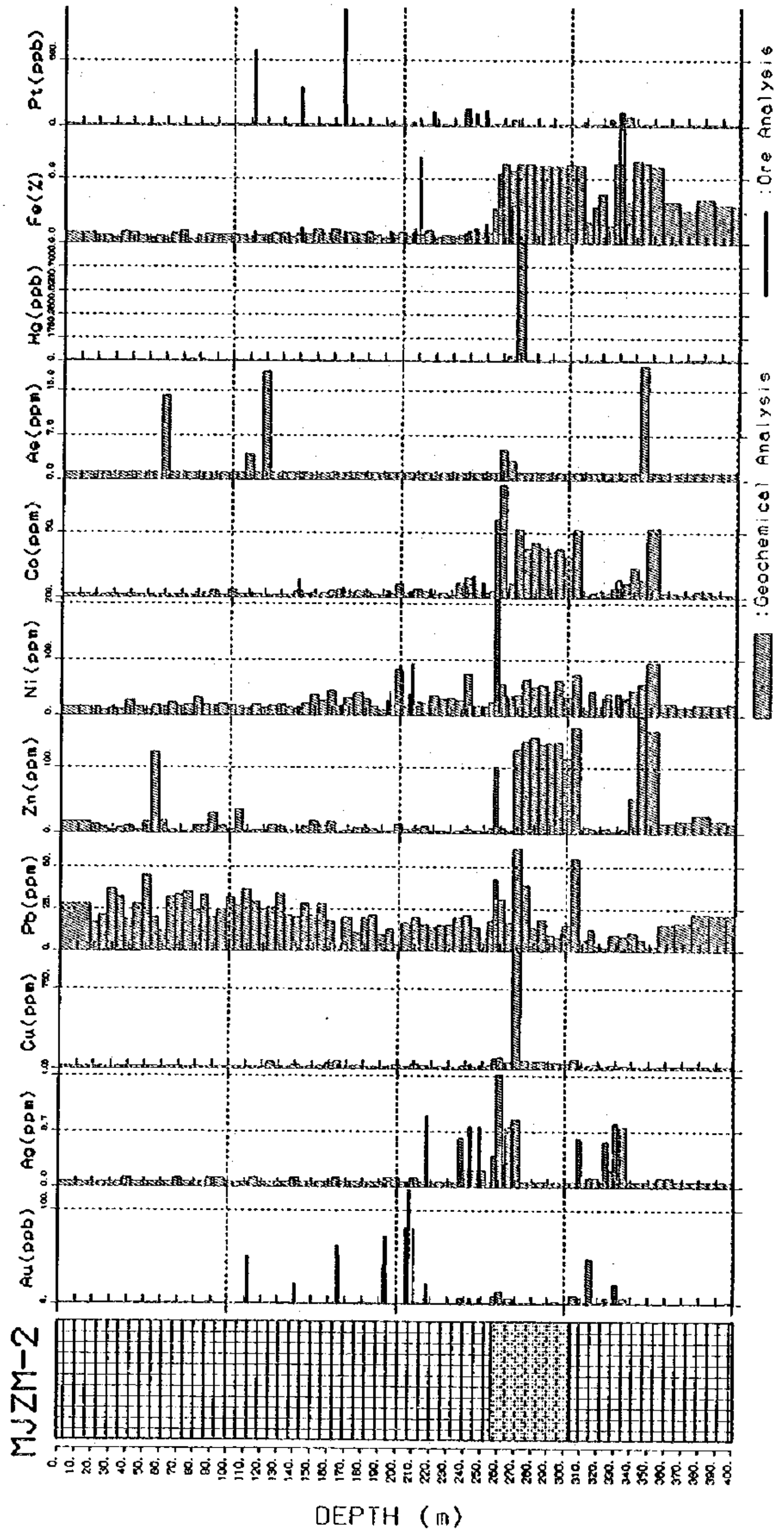

Fig.II-6-8 Chemical analysis diagram of rock and ore samples (MJZM-2)

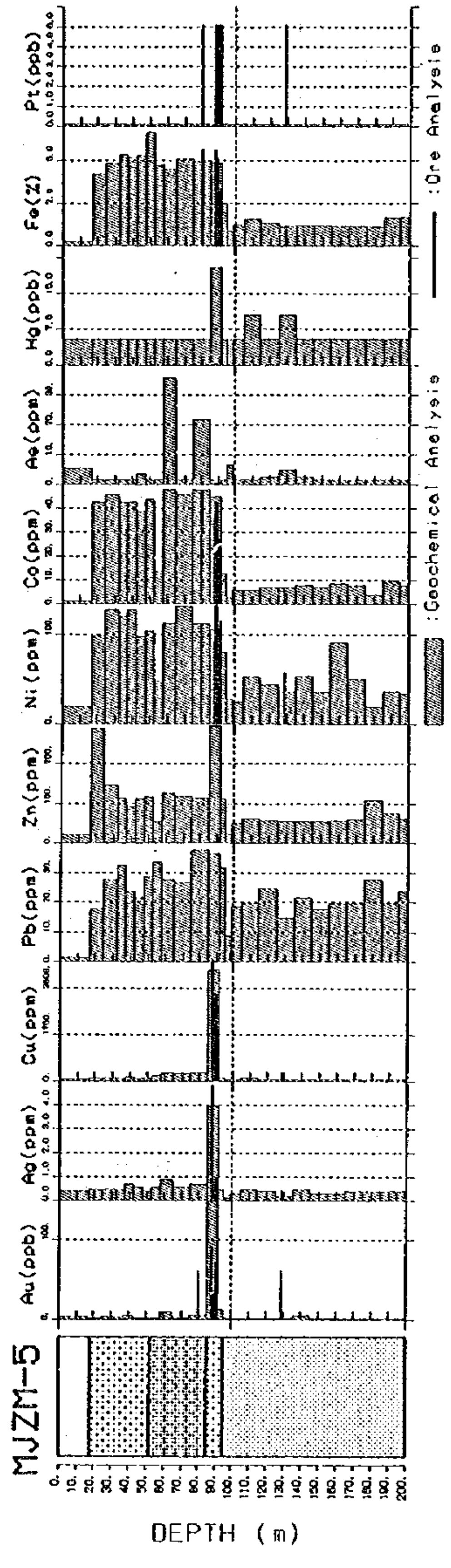

Fig.II-6-9 Chemical analysis diagram of rock and ore samples (MJZM-5)

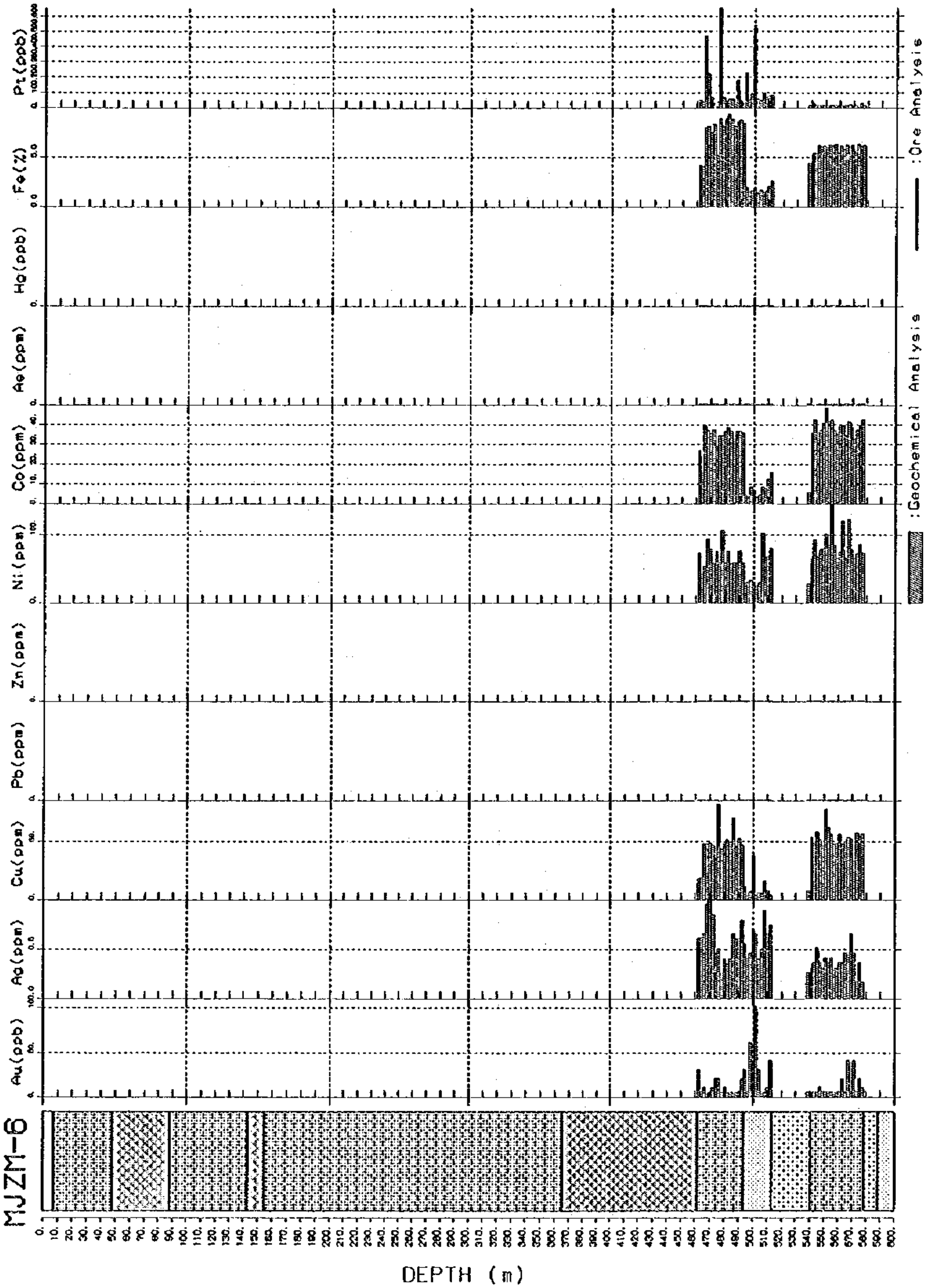

Fig.II-6-10 Chemical analysis diagram of rock and ore samples (MJZM-6)

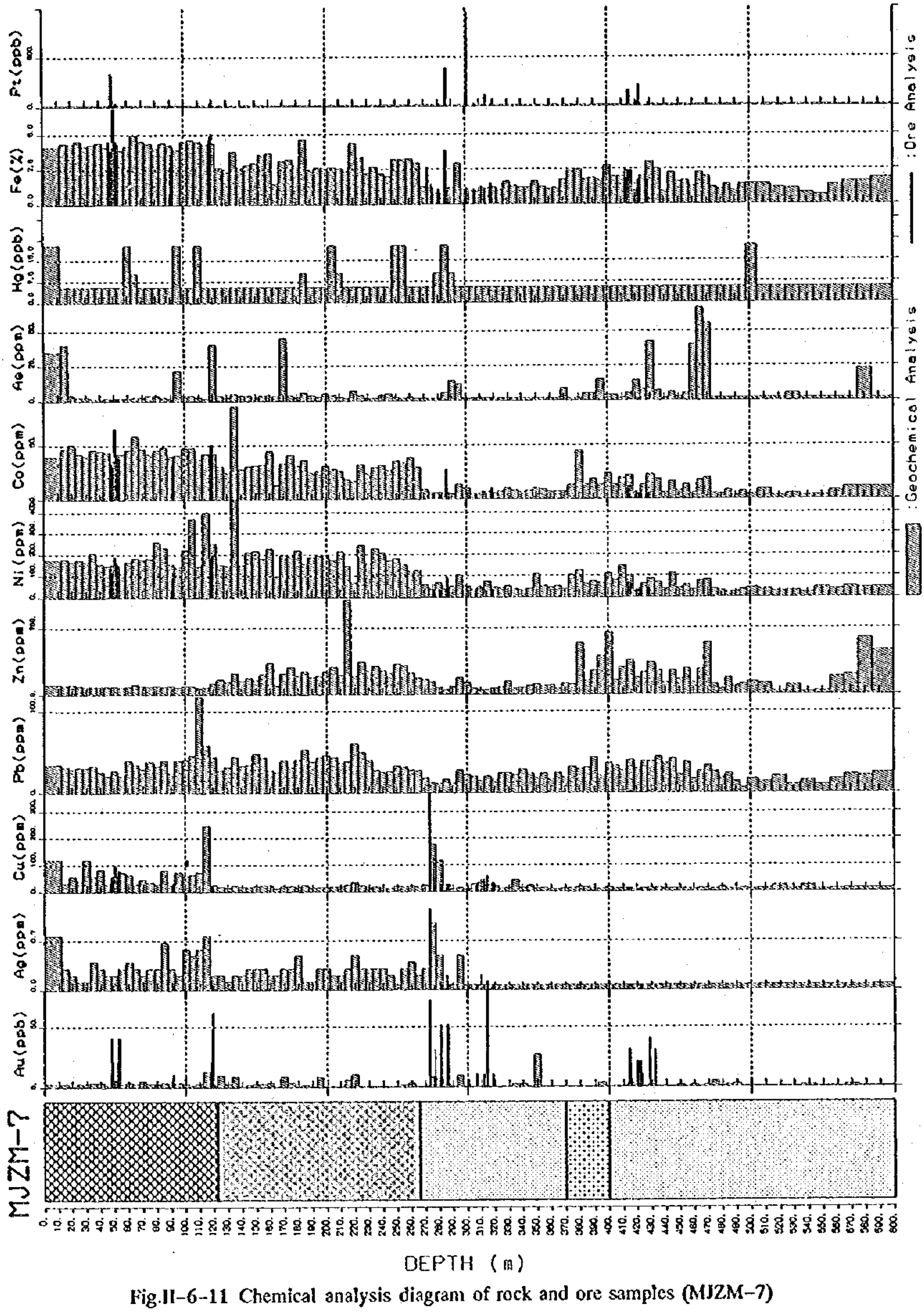

Fig.II-6-11 Chemical analysis diagram of rock and ore samples (MJZM-7)

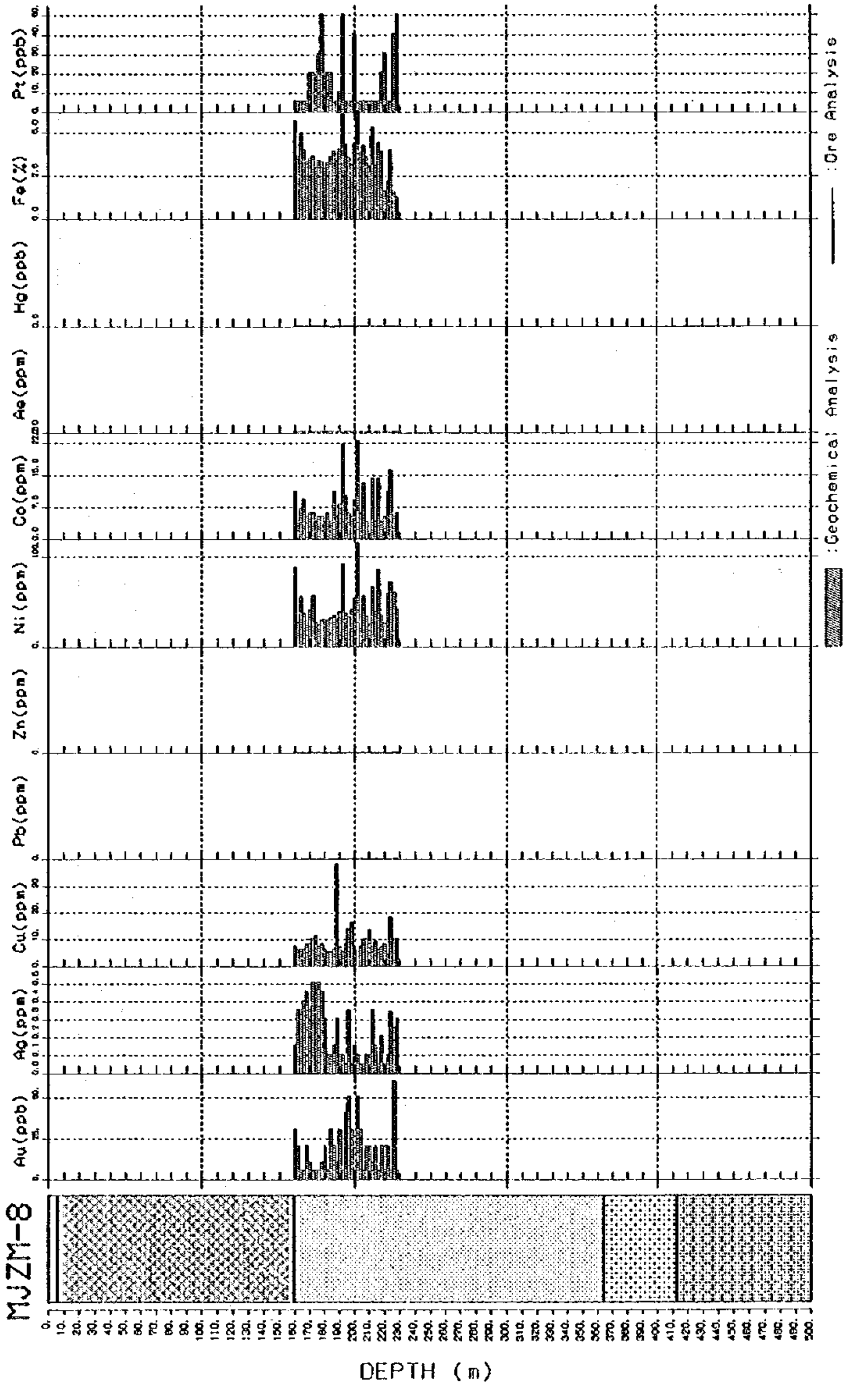

Fig.II-6-12 Chemical analysis diagram of rock and ore samples (MJZM-8)

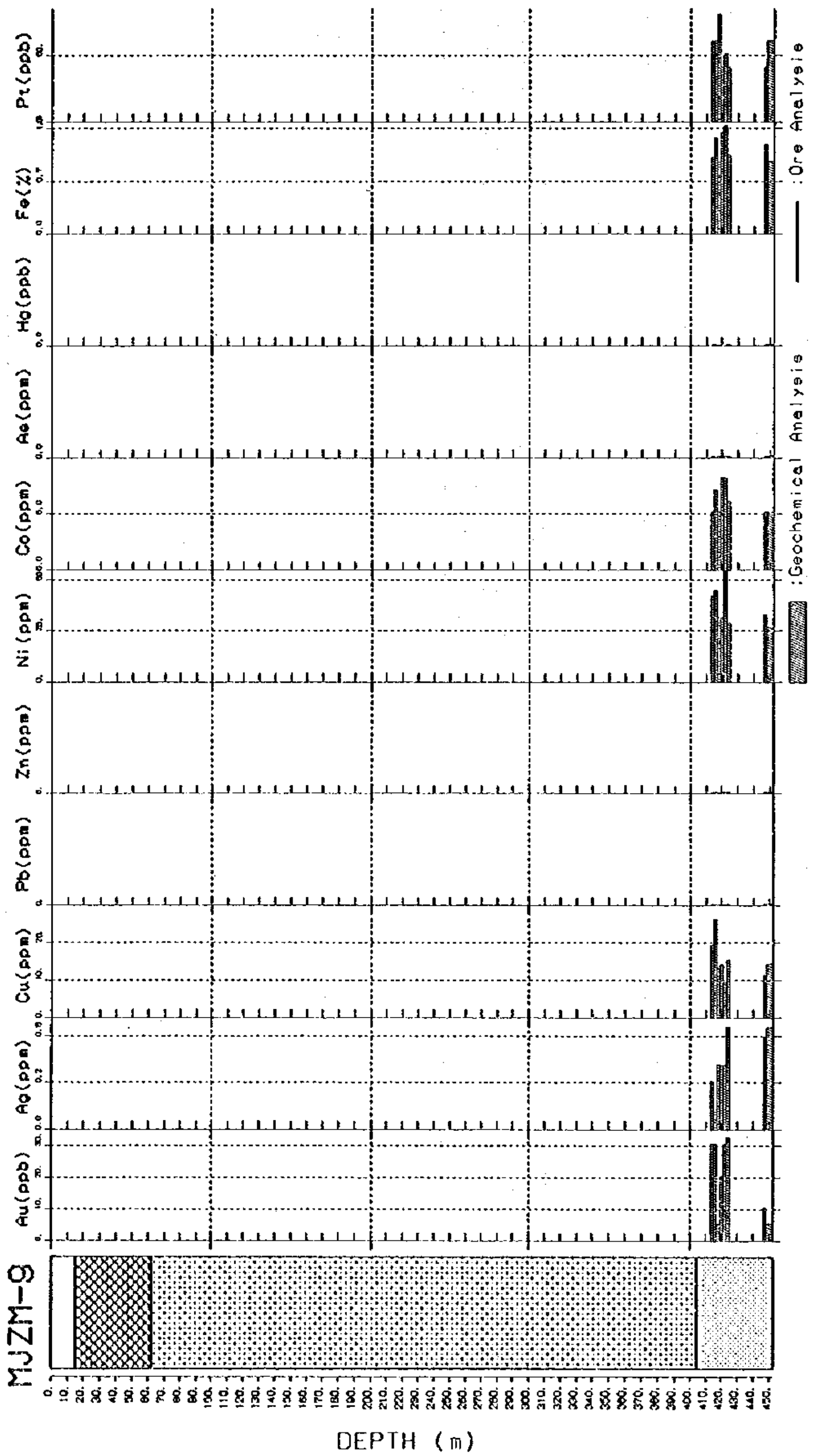

Fig.II-6-13 Chemical analysis diagram of rock and ore samples (MJZM-9)

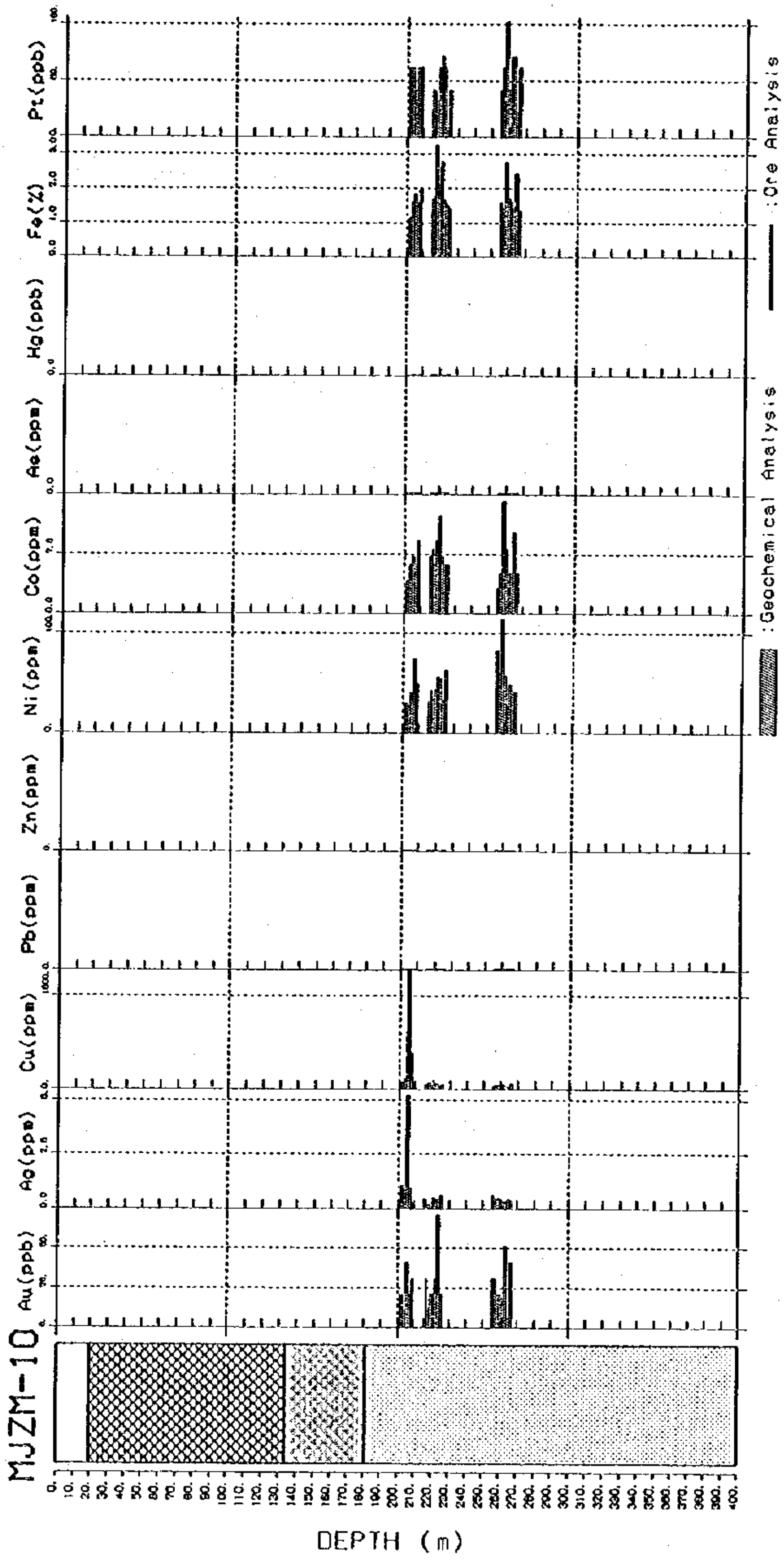

Fig.II-6-14 Chemical analysis diagram of rock and ore samples (MJZM-10)

Chapter 7 Consideration of the survey result

7-1 Controls on mineralization related to the geological structure and characteristics of mineralization

Ore deposits in this area occur in arkose of the Deweras Group. The formation of the ore deposition is considered to be strongly controlled by the sedimentary environment and geological structure of country rock (Simpson, 1990). As the result of the survey of the ore deposits and the mineralization area, the lowest part of the Deweras Group that form a boundary zone of the basement rocks is consider to be important at the northern Mhangura Area, the anticline structure from the direction of the NW-SE is considered to be important at the southern Alaska Area.

7-2 Relationship between geochemical anomalies and the mineralization

Based on the results of the Phase I and Phase II surveys, high potentiality areas of expected new ore deposits conform to the following condition of anomaly area closely related to mineralized area. Therefore, these areas were considered to be important for future exploration.

1) Distribution area of results of the Deweras Group
2) High copper content area of soil geochemistry
3) Distribution of high score of 4th principal component for 6 elements (Cu, Pb, Zn, Fe, Co, Ni)

7-3 Relationship between geophysical anomalies and the mineralization

Based on the physical property test, ores with sulphide mineralization show high chargeability according to the extent of mineralization respectively, however ores with oxide mineralization show low chargeability. Therefore, IP method geophysical survey for deeper place is effective in this area.

An IP anomaly caused by mineralization in this area is considered to be shown in chargeability of 50 mV/V to several hundred mV/V.

7-4 Relationship between results of drilling and the mineralization, soil geochemical anomalies and geophysical IP anomalies

Through the study of results of Phases I and II surveys and especially simulation analysis of geophysical IP anomalies, exploration target sites for drilling were selected.
The following results of drilling exploration were obtained.

MJZM-5 obtained a mineralization of small vein and dissemination mainly consist of chalcopyrite and pyrite , which is concordant with the foliation of country rocks.

MJZM-7 and 10 obtained a weak mineralization of dissemination mainly consist of chalcopyrite, pyrite, bornite, chalcocite and sphalerite.

These mineralization are in same ore horizon of known ore deposits (United Kingdom Mine and Hans Mine) and show similar mineral composition, it seems to be obtained an extension or end portion of known mineralized zone.

On the other hand, by the results of chemical analysis of cores, maximum 4.7ppm of silver and maximum 0.45% of copper are observed. No expected ore with economical value are obtained.

Obtained geochemical anomaly in Inyati farm corresponds to mineralization of MJZM-5 drilling. In the case of Blackwood farm, obtained geochemical anomaly is in a little different position from mineralization and geophysical IP anomaly, therefore, geophysical exploration like the IP method has to be use jointly with in soil geochemical anomalous zone.

On the study of geophysical data, as the results of physical property test of drill core, some of dolerite and basaltic pyroclastics show a similar IP effect to the weak mineralized arkose and granite. Therefore, if weak and clear IP pattern with about 20mV/V of chargeability was observed in the fields survey, it is necessary to consider the effect of these rocks.

Part Ⅲ Conclusion and recommendation

Part III Conclusion and recommendation

Chapter 1 Conclusion

Trough this survey, literature search, reconnaissance geological survey, soil geochemical exploration using GPS positioning system, analysis of previous geochemical data, geophysical IP exploration and drilling were carried out.

Conclusions obtained these surveys are as follows :

(1) An active geochemical survey was carried out to search the copper mineralization in the area from north of Mhangura to south of Alaska. in addition, many E.P.O.s reports, geological map, doctoral theses and others were published.

(2) All the deposits of large scale mines in this area are strata bound disseminated copper sulphide deposit type occurring in arkose of Deweras group.

(3) As the results of geochemical survey, following areas were considered to be important for future exploration.

1) Distribution area of results of the Deweras Group
2) High copper content area of soil geochemistry
3) Distribution of high score of 4th principal component for 6 elements (Cu, Pb, Zn, Fe, Co, Ni)
8 promising sites were selected based on this result.

(4) Based on the physical property test of ore and rock samples, it become clear that the IP method geophysical survey for deeper place is effective in this area. Therefore, reconnaissance and semi-detail IP survey was carried out at the geochemical anomalous sites, and 4 sites of IP anomalous source body was extracted.

(5) Through the study of results of Phases I and II surveys and especially simulation analysis of geophysical IP anomalies, exploration target sites for drilling were selected.
The following results of drilling exploration were obtained.

MJZM-5 obtained a mineralization of small vein and dissemination mainly consist of chalcopyrite and pyrite , which is concordant with the foliation of country rocks.

MJZM-7 and 10 obtained a weak mineralization of dissemination mainly consist of chalcopyrite, pyrite, bornite, chalcocite and sphalerite.

These mineralization are in same ore horizon of known ore deposits (United Kingdom Mine and Hans Mine) and show similar mineral composition, it seems to be obtained an extension or end portion of known mineralized zone.

On the other hand, by the results of chemical analysis of cores, maximum 4.7ppm of silver and maximum 0.45% of copper are observed. No expected ore with economical value are obtained.

By the results of drilling, weak mineralization was observed and around 0.5% of copper content may be obtained. However, high copper content ore that able to develop may be difficult to expect.

Chapter 2 Recommendations foe the future

According to conclusions obtained through the survey results in Phases I to III and study of them, we would like to recommend the following for the future.

Though expected results with economical value were not obtained from the analysis results of mineralized zone, mineralization of sulphide minerals were recognized. Therefore, the following survey method applied by the survey team can be recommended to be effective in the wide area with almost no outcrops like a the Makonde area.

1.Phase I : LANDSAT image interpretation, interpretation of previous works, geological reconnaissance survey and geochemical reconnaissance survey using GPS positioning system.

2.Phase II : Detailed analysis of existing geochemical data and geophysical survey (IP method).

3.Phase III: Drilling exploration on selected sites.

If the mineral exploration will be projected in similar area to Makonde area in the future, we will recommend to apply the above sequence of survey method.

If the geophysical IP survey will be projected, enough collection of ore and rock samples and physical property test of samples will be carried out before the IP survey. It will be necessary to able to separate the IP effect of ore and rocks.

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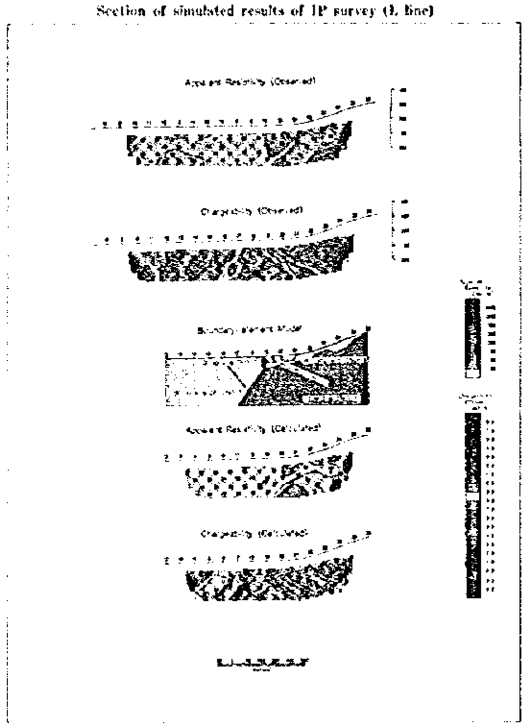
GEOLOGY AND ORE DEPOSITS OF THE MAKONDE AREA. REPUBLIC OF ZIMBABWE

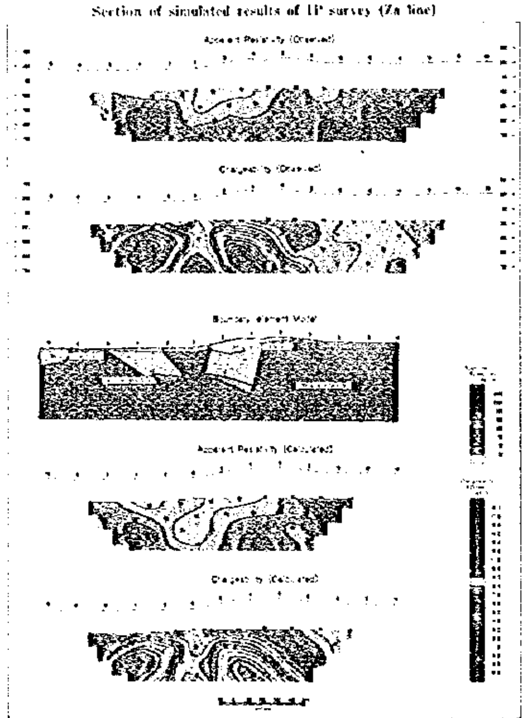
THE COOPERATIVE MINERAL EXPLORATION BY JICA/MMAJ-GSD, 1992-1994

REPORT ON THE MINERAL EXPLORATION
IN THE MAKONDE AREA
REPUBLIC OF ZIMBABWE
PREPARED BY JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
AND METAL MINING AGENCY OF JAPAN (MMAJ) IN COOPERATION
WITH GEOLOGICAL SURUEY DEPARTMENT (GSD) OF MINISTRY OF MINES,
REPUBLIC OF ZIMBABWE. FEBRUARY, 1995

Section of simulated results of IP survey (3, line)

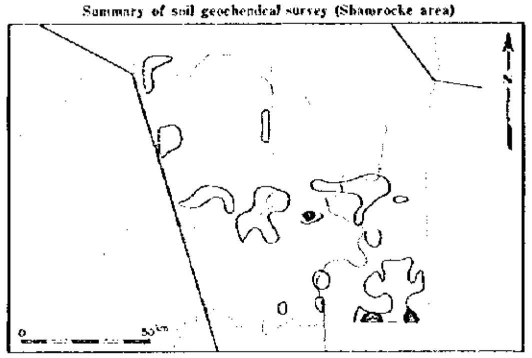


Section of simulated results of IP survey (7a line)

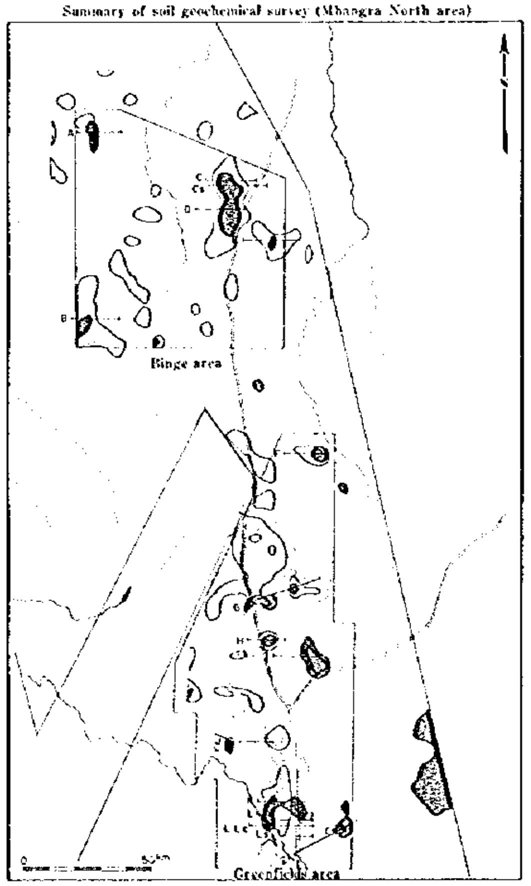


Section of simulated results of IP survey (0s line)

Summary of soil geochemical survey (Shamrocke area)

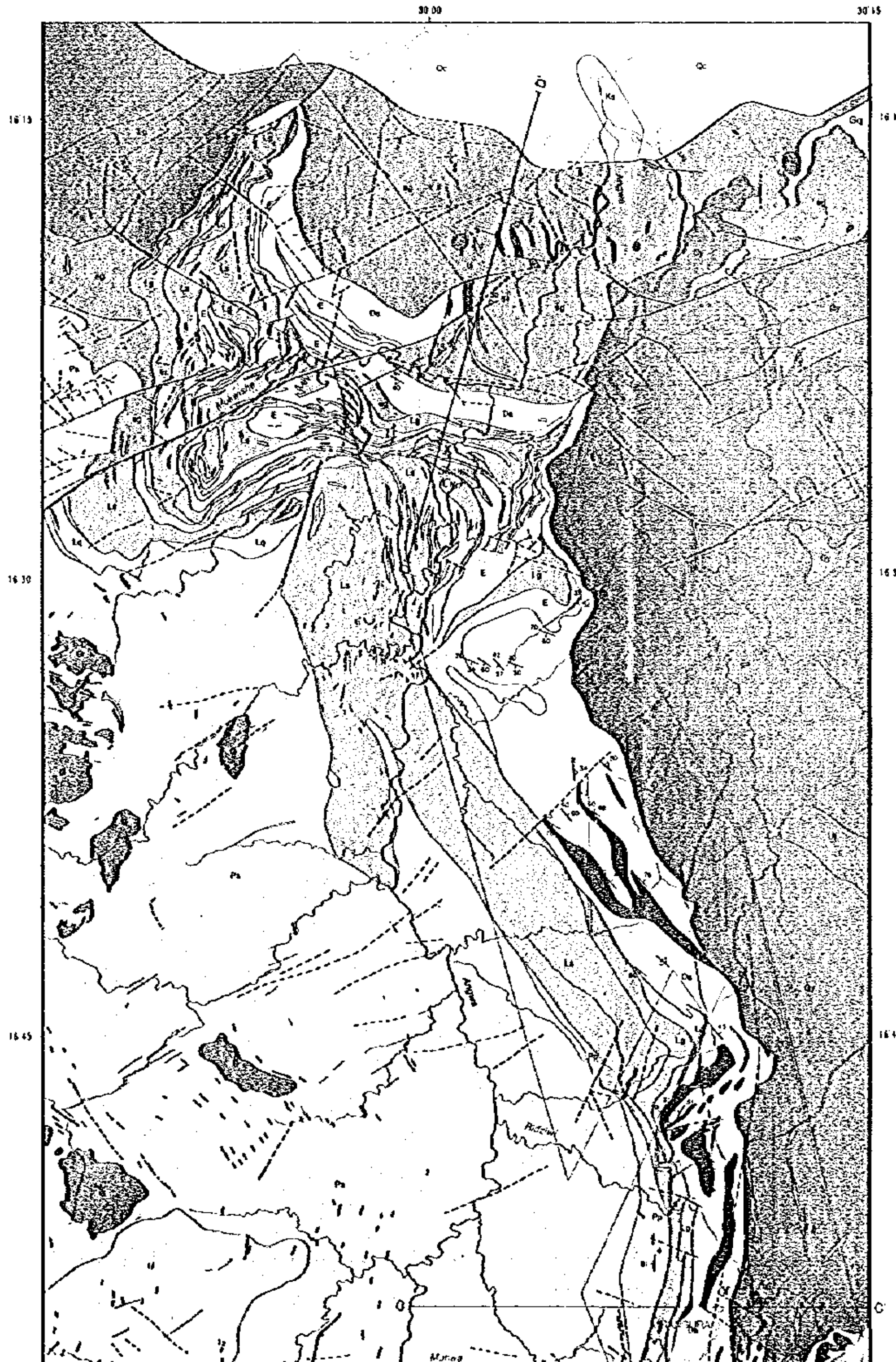


Summary of soil geochemical survey (Mhangra North area)

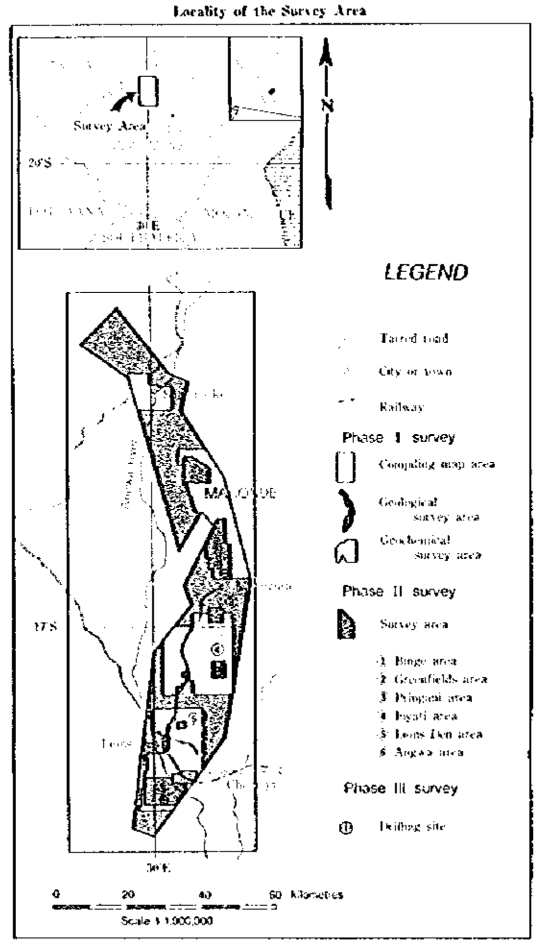


Summary of soil geochemical survey (Umboe area)

Geological Map Scale 1:200,000

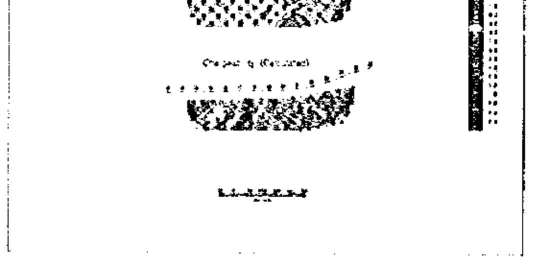


Locality of the Survey Area

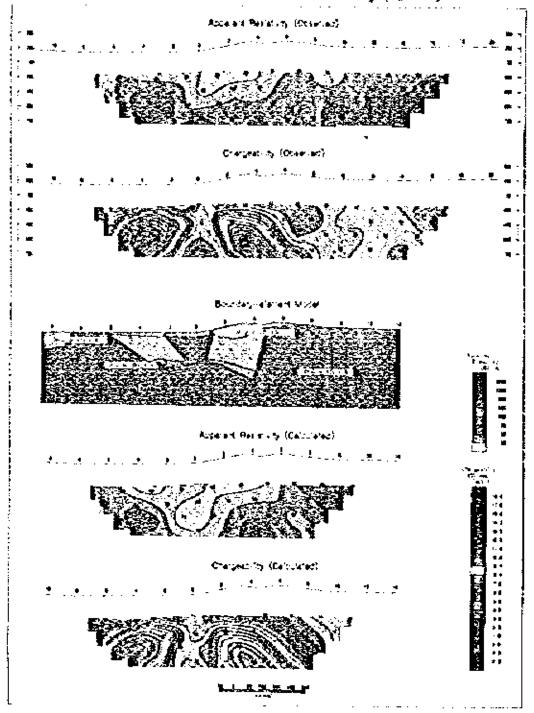


LEGEND

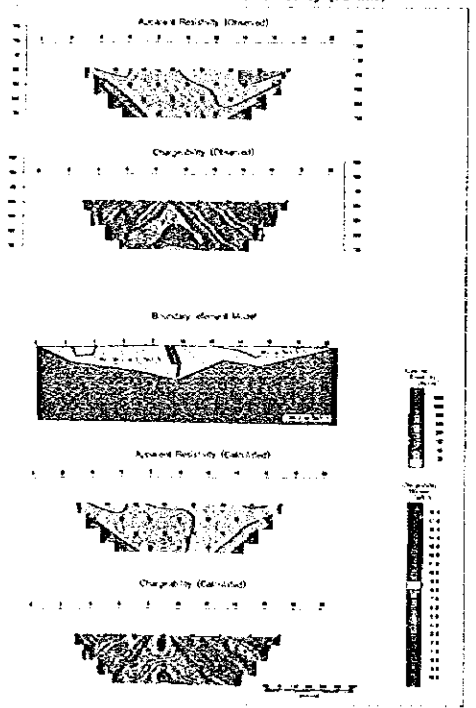
- Quaternary — Qa: Soil, sand, gravel and alluvium
- Quaternary — Qc: Colluvial fan deposit and soil
- Triassic — Upper Karoo Formation — Ks: Aeolian and fluvial sandstone
- Sijarira Group — Ss: Reddish sandstone
- Makonde Intrusive rocks — Q: Quartz vein, quartz-carbonate vein
- P: Pegmatite, Felsite
- E: Epidiorite, amphibolite, amphibolized ...
- Metadolerite, dolerite rocks



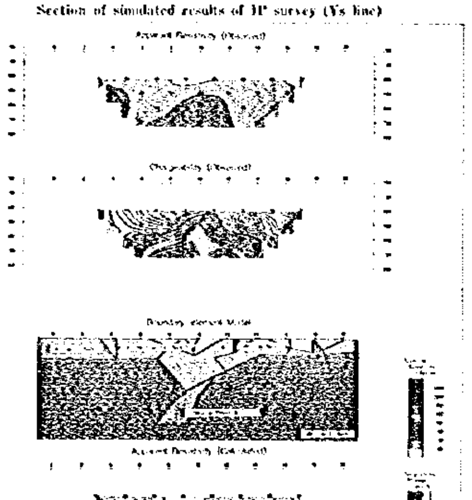
Section of simulated results of IP survey (Za line)

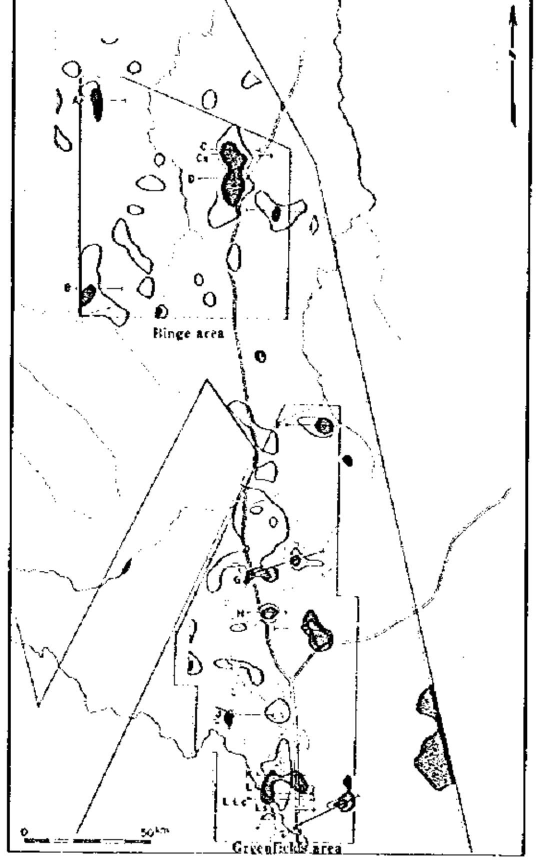


Section of simulated results of IP survey (Os line)

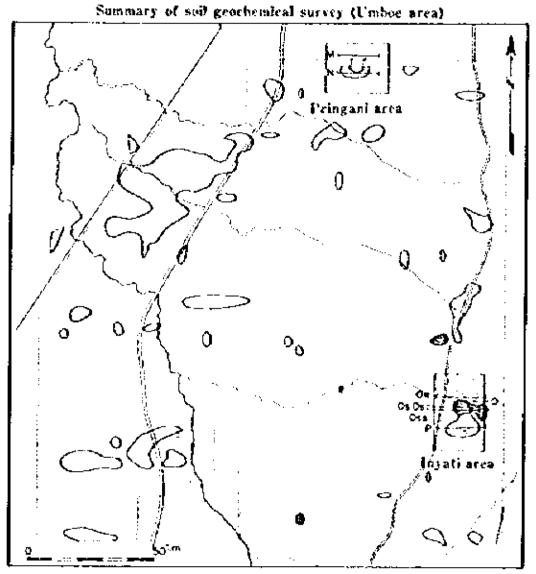


Section of simulated results of IP survey (Ys line)

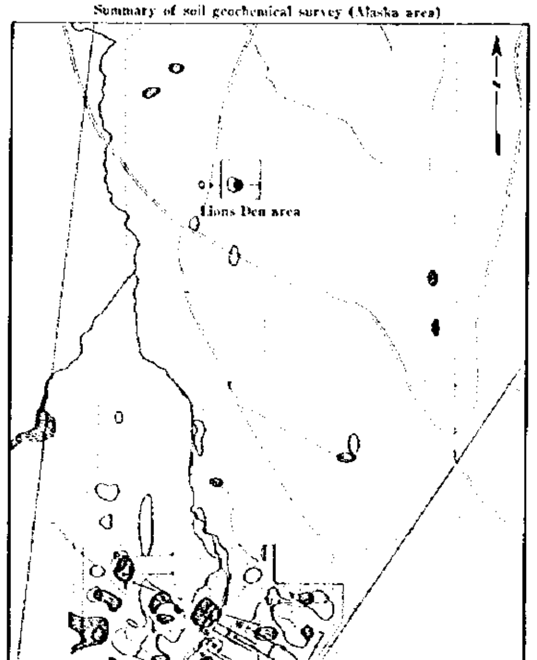


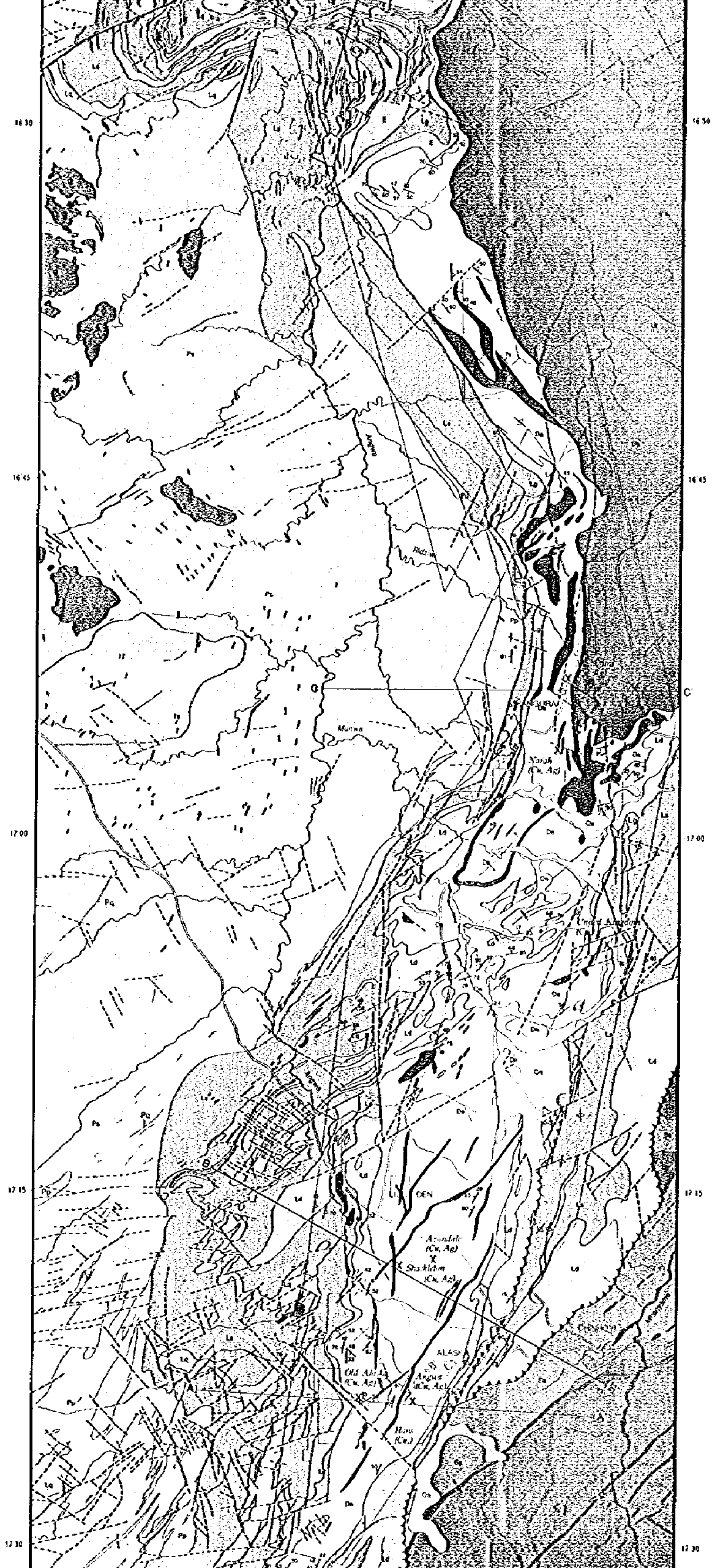


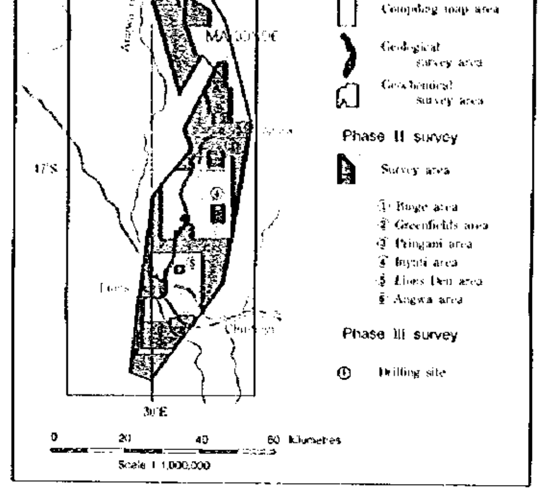
Summary of soil geochemical survey (Umboe area)



Summary of soil geochemical survey (Alaska area)



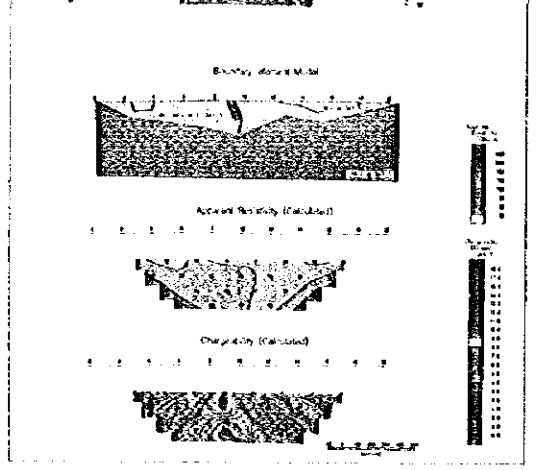




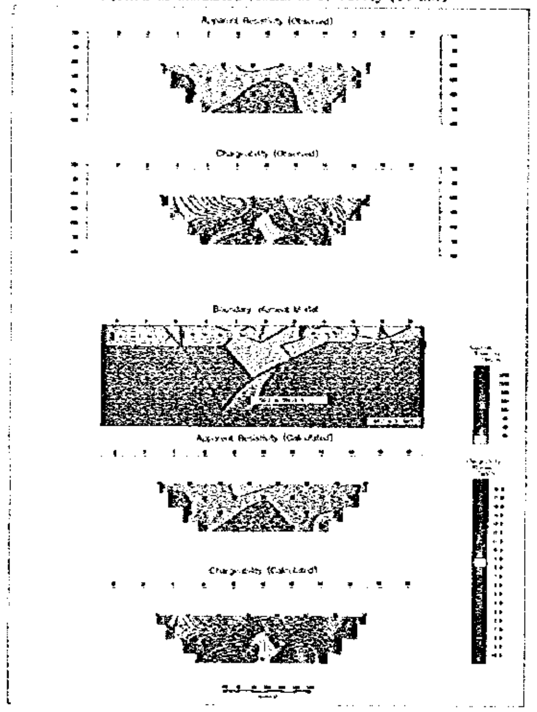
LEGEND

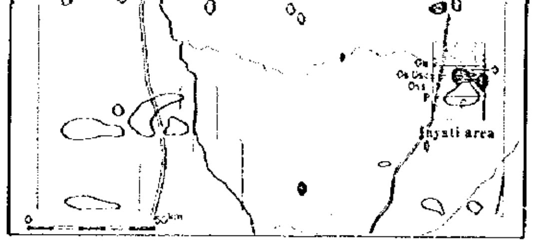
- Quaternary
  - Qa — Soil, sand, gravel and alluvium
  - Qc — Colluvial fan deposit and soil
- Triassic
  - Upper Karoo Formation: Ks — Aeolian and fluvial sandstone
- Lower Proterozoic
  - Sijarira Group: Ss — Reddish sandstone
  - Post Magondi Intrusive rocks
    - Quartz vein, quartz carbonate vein
    - P — Pegmatite, Felsite
    - E — Epidiorite, amphibolite, amphibolized troctolite
    - Metadolerite, doleritic rocks
    - Biotite granite
  - Gurave Metamorphic Complex: Gq — Muscovite quartzite, feldspathic quartzite, biotite schist, amphibole schist
  - Magondi Supergroup
    - Piriwiri Group, Umfuli Formation
      - Ps — Phyllite interbedded with greywacke
      - Pg — Grit
      - Pq — Quartzite, feldspathic quartzite, chert, felsite
      - Pp — Graphitic slate, pyritiferous slate, argillite, greywacke
    - Lomagundi Group
      - Nyagari Formation
        - Ls — Striped slate, argillite, phyllite, graphitic slate, quartzite, grits
        - Lq — Quartzite, feldspathic quartzite
        - Lg — Mountain sandstone, grits
      - McIlwaine Formation: Ld — Dolomite, quartzite, biotite bearing quartzite, chert, calc silicate rock
    - Deweras Group
      - Ardinnerous Formation: Da — Arkose, argillite, arkose pebbly conglomerate
      - Volcanic Formation: Db — Massive and amygdaloidal basalt
- Archaean
  - Pre Magondi Intrusive Rocks
    - Younger Granite: Porphyritic granite, even grain granite
    - Meta gabbro
    - Meta ultramafic rock with serpentine or talc
  - Shamvaian Group: Sd — Metamorphosed arkose, greywacke, conglomerates, siliceous sediment
  - Bulawayan Group
    - Epidiorite, pillow lava, undifferential greenstone
    - Banded ironstone
  - Chitomba paragneiss: Biotite paragneiss
  - Escarpment paragneiss: Biotite paragneiss, biotite hornblende paragneiss, hornblende paragneiss
  - Basement Complex: Orthogneiss

- Anticline with direction of plunge
- Syncline with direction of plunge
- Fault and fracture
- Thrust fault
- Geological survey area
- Geochemical survey area
- Detail survey area
- Mine, operating
- Mine, closed
- Strike and dip of bedding

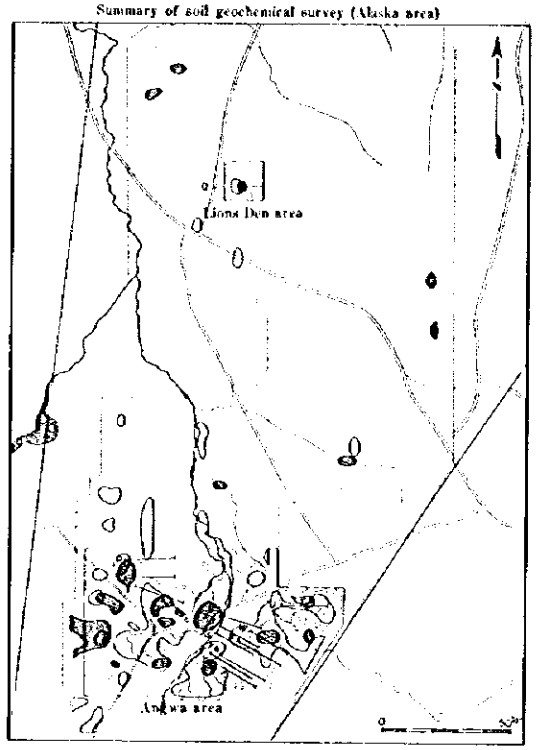


Section of simulated results of IP survey (Ys line)





Summary of soil geochemical survey (Alaska area)

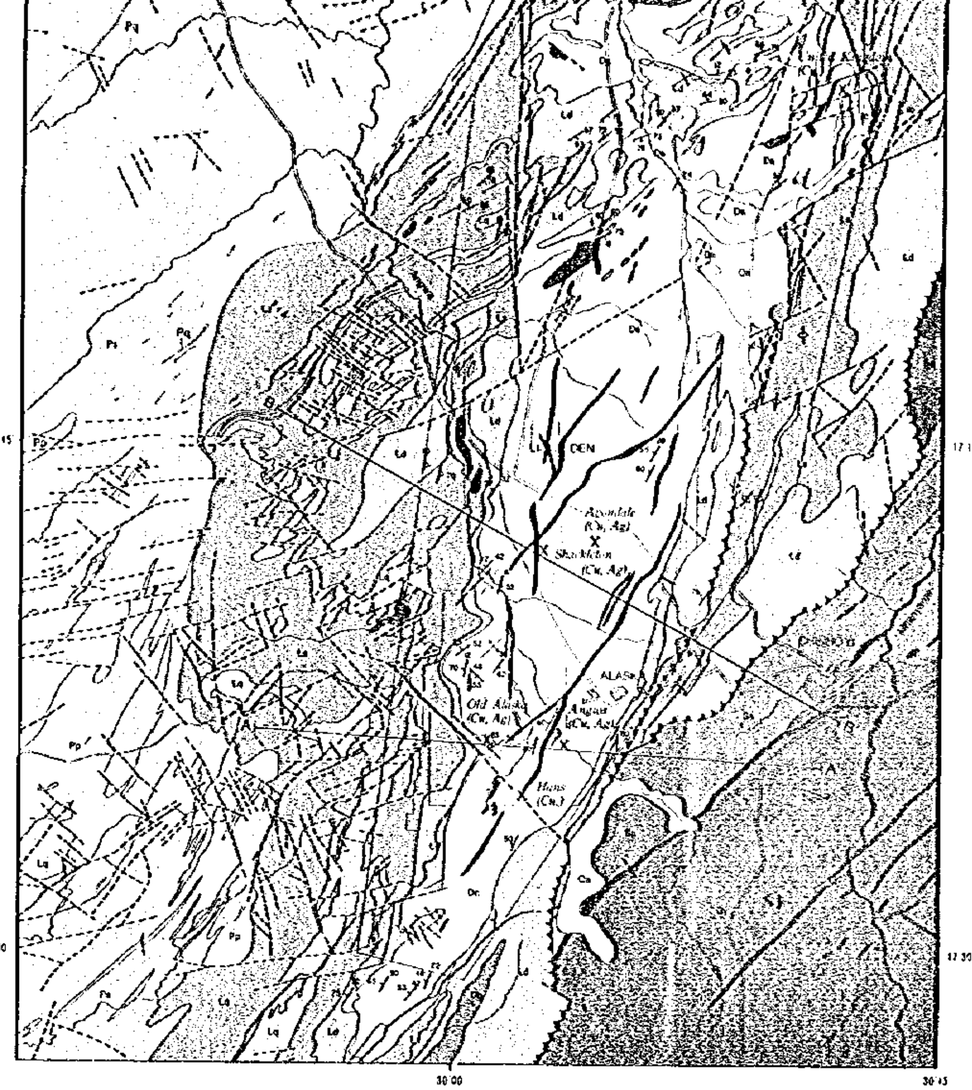


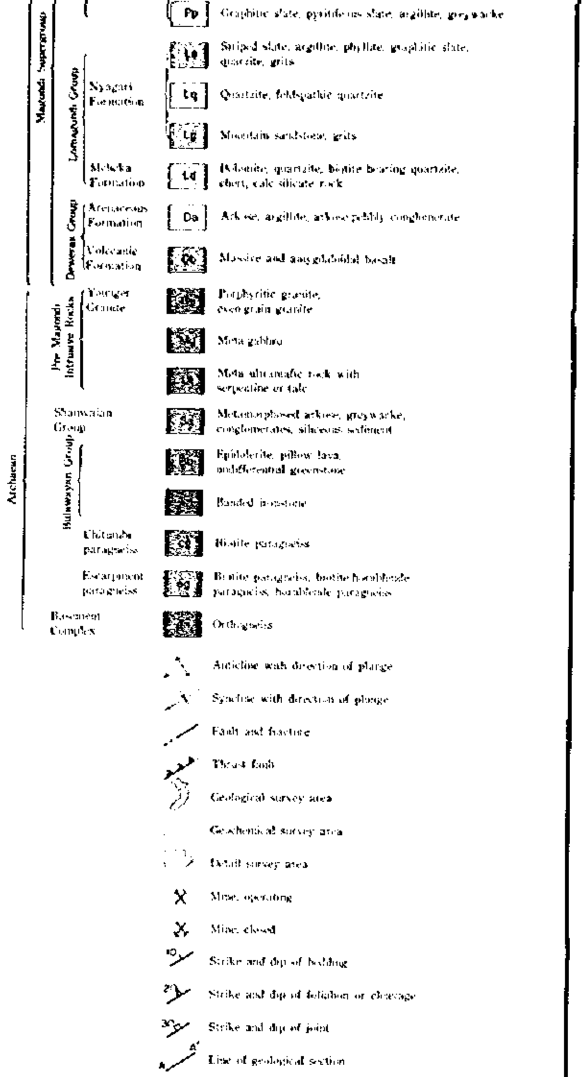
LEGEND

Geochemical Survey
- Survey Area
- Soil Anomaly, Cu≧713ppm
- Soil Anomaly, PC≧0.74
- Soil Anomaly, Cu≧713ppm & PC≧0.74

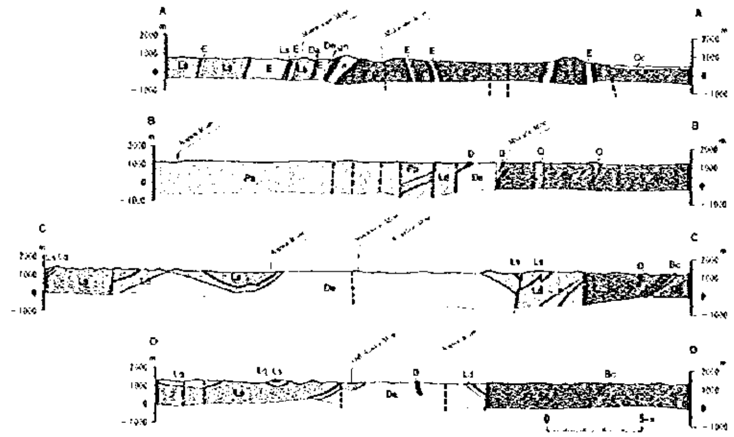
Geochemical Data Analysis
- Survey Area
- Soil Anomaly, Cu≧70.1ppm

Geophysical Survey
- IP Survey Line

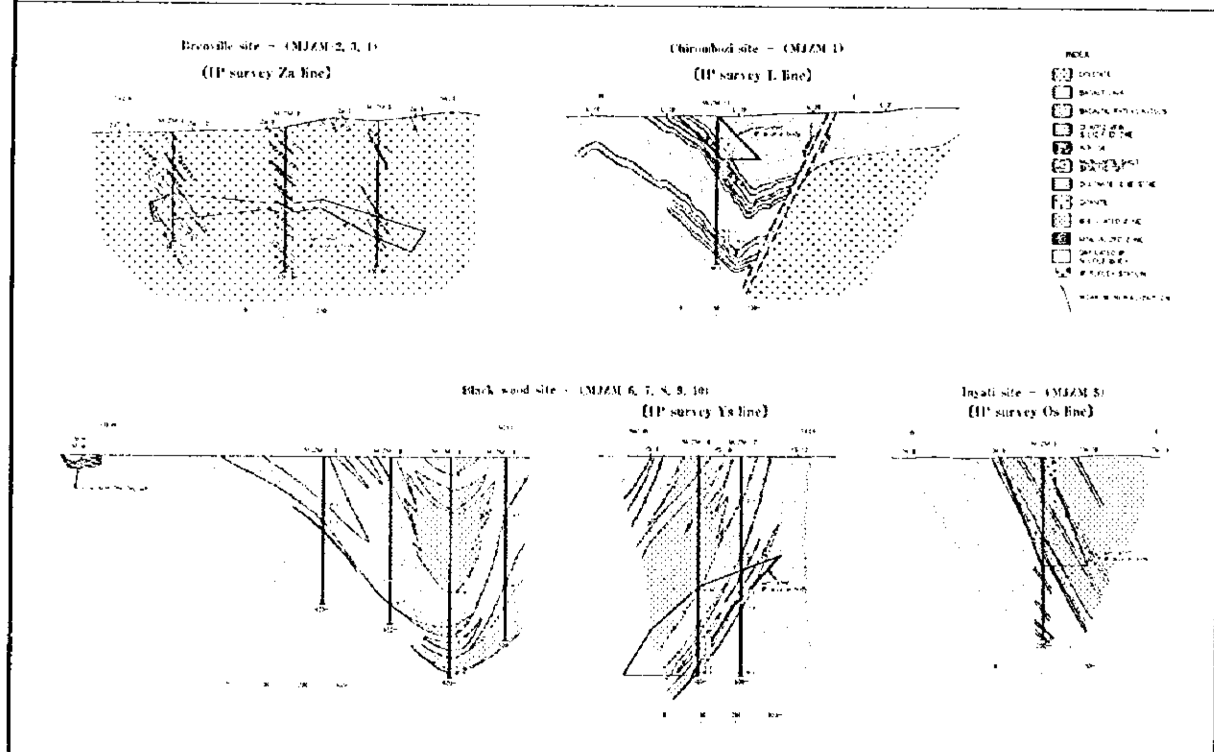




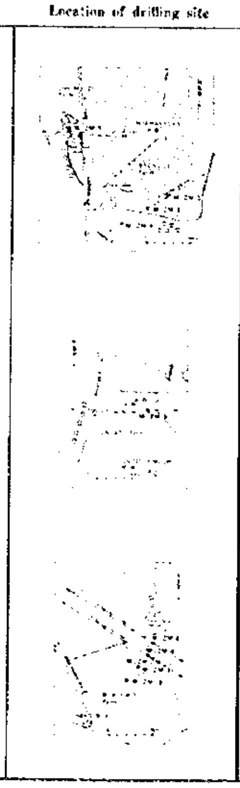
Shematic Geological Sections Scale 1:200,000



Geologic section of drilling survey



Location of drilling site



List of the Known ore deposits

1 [illegible]	[illegible]	Closed	[illegible]	Cu, Ag	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
2 [illegible]	[illegible]	[illegible]	[illegible]	Cu, Ag	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
3 [illegible]	[illegible]	Closed	[illegible]	Cu, Ag	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
4 [illegible]	[illegible]	Closed	[illegible]	Cu, Ag	[illegible]		[illegible]			[illegible]	
5 [illegible]	[illegible]	[illegible]	[illegible]	Cu, Ag	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
6 [illegible]	[illegible]	Closed	[illegible]	Cu, Ag		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
7 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
8 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
9 [illegible]	[illegible]	Closed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	

[illegible]

SUMMARY OF PERIOD AND MEMBERS OF INVESTIGATION IN EACH PHASE

Phase	Phase I	Phase II	Phase III
Priod	1992.6.16～1993.1.25	1993.7.1～1994.2.15	1994.7.14～1995.2.20
Planning and Negotiation	Ministry of Foreign Affairs Mr.Jiro KUMATO Ministry of International Trade and Industry Mr.Shinnji IKEDA Japan International Cooperation Agency Mr.Hitoshi SATO Metal Mining Agency of Japan Mr.Satoshi OKUMURA Mr.Takahisa YAMAMOTO Mr.Nobuyuki MASUDA Mr.Haruhisa MOROZUMI	Metal Mining Agency of Japan Mr.Haruhisa MOROZUMI	Japan International Cooperation Agency Mr.Ken-ichi TAKAHASHI Metal Mining Agency of Japan Mr.Haruhisa MOROZUMI Mr.Yoichi OKUIZUMI
	Geological Survey Department of Zimbabwe Dr.John Lisle ORPEN Mr.Surrender Mlonyiswa Nyabwa NCUBE	Geological Survey Department of Zimbabwe Mr.Surrender Mlonyiswa Nyabwa NCUBE Mr.Edson MUSHAYABASA Mr.Edzanai Borrnell MUPAYA Mr.Jameson RUSERAYA	Geological Survey Department of Zimbabwe Mr.Surrender Mlonyiswa Nyabwa NCUBE
Field Survey	DOWA Engineering Co.,Ltd Mr.Yoshicki NISHITANI Mr.Sanya YONEHARA Mr.Makoto SUGA Mr.Shin-ichi Iwaya Mr.Hirohide KONNO	DOWA Engineering Co.,Ltd. Mr.Yoshicki NISHITANI Mr.Hirohide KONNO Mr.Hiroshi JINGU Mr.Mitio TAKAHASHI Mr.Kazuei IMAI Mr.Tadashi NYUUI	DOWA Engineering Co.,Ltd. Mr.Yoshicki NISHITANI Mr.Katsunori SASAKI
	Geological Survey Department of Zimbabwe Mr.Edzanai Borrnell MUPAYA	Geological Survey Department of Zimbabwe Mr.Edzanai Borrnell MUPAYA Mr.Jameson RUSERAYA Ms.Cheneso MUPFUMI Mr.Joseph MADENESI	Geological Survey Department of Zimbabwe Mr.Edzanai Borrnell MUPAYA

JKA