REPORT
ON
THE MINERAL EXPLORATION
IN
THE MAKONDE AREA
THE REPUBLIC OF ZIMBABWE

PHASE II

MARCH 1995

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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Preface

In response to the request by the Government of Zimbabwe, the Japanese Government decided to conduct a Mineral Exploration Project in the Makonde Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to Zimbabwe a survey team headed by Mr. Yoshioki Nishitani from 27 July to 28 December, 1994.

The team exchanged views with the officials concerned of the Government of Zimbabwe and conducted a field survey in the Makonde area. After they returned to Japan, further studies were made and the present report has been prepared.

We hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

We wish to express our deep appreciation to the officials concerned of the Government of Zimbabwe for their close cooperation extended to the team.

February 1995

Kimio FUJITA
President
Japan International Cooperation Agency

Takashi ISHIKAWA
President
Metal Mining Agency of Japan

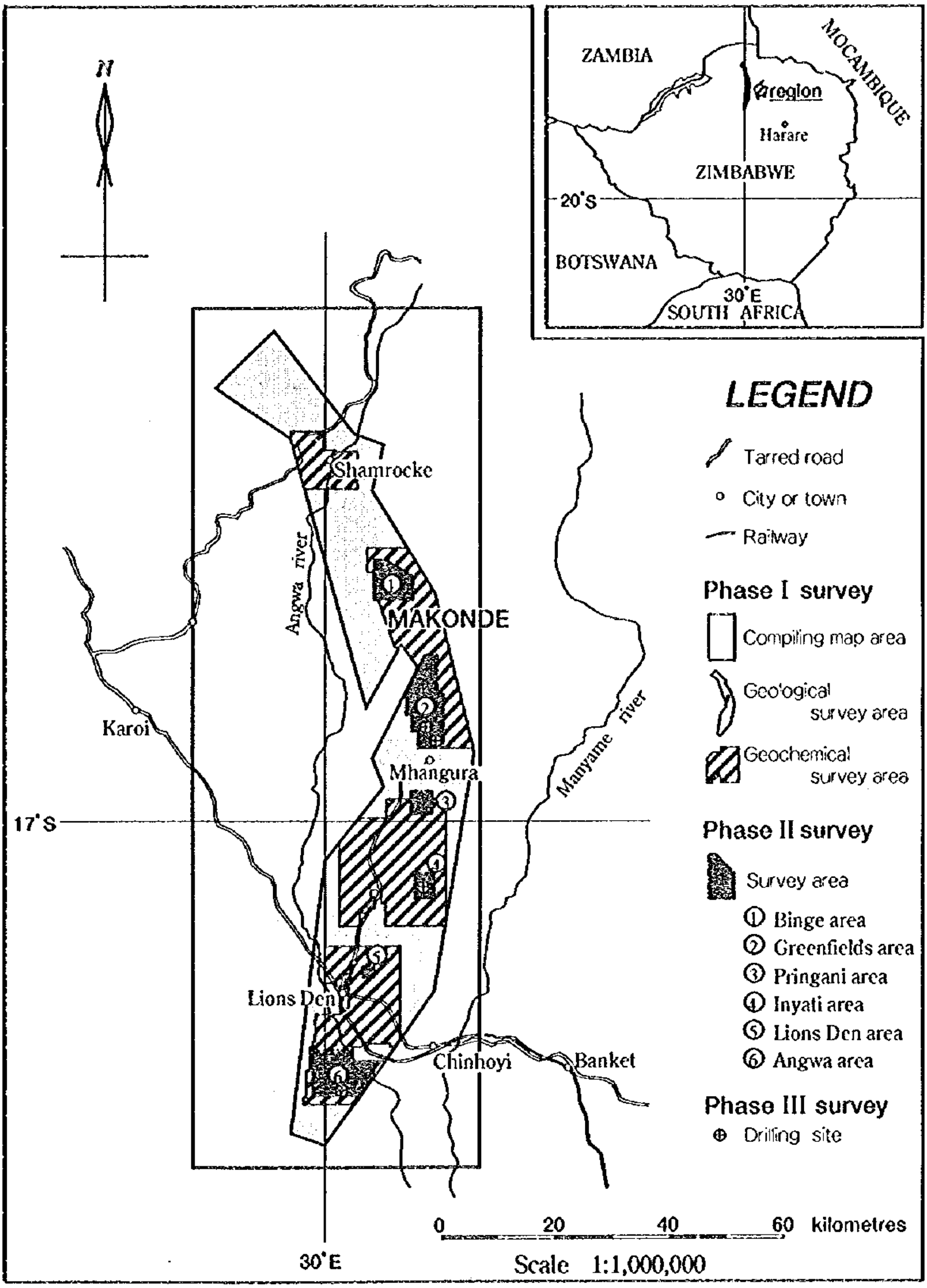

Fig. I-1-1 Locality of the survey area

Abstract

This survey was carried out in order to find out new ore deposits through the study of the geological setting and ore deposits of this area. At the same time, technological transfer from Japan to the related organization of Zimbabwe is one of the important purposes of this project.

The drilling survey (3 areas, 10 holes, total depth 4,057.50m) are carried out as Phase III of this project 1994.

Results of these drilling are as follows :

MJZM-5 obtained a mineralization of small vein and dissemination mainly consist of chalcopyrite, pyrite.

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

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 physical property test of drilling core samples, some samples of basic rocks show similar IP effect to weak mineralized arkose and granite, extracted IP anomalies of the Phase II survey are mainly consider to the effect of basic rocks.

The results of physical property test of ores show that if high grade ore which able to develop is in underground, stronger anomalies may be formed in the fields than the effect of basic rocks. Extracted anomalies mainly caused by the effect of basic rocks suggest the low potentiality of the existence of unknown new ore deposits.

Though the drilling exploration was carried out to the IP anomalous body mainly effected by basic rocks, in spite of low grade the copper mineralization was observed. This thing owing to that the drilling site was selected to the geochemical anomalous area. By the result of MJZM-5 drilling, it become clear that if the mineralization is in the depth of less than about 100m, the existence of underground mineralization is catched by the geochemical survey.

Recommendations for future are as follows :

Though expected results with economical value were not obtained from the analysis results of mineralized zone, mineralization of sulphide minerals were recognized. Therefore, following survey

method applied by survey team can be evaluated to be effective in the wide area with almost no outcrops like a 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 : Detail analysis of existing geochemical data and geophysical survey (IP method).

3.Phase III: Drilling exploration to selected sites.

If The mineral exploration will be projected in similar area to Makonde area in the future, we will recommend to apply this step of survey method. Especially, the geochemical survey using GPS positioning system is effective to extract the promising sites in the wide area.

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

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Part I General remarks

Part I General remarks

Chapter I Introduction

1-1 Background and purpose of the survey

This survey will be carried out within a period of three years commencing from 1992. This year,1994, is the phase III of this project. In the Makonde area, the target area of this survey, there are major Cu-Ag-Au deposits of Zimbabwe such as the Mhangura Mine and the Shackleton Mine. There are the high potentialities of the existence of the same type deposits which are undeveloped. As the production of ore in these mines has been decreasing in recent years, the discovery of new deposits is urgently expected. Therefore, the Government of the Republic of Zimbabwe requested to conduct the Technical Cooperation for a Mineral Exploration to the Government of Japan. The Government of Japan corresponded the request and conducted the drilling surveys. Through these surveys, the survey team was dispatched and carried out the fundamental survey in order to explore new deposits.

1-2 Conclusion and recommendation of the phase II survey

1-2-1 Conclusion of the phase II survey

The existing data analyses (five areas, 110km^2) and IP geophysical prospecting were carried out as the Phase II of this project 1993.

Existing data analyses:

The following geochemical anomalous sites were extracted by the computer analysis of the soil geochemical data of the related areas.

1. Tchetchenini-Binge-Redwing site
2. Wilden-Chimusenga-Greenfields site
3. Chironbozi-Brenville site
4. Piringani site
5. Inyati site
6. Around Old Alaska Mine site
7. South of Alaska smelten site
5. The Angwa mine-The Hans mine site

Geophysical prospecting:

IP geophysical reconnaissance and IP Semi-detailed prospecting were carried out to detect sulphide mineral ore deposits in the geochemical anomalous sites detected by 1992's survey. As a result, the following sites were selected as the promising sites.

1. Chironbozi site (L line No.18–19 stations)
2. Brenville A site (Za line No.3 station)
3. Brenville B site (Za line No.2 station)
4. Inyati site (Os line No.9--Oss line NO.9)
5. Blackwood A site (Ys line No.9 station)
6. Blackwood B site (Y line No.13–14 station)

1–2–2 Recommendation for the phase III survey

The following recommendation are proposed based on the results and examination of the phase II.

Based on the results of Phase I and Phase II surveys, 6 sites encouraging IP anomalous bodies were identified in the geochemical anomalous areas. These anomalous bodies must be confirmed by drilling.

The minimum amount of drilling and priority is as follows;

1) Blackwood A	600m
2) Blackwood B	500m
3) Brenville A	300m
4) Brenville B	400m
5) Inyati	200m
6) Chirobozi	200m

In the case of potential ore deposits revealed by the drilling, detailed drilling will be necessary to explore the extend of mineralization and to calculate the ore–reserves and grade.

1–3 Outline on the works of the phase III surveys

1–3–1 The survey area

The Makonde area is located in the northern part of Zimbabwe. The distance and travel time by car from Harare are as follows.Locality of survey area is shown to Fig.I–1–1.

```
          1.5 hours                  0.8 hours
HARARE ----------- CHINHOYI ----------- MHANGURA
       130 kilometres   |      70 kilometres
                        |         10 minutes
                        ------------------ ALASKA
                            12 kilometres
```

There are paved national roads and local roads from the Capital to the survey area. Even during the rainy season of November to March, it is possible to access to the survey area.

Survey areas that are selected by the phase II survey are as follows.

1.Greenfields area 2.Inyati area 3.Angwa area

During the field survey, Japanese engineers stayed in Chinhoyi. The counterpart stayed in the base camp in the Alaska Smelter during the field surveying. Labors were employed in the survey area.

1-3-2 Purpose of the survey

This survey was carried out in order to explore new ore deposits in the Makonde area, the Republic of Zimbabwe.

1-3-3 Method of the survey

The drilling survey were done for the target sites where selected by phase II survey. Potentiality of new ore deposit were studied.

Outline of the survey are shown in Table I-1-1.

Table I-1-1. Outline of the survey

Specification of the survey	Numbers of survey		
Drilling Survey	Green fields area	MJZM-1	202.60 m
		MJZM-2	400.60 m
		MJZM-3	400.60 m
		MJZM-4	301.70 m
	Inyati area	MJZM-5	200.00 m
	Angwa area	MJZM-6	600.00 m
		MJZM-7	600.00 m
		MJZM-8	500.00 m
		MJZM-9	452.00 m
		MJZM-10	400.00 m
	Total	10 holes	4,057.50 m
Laboratory Test	Thin section of rock samples : 23 samples Polish of ore samples : 11 samples Chemical analysis of ore samples : 183 samples Geochemical analysis rock samples : 228 samples Measurement of Resistivity and Chargeability of rock and ore samples : 122 samples		

1-3-4. Members of the survey team

The following members were organized as the survey team, who negotiate the survey planning and conducted and actual survey.

Planning and Field Superior:

(Japanese Members)

Mr.Ken-ichi TAKAHASHI :JICA

Mr.Haruhisa MOROZUMI :MMAJ

Mr.Yoichi OKUIZUMI :MMAJ

(Zimbabwean Members)

Mr.Surrender Mdunyiswa Nyahwa NCUBE : Director of GSD

Mr.Edson MUSHAYABASA : GSD

Mr.Fadzanai Bornwell MUPAYA : GSD

Mr.Jemeson RUSHWAYA : GSD

Field Survey

(Japanese)

Yoshioki NISHITANI : DOWA Engineering.,Ltd.

Katsunori SASAKI : DOWA Engineering.,Ltd.

(Zimbabwean)

Fadzanai Bornewell MUPAYA : GSD

1-3-5. Term of the survey

Field survey was carried out as follows:

Field survey ; from 27 July to 28 December, 1994

Chapter 2 Physical features

2-1 Topography and river system

The topography of the survey area shows peneplain like a moderate swell of the elevation of 1,000 metres to 1,250 metres.

The mountain system is controlled by the geology in the area. The mountains stretch the direction of the NNE to the SSW in the southern part and NNW to SSE in the northern part.

Rivers flow to the direction of the west or the north, and flow into Angwa river which runs in the western part of the area. Angwa river runs to the north to flow into Zambezi river which make the northern border of Zimbabwe with Zambia.

All the rivers flow only in the rainy season. There is no water in the river except some pools in the dry season.

2-2 Climate and vegetation

The climate of the survey area is divided into the dry season (from April to October) and the rainy season (from November to May). Maximum temperature is constant of 25 to 28 degree centigrade through the year. Minimum temperature shows 17 degree centigrade in rainy season and from 5 to 10 degree centigrade in dry season. Rainfall of each month shows about 180 mm par month in the rainy season and from 1 to 5 mm par month in dry season. No rainfall is recognized in dry season.

As regards vegetation, except short broad-leaved tree as oaks which distributes in the mountainous district, the vegetation is generally thin in the survey area. Tall legume as acacias is usually distributed in the mountain skirts and in the plain, Many coconut palms and cycads characteristically grow along the river. No coniferous trees are generally seen except few in the pasture and afforested area.

The plain extended from the southern part of the survey area to the north of the Mangula Mine is owned by large-scale farmers to grow wheat, corn and grass, and pastures.

Chapter 3. General geology

3-1 General geology

Geology of this area consists of gneiss, green rocks and granites of Archaean era which forms the basement, and sedimentary rocks and volcanic rocks of Proterozoic era called Magondi Supergroup. Geological map is shown in Fig.I-3-1. Schematic geologic column is shown in FigI-3-2.

The basement rock consists of gneiss, green rocks and granites. Gneiss is distributed in the northern part. Green rocks are distributed in the southern part and are composed of mafic rock and felsic sandstone. Granite is distributed in the eastern side of the Mhangura Mine and the southern part of the survey area.

Magondi Supergroup is divided into Deweras Group, Lomagundi Group and Piriwiri Group from the lower to the upper horizon.

Deweras Group mainly consists of alluvial fan sediments such as conglomerate, arkose with cross-bedding and grading, and pelitic schist partly associated with chemical sedimentary rocks. It shows the structure of repeated sedimentation of the unit of Playa. This Group is distributed in the central part of the area successively from the north to the south, and includes strata-bound copper deposits.

Lomagundi Group can be divided into the lower formation which mainly consists of dolomite and poke-marked quartzite and the upper formation which mainly consists of stripped slate.

Piriwiri Group mainly consists of phyllite, graywacke, graphitic slate and quartzite, and is partly accompanied with volcanic rocks and pyroclastic rocks. It is widely distributed in the western part of this area covering Lomagundi Group with conformity.

3-2 Geological structure

The Sedimentary rocks in Magondi Supergroup was formed by sedimentation within the rift valley which was extended by the left lateral fault parallel the Great Dyke direction. According to the extension of the rift valley, alluvial fan sediments and playa sediments (Deweras Group) which was originated from basement rocks were formed at first, and covered lagoon sediments(lower Lomagundi Group) which consists of dolomite, quartzite and slate, later. Finally, pelitic rocks, fissilitic phyllite which was originated from pelitic rocks and alteration of fallen volcanic rocks, and deep sea sediments (Piriwiri Group) deposited.

Initially, parallel faults and anticline axis cross obliquely to rift valley were formed by strike-slip fault according to extension of the rift valley. These faults and anticline axis were formed before compaction of Magondi Supergroup, and formed the environment of ore solution path and strata bounded disseminated copper deposits.

Second structural movement is so-called the Magondi Mobile Belt, which forms fold with N-S

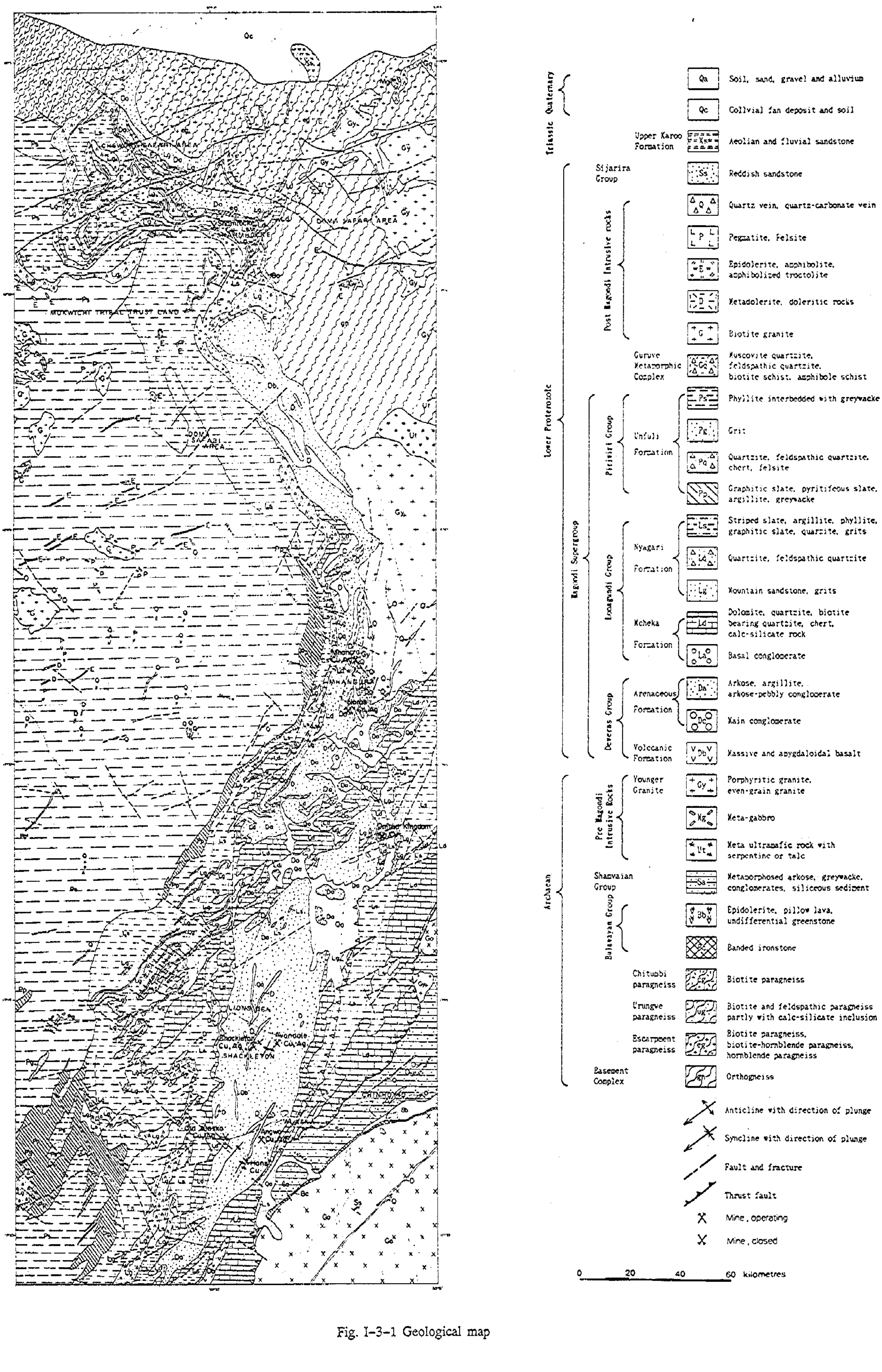
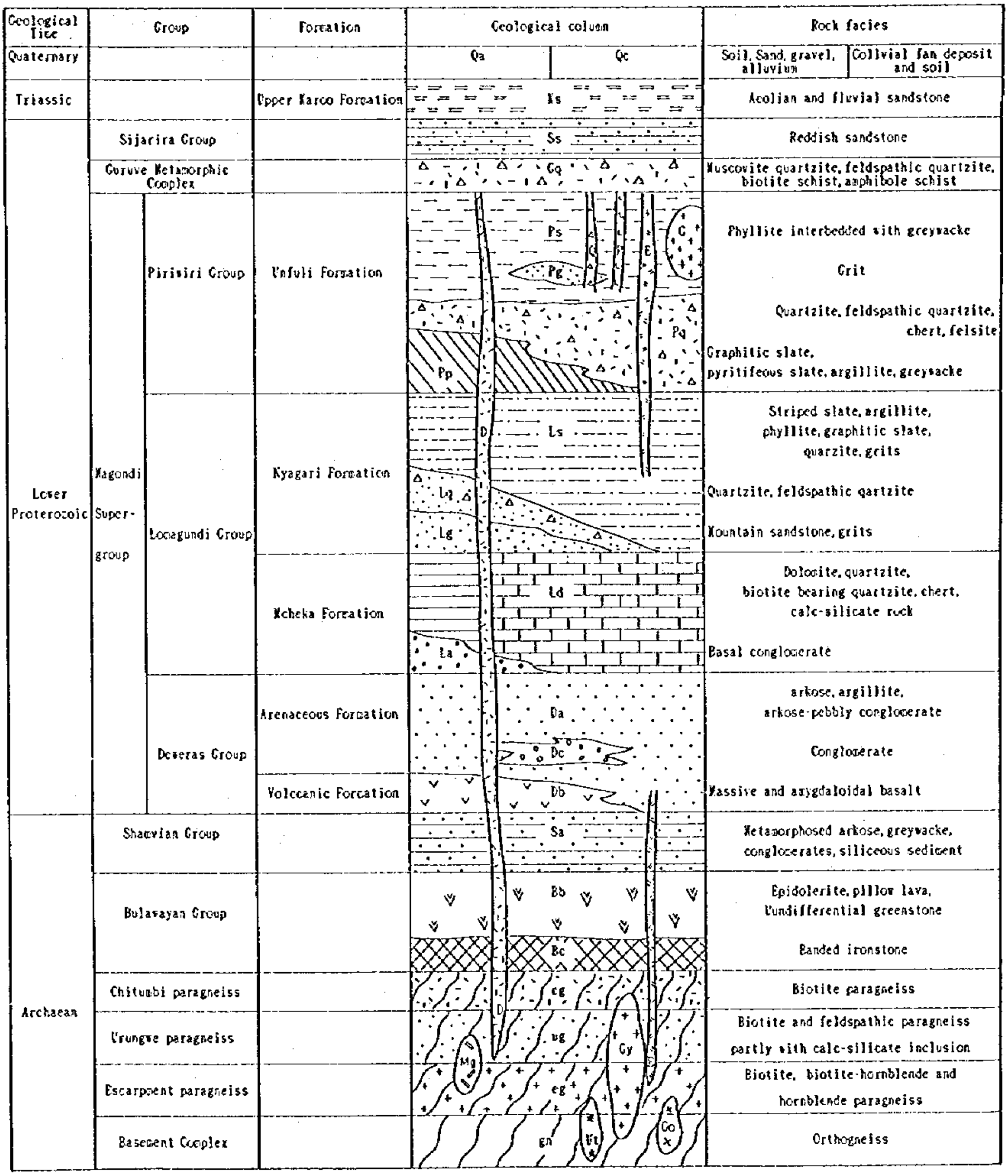


Fig. I-3-1 Geological map



Post Magondi Intrusive rocks
- Q :Quartz vein, quartz-carbonate vein
- P :Pegmatite, Felsite
- E :Epidolerite, amphibolite, amphibolized troctolite
- D :Metadolerite, doleritic rocks
- G :Biotite granite

Pre Magondi Intrusive Rocks
- Gy:Porphyritic granite, even-grain granite (Younger Granite)
- Go:Fine granite, granodiorite, tonalite (Older Granite)
- Mg:Meta-gabbro
- Ut:Meta ultramafic rock with serpentine or talc

Fig. I-3-2 Schematic geological column

and NNE-SSW and thrust structure due to change of this area to compaction. The age of this mobile belt is considered to be 1,800Ma to 2,000Ma by Pb-Pb and Rb-Sr age determination method (Master, 1991).

Final Structural movement is called the Pan-Africa Zambezi Mobile Belt, which affected marked metamorphism to the northern part of this survey area and controlled the fold structure in the Shamrocke area.

3-3. Known ore deposits

List of the known mineralization areas is shown in Table I-3-1.

The copper ore deposits are the only mineral resources which have economic feasibility. Silver and gold associated with copper ore deposits are also recovered. Besides the metal resources, crushed dolomite for construction and slate for building materials are worked in several places.

9 mines and ore deposits have operated before, but now only the Angwa Mine, the Shakleton Mine including the Avondale ore deposit, and the Mhangura (Miriam) Mine are still mining at present. These ore deposits are shown in Fig.I-3-1.

These ore deposits are roughly classified into the two deposits occurring in the Deweras Group and in the Lomagundi Group.

The former are strata bound ore deposits occurring within arkose of the Deweras Group. The Hans Mine, the Angwa Mine, the Shackleton Mine including the Avondale ore deposit, the Norah Mine and the Mhangura (Miriam) Mine are developed. 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 anticline structure from the direction of the NW-SE is considered to be important.

The Old Alaska Mine in the south-western part of the area and the Shamrocke Mine in the northern part belong to the latter.

Moreover, There is the United Kingdom Mine as a vein type ore deposit.

Table I-3-1 List of the known ore deposits

Name of Mine and Mineralized Area	Locality Coordinates	Situation	Type of deposits	Mineralized Metal	Ore reserve	Metal grade	Main ore minerals	Accessory minerals	Gangue minerals	Host rock	Present Production
(1)Hans	17°25.47'S 30°01.95'E	closed	Stratabound and disseminated ore	Cu, Ag	0.3million tons Cu1.0%	AgMax93.5g/t CuMax3.71%	Mal, Bo, Cc	Cp	–	Arkose Conglomerate	
(2)Angwa	17°23.90'S 30°03.37'E	Operating	Stratabound and disseminated ore	Cu, Ag	4.5million tons Cu0.95%	AgMax62.6g/t CuMax1.59%	Bo, Cc, Cp	Py, Mt, Hem	–	Arkose Conglomerate	16,000t/m Cu0.6%
(3)Old Alaska	17°23.87'S 30°00.87'E	closed	Stratabound and disseminated ore	Cu, Ag	5million tons? Cu1.5%	AgMax62.6g/t CuMax1.59%	Mal, Bo, Cc	Cp, Py, Cv, Mt, Hem	–	Lomagundi.G Dolomite	
(4)Shackleton	17°18.08'S 30°02.67'E	closed	Stratabound and disseminated ore	Cu, Ag	6million tons Cu1.2%		Bo, Cc	–	–	Arkose Conglomerate	
(5)Avondale	17°17.85'S 30°04.11'E	Operating	Stratabound and disseminated ore	Cu, Ag	4.4million tons Cu0.9%	Ag 11.6g/t Cu 0.45%	Cc	Bo, Cp	–	Arkose Conglomerate	16,000t/m Cu0.6%
(6)United Kingdom	17°04.67'S 30°11.24'E	closed	qz-cal Vein	Cu, Ag		AgMax45.9g/t CuMax2.69%	Mal, Cc	Cv	Qz, Cal, Hem	Arkose	
(7)William	16°53.31'S 30°09.59'E	Operating	Stratabound and disseminated ore	Cu, Ag, Au Pt, Pd, Se	60million tons Cu1.0%	AgMax33.2g/t CuMax13.0%	Bo, Cc, Cp	Py, Mt, Hem	–	Arkose Conglomerate	4,000t/d Cu0.7%
(8)Norah	16°56.21'S 30°09.16'E	Operating	Stratabound and disseminated ore	Cu, Ag, Ag	8million tons Cu1.2%	AgMax170g/t CuMax13.0%	Cp, Bo, Cc	Py, Cv, Sph, Mt, Hem	–	Arkose Conglomerate	
(9)Shamrocke	16°25.78'S 30°09.52'E	closed	Stratabound and disseminated ore	Cu, Ag, Au	5million tons Cu1.0%	AgMax 8.1g/t CuMax3.47%	Po, Cp	Cub, Sph, Py, Mc, Mt	–	MetaArkose	
(10)Nyamanyoko Hill	16°50.63'S 30°10.57'E		qz-al Vein	Au, Ag?	Extension2km	Au0.03g/t Ag4.5g/t	–	Hem, Mt	–	Granite	
(11)Rivington	17°00.40'S 30°04.82'E		Banded iron	Fe			Mt, Hem	–	–	Slate	
(12)Zani	17°13.88'S 30°01.58'E		Dolomite	Dolomite			Dolomite	–	–	Lomagundi.G Dolomite	
(13)Hilltop	17°19.01'S 30°07.74'E		Slate	slate			slate	–	–	Lomagundi.G slate	

Abbreviations
Py:pyrite Mc:marcasite Po:pyrrhotite Cub:cubanite Cp:chalcopyrite Bo:bornite Cc:chalcocite Cv:covelline Sph:sphalerite
Mt:magnetite Il:ilmenite Hem:hematite Mal:malachite Qz:quartz Cal:calcite Ot:other gangue minerals

Chapter 4 Consideration of the survey results

4-1 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.

4-2 Relationship between geochemical anomalies and the mineralization

Based on the results of the Phase I and Phase II survey, high potentiality areas of expected new ore deposits conform to the following condition of anomaly area.

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

4-3 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.

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

Through the study of results of Phase I and II survey and especially simulation analysis of geophysical IP anomalies, exploration target site 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, therefor, 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.

Chapter 5 Conclusion and recommendation

5-1 Conclusion

Drilling exploration (3 sites, 10 holes, total 4,057.50m) was carried out.

As a result of this drilling, MJZM-5 obtained a mineralization of small vein and dissemination mainly consisting of chalcopyrite and pyrite , which is concordant with the foliation of country rocks. MJZM-7 and 10 obtained a weak mineralization of dissemination mainly consisting of chalcopyrite, pyrite, bornite, chalcocite and sphalerite.

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 is obtained.

By the results of physical property test of ore and rock samples collected at Phases I and II surveys, ore shows more than 10mV/V of chargeability and separated from rocks. On the other hand, by the results of same test of drilling core samples, some samples of basic rocks show near 55mV/V of chargeability, and has a little stronger IP effect than weak mineralized arkose and granite.

The results of simulation analysis based on the physical property test of core samples corresponds to the results of field survey with the assumption of the existence of comparatively low IP body. Extracted IP anomalies of the Phase II survey are mainly considered to be the effect of basic rocks.

The results of physical property test of ores show that if high grade ore which can be developed is in underground, stronger anomalies may be formed in the fields than the effect of basic rocks. Extracted anomalies mainly caused by the effect of basic rocks suggest the low potentiality of the existence of unknown new ore deposits.

Though the drilling exploration was carried out on the IP anomalous body mainly effected by basic rocks. In spite of low grade the copper, mineralization was observed. This was due to the fact that the drilling site was selected on the geochemical anomalous area. By the result of MJZM-5 drilling, it becomes clear that if the mineralization is in the depth of less than about 100m, the existence of underground mineralization is detected by the geochemical survey.

By the result of MJZM-7 and 10 drillings, observed mineralization by drilling are in a little different place from geochemical anomalies. If mineralization is in deeper place, drilling sites have to be decided by using jointly geophysical IP exploration.

Existence of basic rocks which show a similar IP effect to weak mineralized rocks was confirmed in this area. therefore, as the theme for future, if the geophysical IP survey will be projected, enough collection of ore and rock samples and physical property test of samples will be carry out before IP survey, it will be necessary to able to separate the IP effect of ore and rocks.

5-2 Recommendations for 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 recomended to be effective in the wide area with almost no outcrops like 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.

Part Ⅱ Details of the surveys

Part II Details of survey

Chapter 1 The drilling survey

1-1 Method of the survey

1-1-1 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

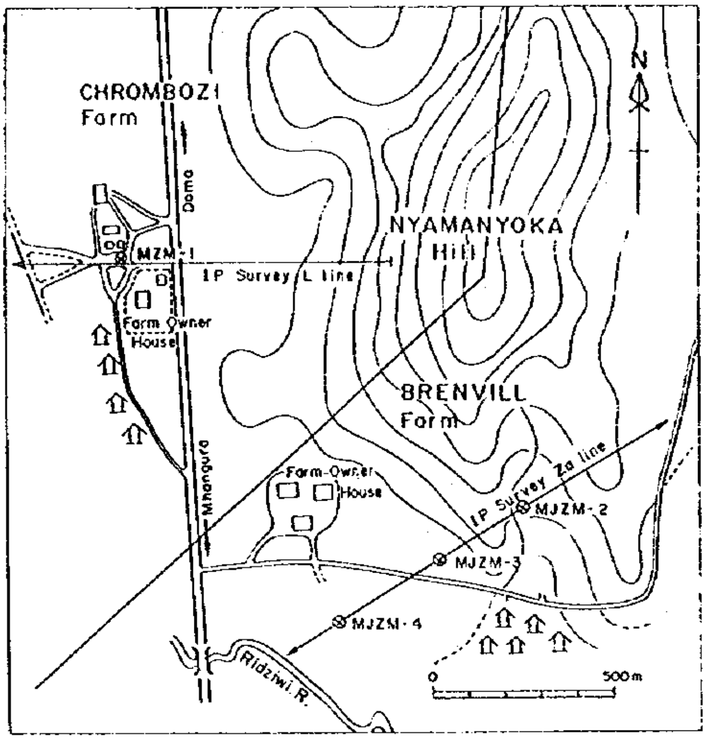
Each drilling sites are shown in FigII-1-1, and details of drilling and laboratory tests are shown in TableI-1-1.

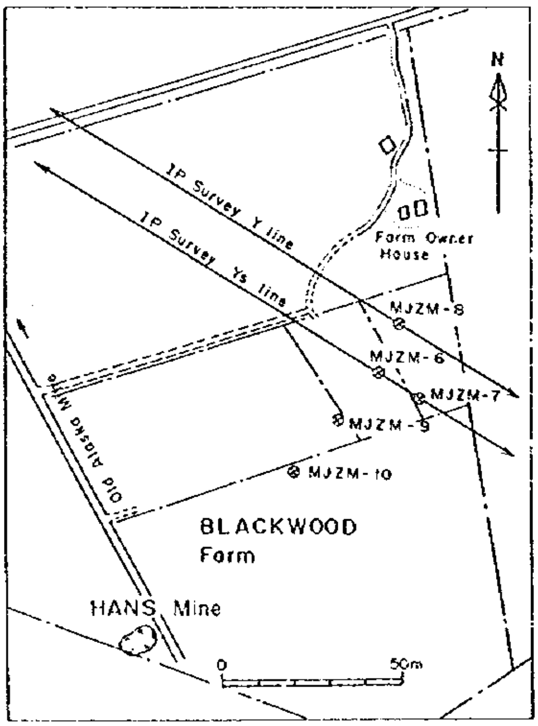
The drilling work was contracted by R. A. Longstaff (Pvt) Ltd., based in Harare.

Each drilling survey was smoothly performed.

1-1-2 Drilling method and equipment used

Five drilling machines were used. All holes were drilled down by wireline and single core tube method using NX diamond bit, then by NQ, and finally by TBW and BQ.
Equipment used and material consumed for drilling operation are all made in Zimbabwe and listed in Table II-1-1 and Table II-1-2.





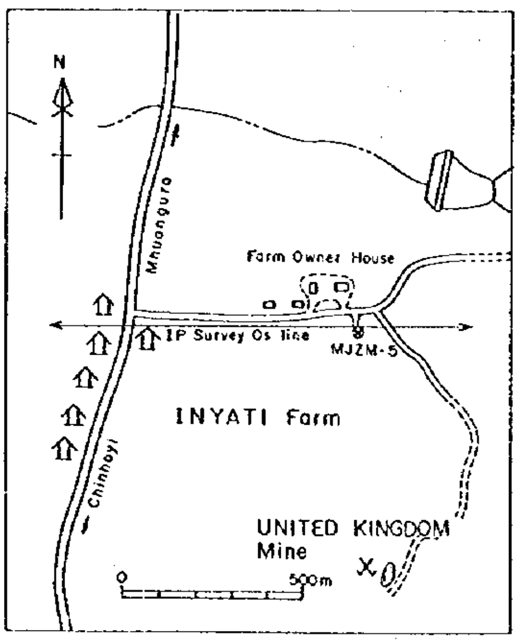


Fig.II-1-1 Locality of drilling sites

Table II-1-1 List of equipment used

Item	Specification	Quantity	Comment
Drilling Machine	Sullivan 22	1	
Drilling Machine	Longyear 44	3	
Drilling Machine	Sullivan 36	1	
Drilling Pump	Royal beans	5	
Bowzer		2	
Shear Legs	12m Dereks	5	
Drill Rods	NQ	700x3m	
Drill Rods	B	80x3m	
Core Barrel	49/16	5	
Core Barrel	NQ	8	
Core Barrel	TBW	1	
Stand Pipe		10x6m	
Casing	NX	50Lengths	
Casing	BX	7Lengths	

Table II-1-2 List of supplies and consumables spent

Item	Specification	Quantity	Comment
Metal Bit	49/16	5	
Diamond Bit	NQ	85	
Diamond Bit	1765TBW	2	
Reaming Shells	NQ	5	
Reaming Shells	TBW	1	
Core Springs	NQ	86	
Basket	NQ	64	
Shackle	"D"	6	
Jaw	18'	10	
Jaw	24'	10	
Jaw	36'	4	
Heel	18'	10	
Heel	24'	10	
Heel	36'	4	
Dromus		345 Litres	
Diesel		10,400 Litres	
Hydraulic Oil		200 Litres	
Engine Oil		300 Litres	
Gear Oil		90 Litres	
Rod Grease		850 Kgs	
Lube Grease		95 Kgs	

1-1-3 Drilling works

1) Site preparation

All drilling sites were in flat plain and gentle slope.

Construction of access roads and site preparation for ten drilling sites were easily performed.

2) Mobilization and demobilization

A 10ton truck was used for all mobilization work. After completion of the final hole, all equipment and tools were checked and repaired and then stored by Longstaff people.

Drilling cores were transported to a storage of the Ministry of Mines in Harare.

3) Core recovery and drilling water control

The depth of weathered zone is in around 30 metres in each hole. Core recovery was 30.2% to 54.2% in this zone. After the drilling reached to fresh rock, core recovery increase to 100% generally and 95.4% in minimum. Total core recovery of each hole was 92.0% to 98.6%, and 95.2% in average.

Pure water was used for drilling and polymer was added to water according to ground condition.

4) Water supply

Drilling water for Chirombozi site and Brenville site was taken from Mhangura Mine. Water for blackwood site was taken from old Alaska Mine. A bowser of capacity 10 cubic metres was used for the water supply. In Inyati site, water was supplied from irrigation well directly

1-1-4 Drilling conditions

Progress of each drill hole is shown in Table II-1-3. Summary of drilling condition is shown in Table II-1-4. Drilling conditions of each hole are shown in Table II-1-5 to Table II-1-14.

Each drilling machine was operated by one driller and three assistants. A shift of 10 hours per day was applied but 12 hours working was also adopted when necessity a rase.

3 m of stand pipe was used at the surface portion, and around 30 m of casing pipe was used according to ground condition in each hole.

MJZM-2 drilling hole encountered a strong silicified and fracture zone, and was forced to try again at side location. Others were smoothly performed.

TableII-1-4 Condition of drillings

No.	Period					Drilling		Casing			Efficiency (m)			
	Start	Complete	Total days	Working days	Day-off	Depth (m)	Recovery (%)	Size (mm)	Depth (m)	Recovery (%)	Depth/ Total -days	Depth/ Working -days	Depth/ Total Drill-days	Depth/ True Drill-days
MJZM- 1	91/09/22	91/10/07	16	13	3	202.60	91.47	86	21.40	86.0	12.66	15.58	18.42	25.33
MJZM- 2	91/08/08	91/11/18	103	84	19	400.60	94.86	86	27.00	68.9	3.89	4.77	4.31	5.14
								70	365.10	100.0				
MJZM- 3	91/10/30	91/12/05	37	32	5	400.60	96.58	86	30.00	80.0	10.88	12.52	12.92	15.41
MJZM- 4	91/08/18	91/09/21	35	28	7	301.70	94.33	86	24.20	87.6	8.62	10.78	10.78	13.71
MJZM- 5	91/08/26	91/09/14	20	17	3	200.00	92.00	86	12.00	75.0	10.00	11.76	11.11	13.33
MJZM- 6	91/07/31	91/09/07	39	29	10	600.00	98.60	86	27.00	100.0	15.38	20.69	23.08	30.00
MJZM- 7	91/09/08	91/10/11	34	27	7	600.00	98.25	86	33.20	91.0	17.65	22.22	22.22	28.57
MJZM- 8	91/07/31	91/09/13	45	36	9	500.00	96.64	86	27.80	89.2	11.11	13.89	13.89	17.86
MJZM- 9	91/12/01	91/12/20	20	20	0	452.00	96.90	86	30.00	80.0	22.60	22.60	30.13	30.13
MJZM-10	91/12/06	91/12/22	17	17	0	400.00	95.93	86	27.00	88.9	23.53	23.53	30.77	30.77

TableII-1-3 Time table of drillings

		July, 1994	August, 1994	September, 1994	October, 1994	November, 1994	December, 1994	Remarks			
		10 20	10 20	10 20	10 20	10 20	10 20	Dir.	Inc.	Depth	Recovery
MJZM- 1	Set up Drilling Withdraw			22-23 24 —	4 5 — 7			—	-90°	202.60m	94.47%
MJZM- 2	Set up Drilling Withdraw		8 — 14 15 —			15 16 — 18		—	-90°	400.60m	94.86%
MJZM- 3	Set up Drilling Withdraw				30 —	1 2 —	2 3 — 5	—	-90°	400.60m	96.58%
MJZM- 4	Set up Drilling Withdraw		18 — 22 23 —	19 20 — 21				—	-90°	301.70m	94.33%
MJZM- 5	Set up Drilling Withdraw		26-27 27 —	13 14 - 14				—	-90°	200.00m	92.00%
MJZM- 6	Set up Drilling Withdraw	31 —	4 5 — 30 31 —	7				—	-90°	600.00m	98.60%
MJZM- 7	Set up Drilling Withdraw			8 — 10 11 —	7 8 — 11			—	-90°	600.00m	98.25%
MJZM- 8	Set up Drilling Withdraw	31 —	4 5 —	9 10 — 13				—	-90°	500.00m	96.64%
MJZM- 9	Set up Drilling Withdraw						1 — 2 3 — 17 18 — 20	—	-90°	452.00m	96.90%
MJZM- 10	Set up Drilling Withdraw						6 — 7 8 — 20 21 — 22	—	-90°	400.00m	95.93%

1-2 Result of the survey

1-2-1 Geology and mineralization

Drilling logs are shown in Fig.II-1-2. Geologic sections are shown in Fig.II-1-3 to Fig.II-1-7. The results of microscopic observation of thin sections of rocks are shown in Table II-1-15. The results of polished sections of ores are shown in Table II-1-16 and the results of chemical analysis of ores are shown in Table II-1-17.

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 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.

(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.

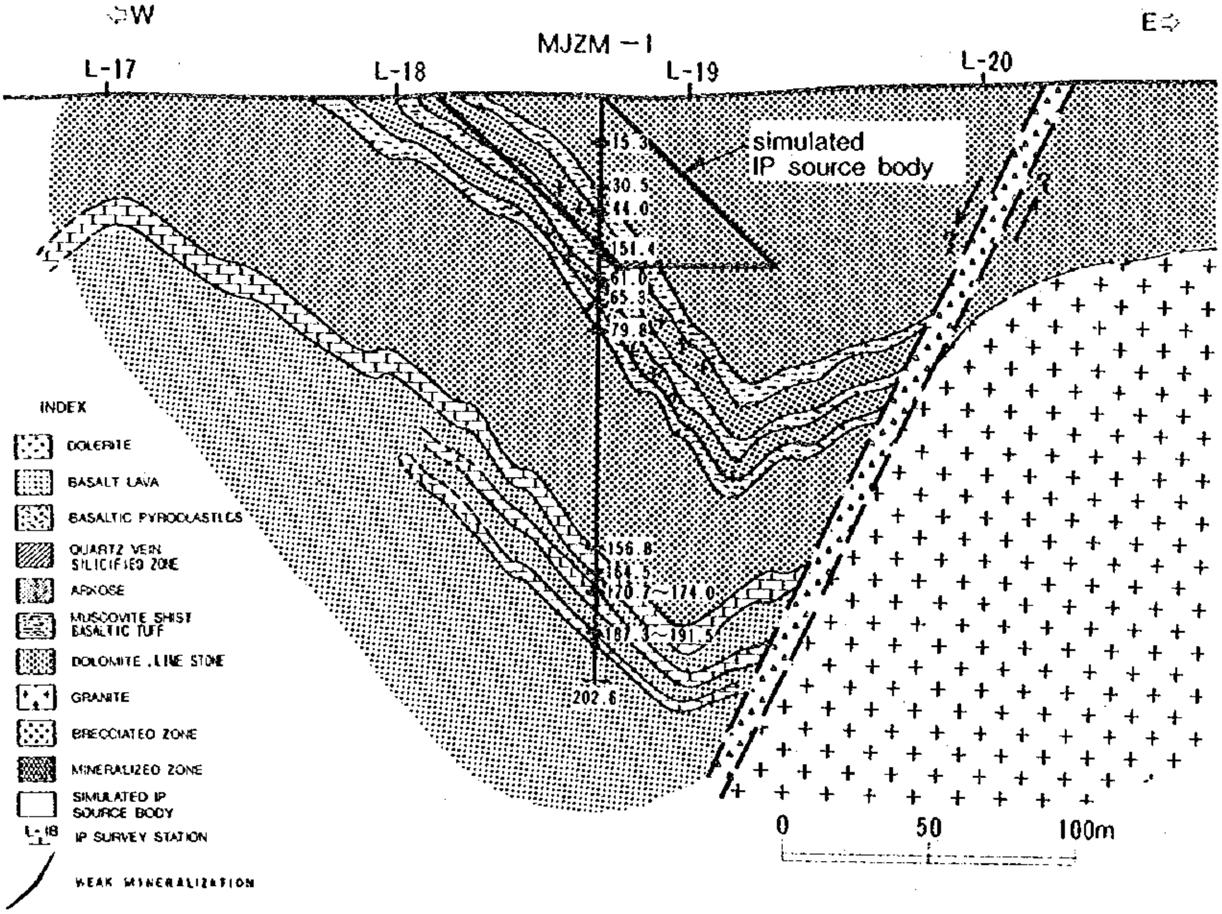


Fig.II-1-3 Drilling section (MJZM-1)

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.

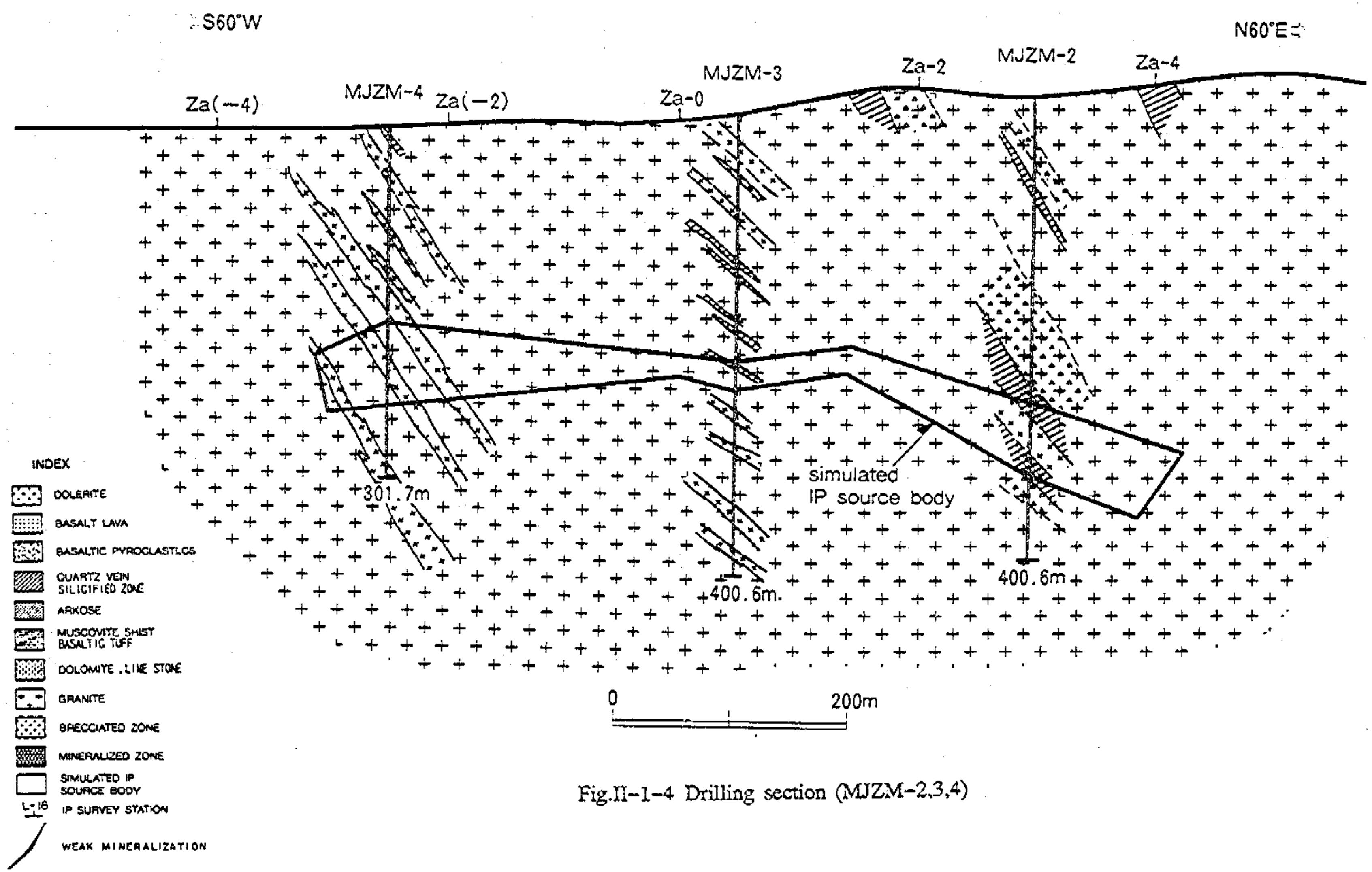


Fig.II-1-4 Drilling section (MJZM-2,3,4)

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 occuring 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.

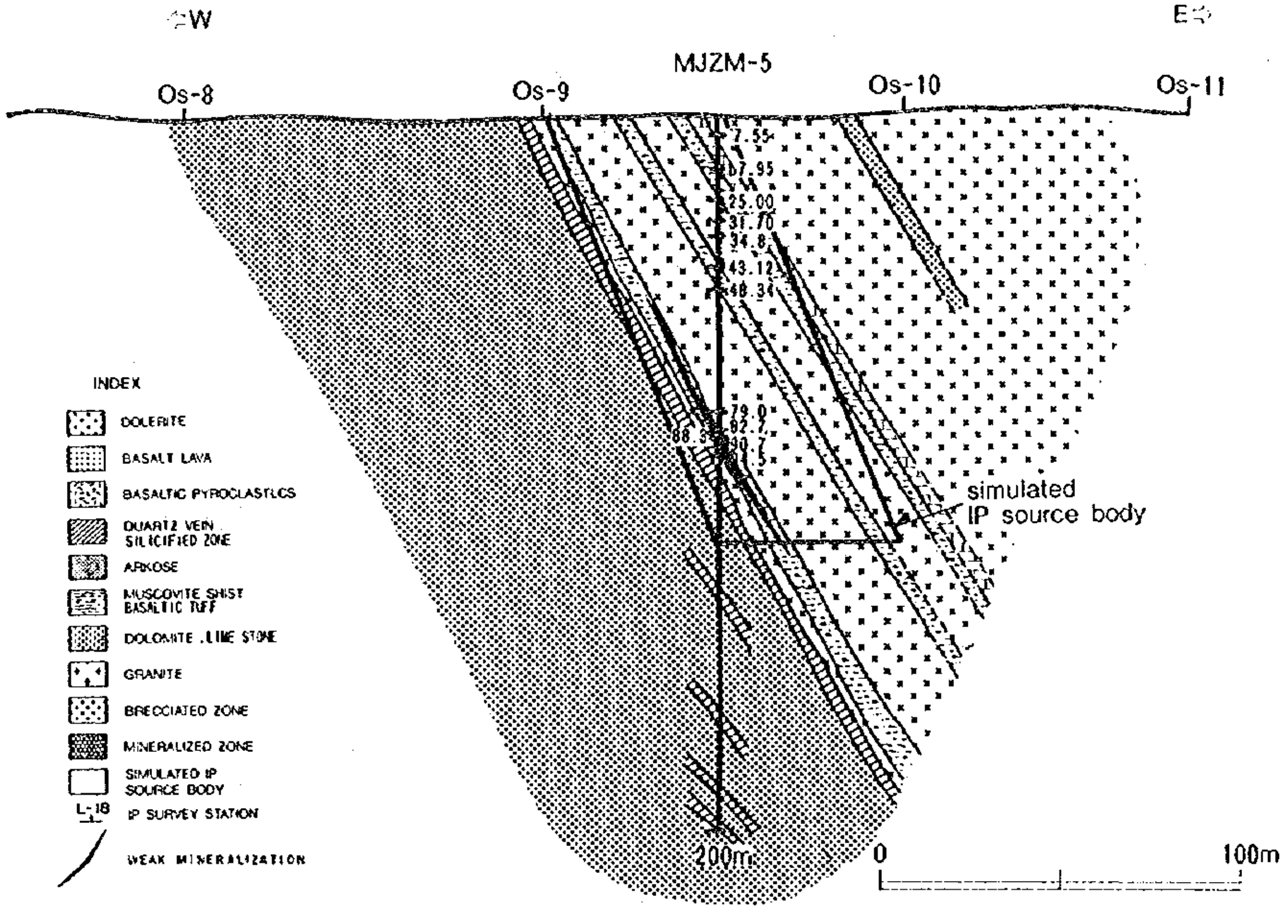


Fig.II-1-5 Drilling section (MJZM-5)

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.

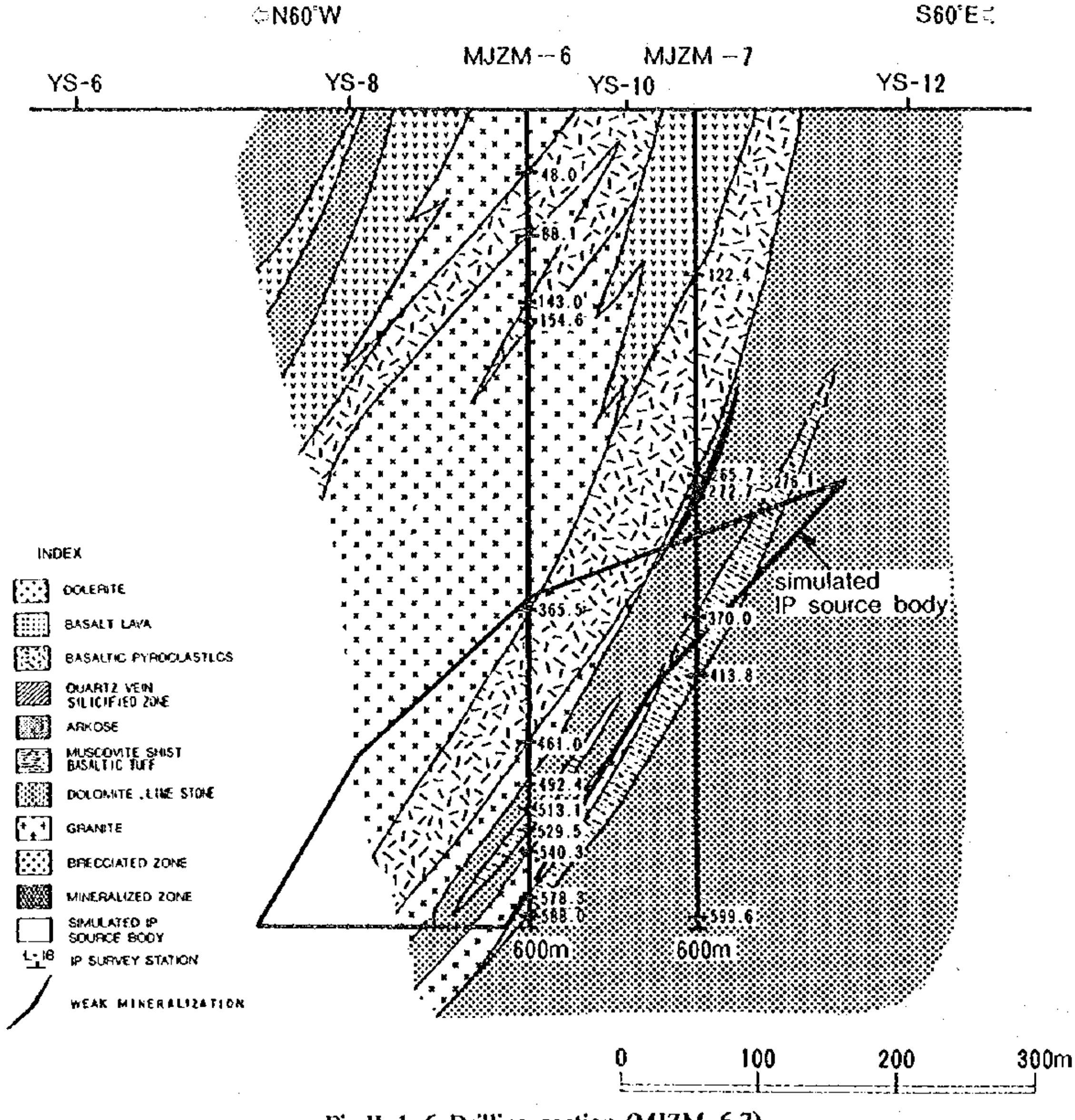


Fig.II-1-6 Drilling section (MJZM-6,7)

(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 occuring 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.

(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

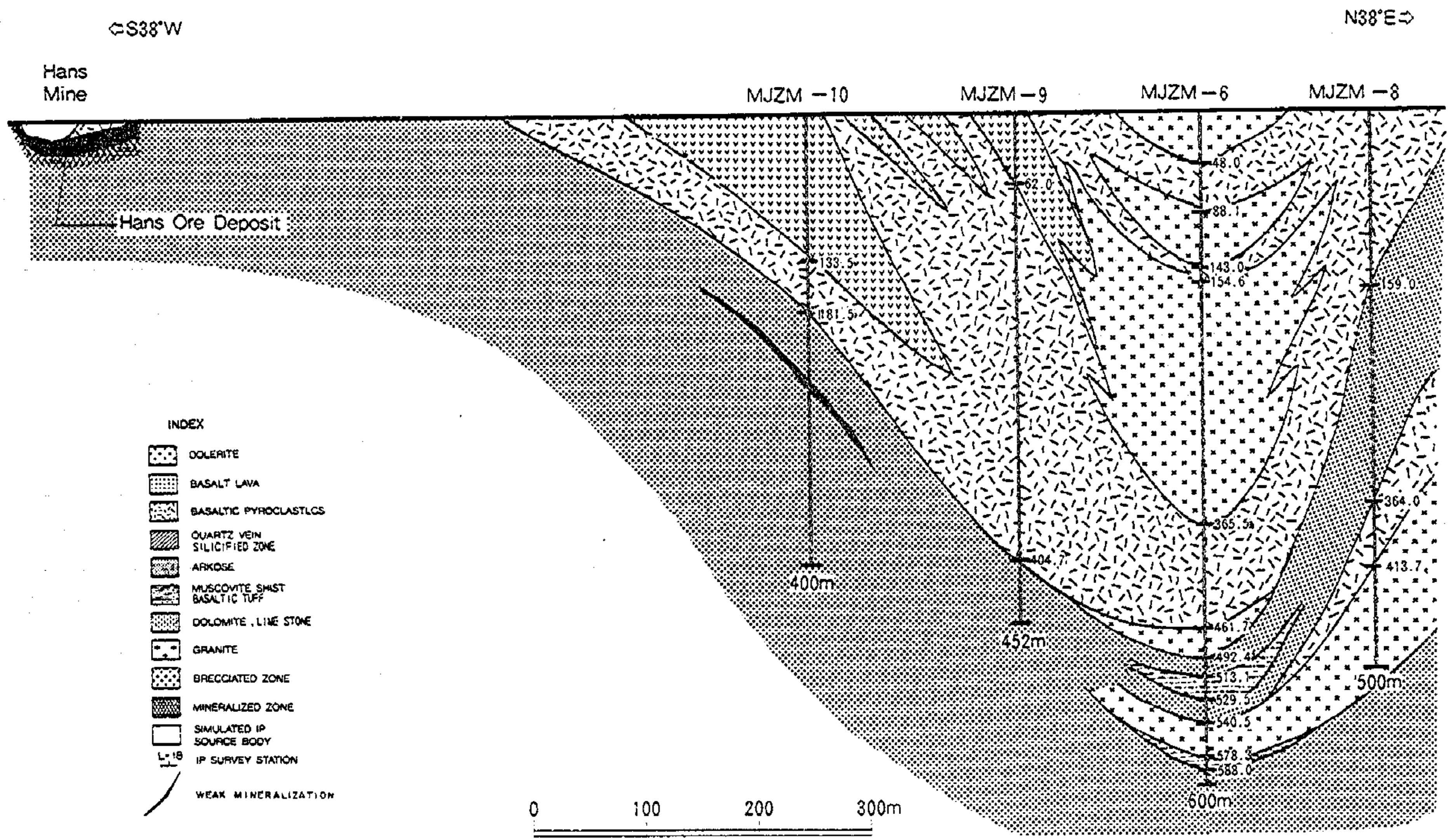


Fig.II-1-7 Drilling section (MJZM-6,8,9,10)

TableII-1-15 Results of microscopic observation of thin section of rock samples

No.	Rock name defined by microscopic observation	Origin	Formation	Locality	Latitude	Longitude	Mineral assemblages																										Texture	Remarks
							Qtz	Pl	Ab	Kfs	Bt	Ms	Phl	Hbl	Tr	Pmp	Ep	Czo	Di	Grt	St	Chl	Cld	Tol	Cal	Dol	Gr	Ir	Sp	Ru	Ap	Zr		
TS-1	Altered basalt	Basalt lava	Deveras	MJZM-7, 40m	17°25.11	S30° 2.16 E	△	○			○						△					◎			○				△				intersertal	
TS-2	Altered basalt	Basalt lava	Deveras	MJZM-7, 65m	17°25.11	S30° 2.16 E	△	◎			○						○					◎			○				△				intersertal	
TS-3	Cal,pebble congromerate	Basaltic pyroclastics	Deveras	MJZM-7,150m	17°25.11	S30° 2.16 E	○	○		○	○	△										○			◎						·		lepidoblastic	
TS-4	Cal,pebble congromerate	Basaltic pyroclastics	Deveras	MJZM-7,160m	17°25.11	S30° 2.16 E	◎	○		○	○	△										○			◎								lepidoblastic	
TS-5	Limestone		Deveras	MJZM-5, 15m	17° 4.36	S30°11.11 E	△																		◎								saccharoidal	with fossil
TS-6	Cal-Chl rock	Basaltic tuff	Deveras	MJZM-5,19.5m	17° 4.36	S30°11.11 E	◎	·				·										◎		·	◎									
TS-7	Dolerite(altered)	Dolerite	Deveras	MJZM-5, 30m	17° 4.36	S30°11.11 E	△	◎														◎			◎			○					ophitic	with augite
TS-8	Dolerite(altered)	Dolerite	Deveras	MJZM-5, 40m	17° 4.36	S30°11.11 E		◎														○			○			○	○				ophitic	with augite
TS-9	Cal-Qt-Pl-Chl semuschist	Basaltic tuff	Deveras	MJZM-5, 45m	17° 4.36	S30°11.11 E	○	◎														◎			○			○	△				lepidoblastic	Schistose
TS-10	Dolerite(amigdaloidal cavitya)	Basalt lava	Deveras	MJZM-5, 50m	17° 4.36	S30°11.11 E	△	◎														○			△			○	○				intergranular	
TS-11	Dolerite(altered)	Dolerite	Deveras	MJZM-5, 70m	17° 4.36	S30°11.11 E	○	○														◎			○			△	○				ophitic?	
TS-12	Qt-Cal-Chl schist	Basaltic tuff	Deveras	MJZM-5, 90m	17° 4.36	S30°11.11 E	◎	△				△										◎			◎								lepidoblastic	with Cp,Py
TS-13	Calcareous arkose	Basaltic pyroclastics	Deveras	MJZM-7,245m	17°25.11	S30° 2.16 E	◎	○		△		△			◎		△					△		·	◎									
TS-14	Calcareous arkose	Arkose	Deveras	MJZM-7,275m	17°25.11	S30° 2.16 E	◎	◎		△	·	△			△		△								◎						·			with Py
TS-15	Red calcareous arkose	Arkose	Deveras	MJZM-7,300m	17°25.11	S30° 2.16 E	◎	○		△	·	△			◎		△								○									Fe hydro oxide
TS-16	Calcareous lithic sandstone	Basaltic tuff	Deveras	MJZM-7,375m	17°25.11	S30° 2.16 E	◎	○		○		○					○					○			◎								lepidoblastic	Py,Fe hydro oxide
TS-17	Calcareous and micaceous arkosic arenite	Basaltic tuff	Deveras	MJZM-7,390m	17°25.11	S30° 2.16 E	◎	○		△		○												·	◎							·	lepidoblastic	Py?
TS-18	Micaceous(biotite)arkosic arenite	Basaltic tuff	Deveras	MJZM-7,410m	17°25.11	S30° 2.16 E	◎	○		△	○											△		·	○						△	·		
TS-19	Cal-Mus-Qt schist	Basaltic tuff	Deveras	MJZM-1, 55m	16°51.63	S30° 9.94 E	◎	△				◎												·	◎								lepidoblastic	
TS-20	Cal-Mus-Qt semischist	shale-fine sandstone	Deveras	MJZM-1,100m	16°51.63	S30° 9.94 E	◎	○		△		◎													○						·	·	lepidoblastic	
TS-21	Micaceous arkose	shale - sandstone	Deveras	MJZM-1,118m	16°51.63	S30° 9.94 E	◎	◎		○		◎													○				·			·	lepidoblastic	
TS-22	Arkose	Arkose	Deveras	MJZM-7,440m	17°25.11	S30° 2.16 E	◎	◎		○		△										△			○				·		·	·	granoblastic	
TS-23	Arkose	Arkose	Deveras	MJZM-7,450m	17°25.11	S30° 2.16 E	◎	◎		○	··	△										△			○				·		·			

* ◎:abundant ○:common △:minor ·:rare

Abbreviation of mineral names

Qtz:quartzite Pl:plagioclase Ab:albite Kfs:potassium feldspar Bt:biotite Ms:muscovite Phl:philogopite Hbl:hornblende Tr:tremolite Pmp:pumpellyite Ep:epidote Czo:clinozoisite

Di:diopside Grt:garnet St:staurolite Chl:chlorite Cld:chloritoid Tol:tourmaline Cal:calcite Dol:dolomite Gr:graphite Ir:iron oxides Sp:sphene Ru:rutile Ap:apatite Zr:zircon

TableII-1-16 Results of microscopic observation of polish section of ore samples

No.	Rock names	Locality	Coordinate		sulphides									Oxide minerals				Others			Remarks
			Latitude	Longitude	Py	Mc	Po	Cub	Cp	Bo	Cc	Cv	Sph	Mt	Il	Hem	Fh	Mal	Qtz	Ca	Ot	
PS- 1	Basalt with Py disseminate	MJZM-7 , 48.5 m	17 °25.11 'S	30 ° 2.16 'E	△								*								◎	
PS- 2	Basdaltic Tuff with Cp & Py	MJZM-5 , 89.3 m	17 ° 4.36 'S	30 °11.11 'E					△	*			·						○	○	◎	
PS- 3	Arkose with Qt, Py & Cp	MJZM-7 , 272.9 m	17 °25.11 'S	30 ° 2.16 'E	△				○	○	○		△	○					◎	△	○	
PS- 4	Arkose with Qt, Py & Cp	MJZM-7 , 285.9 m	17 °25.11 'S	30 ° 2.16 'E	△								·						*	*	◎	
PS- 5	Arkose with Qt, Py & Cp	MJZM-7 , 301.0 m	17 °25.11 'S	30 ° 2.16 'E	△								*								◎	
PS- 6	Arkose with Qt, Py & Cp	MJZM-7 , 314.1 m	17 °25.11 'S	30 ° 2.16 'E	△								*								◎	
PS- 7	Quartz Vein	MJZM-2 , 210.1 m	16 °52.07 'S	30 °10.60 'E	*									○		△			◎			
PS- 8	Quartz Vein	MJZM-5 , 54.95 m	17 ° 4.36 'S	30 °11.11 'E										△							◎	
PS- 9	Arkose with Qt, Mt and Py?	MJZM-1 , 44.3 m	16 °51.63 'S	30 ° 9.94 'E									*	△							◎	Maghemite
PS-10	Arkose with Qt. Mt and Py?	MJZM-1 , 64.46 m	16 °51.63 'S	30 ° 9.94 'E	*																◎	Maghemite
PS-11	Arkose with Qt, Mt and Py?	MJZM-1 , 198.7 m	16 °51.63 'S	30 ° 9.94 'E										△		*					◎	Maghemite

◎:abundant ○:commom △:minor ·:rare *:vary rare

Abbreviations

Py:pyrite Mc:marcasite Po:pyrrhotite Cub:cubanite Cp:chalcopyrite Bo:bornite Cc:chalcocite Cv:covelline Sph:sphalerite
Mt:magnetite Il:ilmenite Hem:hematite Fh:Fe-hydroxides Mal:malachite Qtz:quartz Ca:carbonates Ot:other gangue minerals

Remarks

1) Pyrrhotite is partly replaced by marcasite.
2) graphic texture between bornite and covelline.

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 amineralized zone. Other elements are not remarkable.

1-2-2 Geochemical test of drilling core

Norah Mine, Shackleton Mine, Avondale Mine and Angwa Mine were discovered by geochemical survey. Surface geochemical copper anomaly was observed by Phase I and II survey. Relationship between surface and under ground geochemical condition was studied.

A subject of study is as follows :

Table II-1-18 List of drill hole and number of samples for geochemical study

Area	Name of hole	Number of samples
Greenfields(Chirombozi farm)	MJZM-1	21
Greenfields(Brenville farm)	MJZM-2	74
Inyati(Inyati farm)	MJZM-5	23
Angwa(Blackwood farm)	MJZM-7	108
Total	4 holes	228

Numbers of analyzed elements are 10. They are Au, Ag, Cu, Pb, Zn, Fe, Ni, Co, As and Hg. The results of chemical analysis are shown in Table II-1-19, and diagrams of analysis of each hole are shown in Fig.II-1-8.

Some difference of content of elements are recognized according to the type of rocks. Summary of difference are as follows :

Copper shows high content of 30ppm to 60ppm in basalt lava, and relatively low content around 10ppm in basaltic pyroclastics.Arkose and granite show mainly less than 10ppm of copper content, around 5ppm .

Zinc shows high content of 150ppm to 400ppm in basalt lava and basaltic pyroclastics. Zinc content of arkose vary 30ppm to 300ppm. granite show mainly less than 10ppm of zinc content, and 2ppm to 8ppm.

Lead shows 30ppm to 50ppm in basalt lava, basaltic pyroclastics and tuff. Arkose and granite show 10ppm to 30ppm of lead content. No remarkable difference is recognized through all rocks.

Nickel shows high content of 100ppm to 200ppm in basalt lava and pyroclastics. Basaltic tuff and arkose show 20ppm to 50ppm of nickel content. Lowest content of 5ppm to 30ppm is shown in granite.

Cobalt shows high content of 30ppm to 50ppm in basalt lava and pyroclastics. Basaltic tuff and arkose show 5ppm to 20ppm of cobalt content. Around and less than the detection limit (1ppm) is shown in granite.

Iron shows high content of 3 to 5% in basalt lava and pyroclastics. Basaltic tuff and arkose show around 1% of iron content. Lowest content around 0.5% is shown in granite.

More than 73.3ppm or 70.1ppm of copper content in soil was judged as a copper geochemical anomaly in Phases I and II surveys. Geochemical characteristics of each hole are as follows :

MJZM-1 shows no remarkable geochemical anomaly of copper.

MJZM-2 shows high geochemical content of copper at 256.70m, 260.00m and 270.00m. High mercury content is accompanied at 270.00m. This high content portion coincides with the dolerite dyke, and seems to be due to a different kind of mineralization than the copper mineralization of this area.

MJZM-5 shows high geochemical content of copper and silver in 55.00m to 90.00m. Extension of quartz vein intersected in drill hole is recognized at surface. Therefore, copper geochemical anomalies of Phases I and II surveys may be closely related to this mineralization.

MJZM-7 shows high geochemical content of copper at 10.00m, 29.90m, 40.00m, 115.00m. This high content portion corresponds to white color alteration and pyrite dissemination in and around a quartz and calcite vein accompanied with basaltic activity. On the other hand, high copper content is also recognized in arkose at 275.00m and 280.00m. This copper high content portion corresponds to the ore horizon of Hans Mine, and seems to have encountered an extension of a mineralized zone. However, obtained geochemical anomaly on the surface is in a little different position from mineralization and geophysical IP anomaly.

1-2-3 Physical property test of drilling core

1.Samples

Physical property test of drill core was carried out in order to collect the electric characteristics of rocks.

The subject of study is as follows :

Table II-1-20 List of drill hole and number of samples for physical property test

Area	Name of hole	Number of samples
Greenfields(Chirombozi farm)	MJZM-1	11
Greenfields(Brenville farm)	MJZM-2	37
Inyati(Inyati farm)	MJZM-5	13
Angwa(Blackwood farm)	MJZM-7	55
Total	4 holes	116

2.Measurement

Measurement of IP and apparent resistivity was carried out by time domain method using platinum wire as current and potential electrodes. Samples were immersed water through all day before measurement. Transmitted current was under 1 micro ampeire per cm.

Collected samples were homogeneous rocks generally. Banded rocks with sandstone and mudstone were few.

Measuring equipment was as follows :

Table II-1-21 List of measuring equipments

Equipment	Manufacture	Type	Specification	Amount
Transmitter	IRIS	IP-1	Output Range:1uA-100uA max10V	1 set
Receiver	SCINTREX	IPR-12	8channel, 14window Input Range:50uV-14V	1 set
Electrode		Pt wire		1 set

3.Results of measurement

Results of measurement are shown in Table II-1-22. Logs showing physical characteristics are shown in Fig.II-1-9 to Fig.II-1-12. Crossplot of apparent resistivity against chargeability shows in Fig.II-1-13. Crossplot of iron content against chargeability shows in Fig.II-1-14. Crossplot of copper content against chargeability is shown in Fig.II-1-15. IP was shown by value 935 msec.

Summary of results of measurement are as follows :

(1) Clear relationship between apparent resistivity and chargeability are not recognized.

(2) Apparent resistivity shows 20 to maximum 6,500 ohm-meter. Chargeability shows 0.5 to maximum 55mV/V.

TableII-1-22 Results of physical property test (1)

MJZM-1 M12:935msec

Dep(m)	Remark	VP(mv)	RHO(ohm-m)	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
23.00	Arkose	21.30	56.3	52.15	45.85	40.17	34.48	29.25	24.60	20.41	16.83	13.64	10.84	8.66
40.50	Bstf	13.42	40.5	26.60	22.29	18.92	15.50	12.86	10.95	9.37	7.94	6.73	5.77	5.26
55.00	Bstf	37.79	102.9	25.53	20.73	17.12	14.14	11.47	9.33	7.56	6.12	4.83	3.77	2.81
70.70	Bstf	22.35	77.7	27.78	23.60	20.34	17.17	14.28	11.77	9.58	7.58	5.70	4.35	3.07
86.80	Ark-Sand	35.35	97.6	21.15	17.65	14.84	12.25	9.89	7.91	6.37	4.99	4.02	3.17	2.62
92.50	QtzCalvein	25.04	64.6	26.82	22.50	18.67	15.18	12.55	10.10	8.25	6.59	5.47	4.24	3.12
105.40	Md>Ss-band	27.48	70.7	19.04	15.75	13.15	10.71	8.59	6.84	5.78	4.68	3.78	2.97	2.36
118.00	Md>Ss	81.10	206.9	28.08	24.20	20.88	17.78	15.01	12.44	10.34	8.46	6.81	5.47	4.41
143.50	Arkose	67.30	163.3	24.03	20.11	16.98	13.90	11.33	9.09	7.32	5.62	4.41	3.37	2.60
157.00	Dolomite	50.64	141.6	28.23	23.57	20.03	16.73	12.94	10.05	8.01	7.92	6.00	4.87	3.55
198.00	ArcCcbo?	97.11	243.3	12.76	10.86	9.35	7.96	6.56	5.44	4.45	3.61	2.98	2.19	1.66

MJZM-2

Dep(m)	Remark	VP(mv)	RHO(ohm-m)	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
20.00	Granite	38.11	242.7	30.25	25.85	22.30	18.79	15.65	12.99	10.74	8.79	7.17	5.92	4.87
30.00	Granite	58.46	424.8	30.71	26.55	22.93	19.44	0.00	16.32	13.55	11.15	9.08	7.38	5.80
40.00	Granite	132.95	342.0	8.73	7.27	6.16	5.10	4.13	3.34	2.68	2.19	1.83	1.40	1.37
51.00	Granite	84.63	208.8	17.80	15.27	13.09	11.01	9.13	7.53	6.08	4.83	3.80	2.94	2.31
60.00	Granite	210.56	501.8	14.32	12.29	10.57	8.96	7.51	6.22	5.07	4.08	3.25	2.63	2.09
70.00	Granite	136.54	294.0	22.40	19.30	16.65	14.14	11.95	9.91	8.19	6.72	5.43	4.35	3.45
80.00	Granite	69.72	175.4	19.14	16.18	13.72	11.45	9.51	7.77	6.29	5.11	4.03	3.15	2.36
89.50	Granite	67.19	170.5	21.18	18.11	15.61	13.14	10.91	8.87	7.20	5.76	4.55	3.56	2.65
100.00	Granite	48.37	123.3	20.03	17.26	14.91	12.65	10.61	8.82	7.27	5.94	4.86	3.97	3.29
110.00	Granite	178.77	531.7	21.40	18.48	15.98	13.56	11.38	9.43	7.77	6.33	5.10	4.07	3.21
120.00	Granite	390.95	808.2	19.94	17.15	14.76	12.50	10.48	8.69	7.10	6.01	4.82	3.56	2.52
130.00	Granite	437.36	1080.3	18.29	15.75	13.60	11.52	9.64	7.98	6.54	5.30	4.26	3.38	2.67
140.00	Granite	8.56	20.5	6.56	10.97	8.19	6.23	4.51	3.63	3.18	2.76	2.57	2.60	2.15
150.00	Granite	217.33	556.9	4.19	3.41	2.85	2.30	1.79	1.38	1.05	0.80	0.57	0.46	0.27
160.00	Granite	15.08	46.4	25.59	21.93	18.82	15.87	13.22	10.92	9.03	7.40	5.99	4.70	3.67
169.00	Granite	85.01	198.0	29.91	25.91	22.44	19.07	16.10	13.40	11.12	9.15	7.65	6.25	5.44
180.00	Granite	532.38	1382.1	19.92	16.98	14.51	12.16	10.09	8.24	6.67	5.34	4.24	3.34	2.57
190.00	Granite	219.74	670.9	26.45	23.03	20.04	17.11	14.44	12.03	9.94	8.09	6.62	5.29	4.30
199.00	Granite	22.36	53.2	23.61	20.57	18.00	15.53	13.29	11.22	9.46	7.93	6.56	5.44	4.43
210.00	Granite	202.50	512.4	16.12	13.91	12.06	10.27	8.63	7.15	5.88	4.76	3.81	3.02	2.32
220.00	Granite	72.64	188.4	17.98	15.47	13.36	11.30	9.43	7.79	6.28	4.93	3.92	3.24	2.57
230.00	Granite	47.09	159.0	18.84	14.67	11.53	9.00	7.06	5.59	4.47	3.54	2.72	2.03	1.48
240.00	Granite	16.75	45.7	18.90	15.19	12.34	9.93	8.01	6.54	5.52	4.86	4.60	3.90	2.12
250.00	Granite	63.28	147.9	16.80	14.24	12.13	10.17	8.44	6.91	5.64	4.53	3.64	2.84	2.20
256.70	Lamprophyre	18.80	35.7	10.1	8.8	7.3	5.8	5.2	5.1	4.7	4.3	1.6	1.1	1.0
265.00	brcGranite			Imposible to measurement by break										
275.00	basic dyke	15.15	38.4	11.41	9.28	7.69	6.26	5.16	4.17	3.27	2.58	2.16	2.04	2.18
285.00	basic dyke	189.21	554.8	26.12	22.47	19.42	16.48	13.88	11.55	9.56	7.85	6.39	5.13	4.10
295.00	basic dyke	84.65	224.7	23.63	20.23	17.38	14.68	12.29	10.16	8.35	6.79	5.48	4.38	3.56
305.00	basic dyke	304.09	743.9	14.81	12.55	11.66	10.05	8.68	7.80	6.46	5.37	2.88	2.63	3.35
315.00	QtzGranite	490.89	1380.8	17.07	14.62	12.57	10.61	8.86	7.33	6.03	4.91	3.95	3.16	2.52
323.00	QtzGranite	1070.90	2797.5	5.02	3.96	3.20	2.53	1.96	1.47	1.07	0.74	0.56	0.40	0.24
329.20	QtzGrnHem	16.51	41.7	68.99	58.18	48.85	40.15	32.59	25.95	20.47	15.71	11.60	7.86	4.77
340.00	Basic tf	107.39	275.2	10.76	9.14	7.92	6.71	5.54	2.90	3.58	3.05	2.62	2.28	1.79
350.00	Basic dyke	412.02	1100.3	19.00	15.89	13.40	11.10	9.12	7.40	5.97	4.75	3.77	2.93	2.28
370.00	Granite	530.71	819.7	18.08	15.51	13.36	11.32	9.51	7.82	6.36	5.17	4.17	3.32	2.58
390.00	Granite	566.40	1105.4	24.02	20.69	17.87	15.19	12.80	10.66	8.80	7.17	5.84	4.70	3.73

MJZM-5

Dep(m)	Remark	VP(mv)	RHO(ohm-m)	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
15.00	Qtzite	103.97	536.7	14.07	12.02	10.31	8.70	7.23	5.94	4.82	3.84	3.06	2.39	1.85
30.00	Bstf-lv	23.34	46.6	11.33	9.23	7.74	6.46	5.39	4.53	3.92	3.40	3.04	2.46	1.62
40.00	Dol?	74.18	167.6	21.47	17.12	13.77	10.51	8.58	6.76	5.31	4.15	3.29	2.47	1.85
50.00	Bslv	9.54	21.0	9.93	8.77	7.85	6.98	6.06	5.03	3.97	3.10	2.52	2.00	1.10
60.00	Dol	78.10	174.8	16.49	13.02	10.32	7.98	6.06	4.54	3.37	2.49	1.85	1.32	0.88
79.50	Dol	165.86	374.0	12.94	10.69	8.83	7.15	5.72	4.50	3.50	2.70	2.04	1.52	1.11
93.00	Bsconglo	85.28	196.7	21.65	18.72	16.24	13.82	11.62	9.68	7.97	6.48	5.21	4.16	3.34
100.00	Arkose	1444.29	3321.2	16.17	13.86	11.97	10.15	8.56	7.18	5.94	4.89	3.99	3.23	2.60
120.00	Arkose	181.69	416.5	8.90	7.22	5.94	4.78	3.80	3.00	2.33	1.79	1.40	1.07	0.85
140.00	Arkose	207.83	454.4	14.43	12.12	10.23	8.48	6.97	5.65	4.55	3.63	2.89	2.34	1.79
160.00	Arkose	211.88	509.1	22.15	19.34	16.90	14.53	12.37	10.40	8.67	7.16	5.85	4.73	3.81
180.20	Arkose	90.92	272.7	8.64	6.99	5.77	4.71	3.81	3.07	2.47	2.02	1.65	1.35	1.14
200.00	Arkose	277.75	664.1	17.34	14.04	11.43	9.13	7.23	5.68	4.44	3.41	2.61	1.97	1.46

Bs:Basaltic Md:Mud stone Dol:Dolerite pyroclas:Pyroclatics
tf:Tuff Ss:Sand stone Bo:Bornite Py:Pyrite
lv:Lava Cal:Calcite Cc:Charcocite w:White
brc:brecciate Ark:Arkose Hem:Hematite r:Red
Qtz:Quartz Pydis:Pyrite disseminate Grn:Granite

TableⅡ-1-22 Results of physical property test (2)

MJZM-7 M12:935msec

Dep(m)	Remark	VP(mv)	RHO(ohm·m)	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
10.00	Bslv	111.15	551.2	8.94	7.11	6.99	6.31	5.98	5.33	4.90	3.31	1.90	1.60	1.10
20.00	Bslv	1134.08	6513.5	22.16	15.97	11.16	8.23	4.23	3.01	2.42	1.68	1.42	0.87	0.66
29.90	Bslv	91.05	235.3	12.04	10.20	8.72	7.29	6.02	4.94	4.02	3.17	2.43	1.78	1.20
40.00	Bslv	399.94	955.3	18.51	15.73	13.42	11.22	9.28	7.59	6.13	4.89	3.85	2.99	2.31
50.00	Bslv, Pydis	597.80	1531.5	43.71	38.92	34.56	30.05	25.83	22.04	18.63	15.54	12.86	10.52	8.55
60.00	Bslv	326.28	837.0	16.70	14.10	11.94	9.89	8.13	6.64	5.23	4.09	3.16	2.37	1.75
70.00	Bslv	369.91	971.6	14.19	11.87	10.05	8.39	6.90	5.57	4.37	3.48	2.71	2.07	1.52
80.00	Bslv	410.29	1020.7	17.02	14.62	12.61	10.68	8.94	7.39	6.05	4.89	3.94	3.11	2.40
90.00	Bslv	333.11	878.9	7.93	6.48	5.38	4.38	3.55	2.81	2.22	1.76	1.31	0.95	0.81
100.00	Bslv	339.17	900.1	15.33	12.81	10.74	8.80	7.09	5.62	4.40	3.48	2.68	1.97	1.40
110.00	Bslv	229.12	925.4	11.37	9.46	7.95	6.56	5.35	4.29	3.43	2.70	2.12	1.62	1.22
120.00	Bslv, Pydis	347.44	849.8	6.20	5.14	4.33	3.59	2.94	2.39	1.90	1.49	1.15	0.86	0.63
130.00	Bspyroclas	344.64	894.1	23.43	19.73	16.64	13.76	11.24	9.08	7.26	5.76	4.52	3.54	2.76
140.00	Bspyroclas	230.58	590.9	59.16	50.88	43.66	36.74	30.58	25.19	20.55	16.59	13.28	10.54	8.27
150.00	Bspyroclas	245.46	630.7	43.87	37.88	32.83	27.99	23.62	19.81	16.52	13.79	11.07	8.94	7.13
160.00	Bspyroclas	151.01	380.4	85.86	75.06	65.40	55.93	47.42	39.73	33.03	27.19	22.20	17.94	14.42
170.00	Bspyroclas	83.17	212.5	40.30	33.86	28.44	23.45	19.13	15.44	12.37	9.83	7.71	5.95	4.53
180.00	Bspyroclas	293.59	740.6	57.67	48.44	40.69	33.54	27.61	22.36	17.74	14.15	11.21	8.82	6.95
190.00	Bspyroclas	649.07	1699.2	47.66	40.46	34.36	28.67	23.72	19.42	15.82	12.75	10.21	8.12	6.41
200.00	Bspyroclas	259.16	628.1	58.10	48.85	40.98	33.74	27.52	22.19	17.79	14.12	11.12	8.68	6.72
210.00	Bspyroclas	114.87	276.2	35.41	30.06	25.58	21.37	17.72	14.51	11.79	9.47	7.50	5.88	4.51
220.00	Bspyroclas	473.66	1218.7	279.10	241.62	205.63	169.13	135.83	106.35	81.69	61.38	45.32	32.88	23.51
230.00	Bspyroclas	283.52	734.7	36.84	30.95	26.00	21.47	17.56	14.22	11.44	9.11	7.21	5.65	4.41
240.00	Bspyroclas	223.14	546.8	96.13	82.83	71.07	59.74	49.63	40.71	33.09	26.60	21.18	16.69	13.03
250.00	Bspyroclas	19.89	59.0	27.82	22.33	18.11	14.49	11.53	9.17	7.29	5.75	4.56	3.51	2.51
260.00	Dol?	129.75	340.7	158.36	134.67	113.10	92.28	73.86	58.00	44.91	34.20	25.72	19.12	14.06
270.00	Arkose.w	151.74	385.5	16.76	14.19	12.09	10.10	8.35	6.82	5.52	4.43	3.51	2.76	2.15
280.00	Arkose.r	1189.53	3347.6	14.60	12.52	10.80	9.14	7.64	6.31	5.19	4.20	3.38	2.67	2.10
290.00	Arkose.r	71.12	223.8	11.59	9.77	8.30	6.93	5.72	4.69	3.81	3.01	2.37	1.83	1.37
300.00	Arkose.r	168.50	455.0	12.93	10.96	9.34	7.86	6.54	5.38	4.38	3.53	2.81	2.21	1.69
310.00	Arkose.r	117.29	331.3	30.34	26.54	23.21	19.98	17.04	14.37	12.05	10.03	8.30	6.83	5.57
320.00	Arkose.r	25.75	67.3	19.77	16.64	14.11	11.81	9.85	8.15	6.69	5.42	4.34	3.48	2.70
329.65	Arkose.r	78.89	191.4	29.33	25.57	22.30	19.12	16.25	13.66	11.43	9.47	7.80	6.42	5.25
340.00	Arkose.r	110.10	292.3	42.48	37.89	33.78	29.58	25.64	22.00	18.71	15.74	13.17	10.89	9.00
350.10	Arkose.r	45.86	122.1	13.13	10.85	9.07	7.48	6.11	4.94	3.96	3.13	2.45	1.90	1.41
360.30	Arkose	146.87	369.5	32.99	29.01	25.58	22.15	19.04	16.21	13.73	11.51	9.57	7.95	6.51
370.00	Bstf	595.05	1599.8	39.85	33.78	28.65	23.85	19.71	16.13	13.10	10.57	8.47	6.73	5.34
380.00	Arkose	222.75	611.3	25.00	21.72	18.86	16.06	13.58	11.33	9.36	7.66	6.19	5.00	3.98
390.00	Bstf	846.43	2053.3	24.63	20.51	17.13	14.04	11.41	9.16	7.28	5.71	4.48	3.44	2.62
400.00	Bstf	323.71	860.9	26.70	23.10	19.98	16.98	14.26	11.80	9.68	7.83	6.28	4.95	3.89
410.10	Bstf	325.33	1006.6	28.07	23.87	20.23	16.77	13.66	11.02	8.97	7.86	5.31	3.86	2.97
420.50	Arkose	176.59	455.3	22.36	19.66	17.29	14.97	12.75	10.75	8.98	7.32	6.00	5.09	4.04
430.00	Arkose	159.63	442.7	22.52	18.21	14.82	11.81	9.32	7.33	5.66	4.35	3.30	2.50	1.84
440.10	Arkose	403.05	1043.9	26.99	23.51	20.48	17.50	14.83	12.38	10.23	8.36	6.78	5.45	4.34
450.00	Arkose	742.16	1776.3	29.96	25.77	22.16	18.68	15.61	12.85	10.51	8.49	6.80	5.38	4.30
460.00	Arkose	557.51	1424.9	27.87	24.05	20.80	17.69	14.92	12.32	10.15	8.23	6.67	5.31	4.21
470.00	Arkose	718.29	1799.4	33.61	28.64	24.40	20.41	16.96	13.84	11.32	9.11	7.26	5.70	4.75
480.00	Arkose	123.40	304.8	34.62	30.49	26.83	23.14	19.84	16.75	14.10	11.88	9.58	7.86	6.50
490.00	Arkose	1081.67	2829.8	22.79	19.70	17.09	14.60	12.33	10.36	8.60	7.11	5.83	4.75	3.84
500.00	Arkose	681.31	1716.5	28.08	24.29	21.05	17.98	15.22	12.70	10.58	8.73	7.14	5.77	4.67
520.00	Arkose	237.57	683.1	30.31	25.42	21.34	17.56	14.38	11.65	9.35	7.50	5.94	4.67	3.65
540.00	Arkose	378.97	974.1	18.89	15.69	12.55	10.13	8.28	7.18	5.79	4.86	3.74	3.11	1.34
560.00	Arkose	189.65	493.9	36.58	31.82	27.79	23.85	19.92	16.79	13.66	11.45	9.23	7.44	5.95
580.00	Arkose	384.98	1037.8	23.56	20.01	17.09	14.34	11.82	9.61	7.75	5.97	4.65	4.28	3.25
590.00	Arkose	135.94	380.2	38.90	32.94	27.80	22.99	18.77	15.14	12.00	9.44	7.22	5.71	4.33

Other special samples

MJZM-7

Dep(m)	Remark	VP(mv)	RHO(ohm-m)	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
286.00	Arkose, Py	79.60	122.70	159.20	140.80	123.30	105.50	88.90	73.70	60.40	48.70	38.80	30.60	23.80
310.00	QtzVein, Py	501.00	742.60	16.30	14.00	12.10	10.30	8.70	7.20	5.90	4.90	4.00	3.20	2.60
310.50	Py	2.60	4.80	887.60	856.40	821.10	779.50	734.20	685.80	637.40	587.40	538.00	488.70	441.30
311.52	Py	225.30	378.40	476.40	440.90	404.60	364.70	324.90	285.50	248.60	213.70	182.00	153.40	128.30

MJZM-6

Dep(m)	Remark	VP(mv)	RHO(ohm-m)	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
351.00	Dol	408.30	1362.60	177.00	158.30	140.90	123.10	106.40	90.80	76.80	64.20	53.20	43.70	35.60
557.30	Dol	324.00	1123.00	126.40	112.60	99.80	86.80	74.70	63.50	53.50	44.50	36.70	29.90	24.20

Bs:Basaltic
tf:Tuff
lv:Lava
brc:brecciate
Qtz:Quartz

Md:Mud stone
Ss:Sand stone
Cal:Calcite
Ark:Arkose
Pydis:Pyrite disseminate

Dol:Dolerite
Bo:Bornite
Cc:Charcocite
Hem:Hematite
Grn:Granite

pyroclas:Pyroclatics
Py:Pyrite
w:White
r:Red

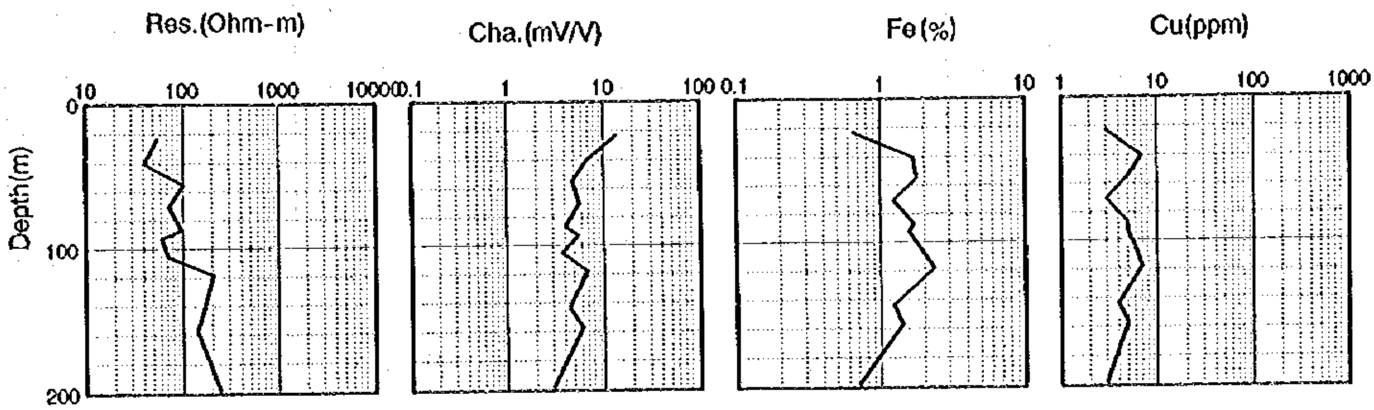


Fig.II-1-9 Log showing physical characteristics (MJZM-1)

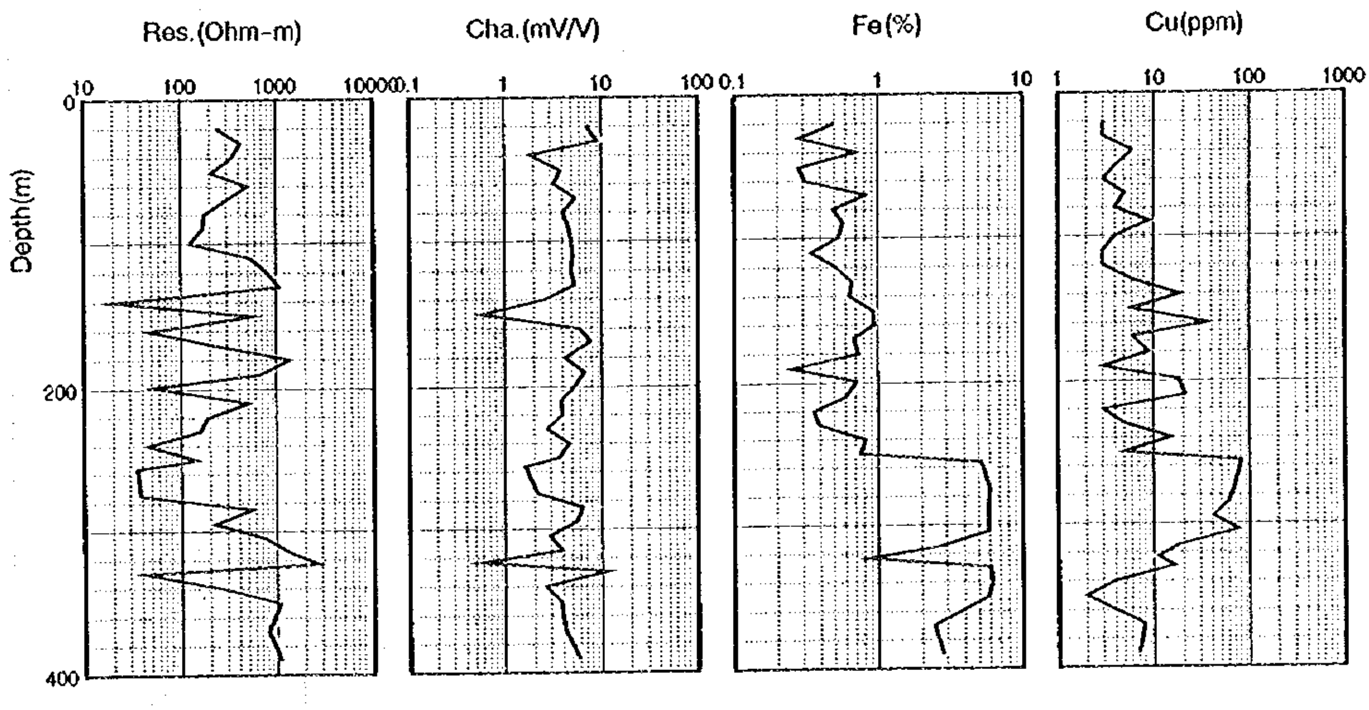


Fig.II-1-10 Log showing physical characteristics (MJZM-2)

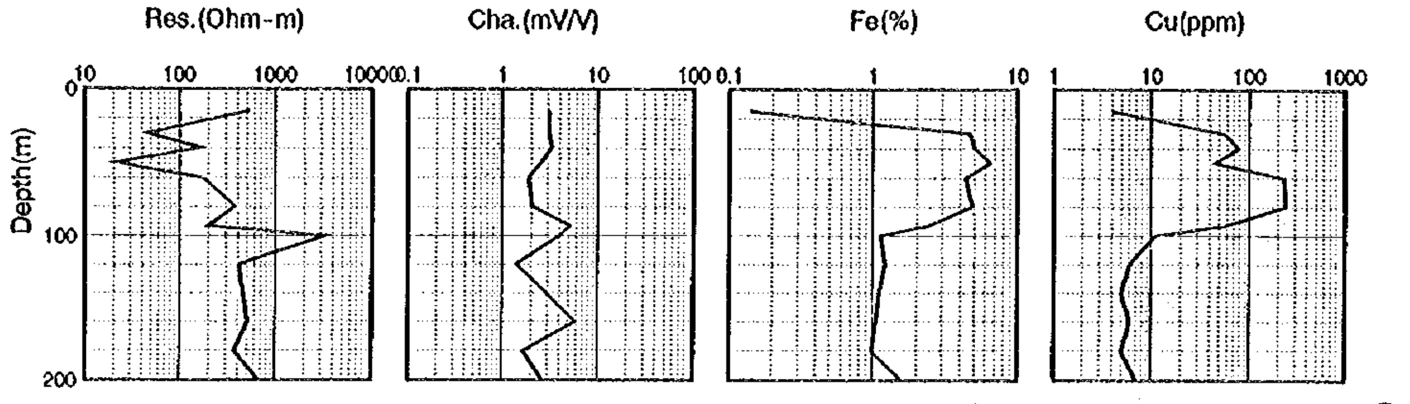


Fig.II-1-11 Log showing physical characteristics (MJZM-5)

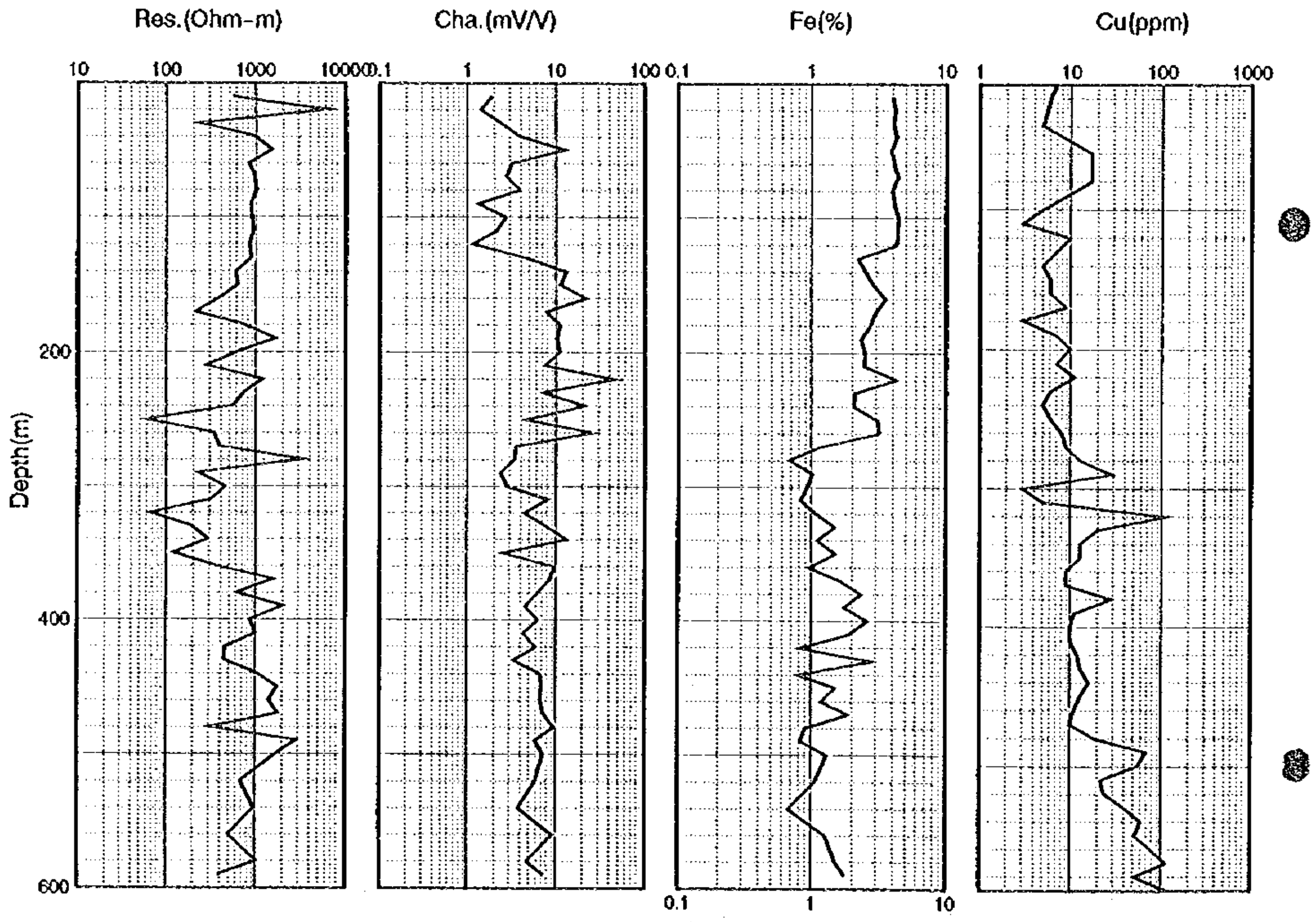


Fig.II-1-12 Log showing physical characteristics (MJZM-7)

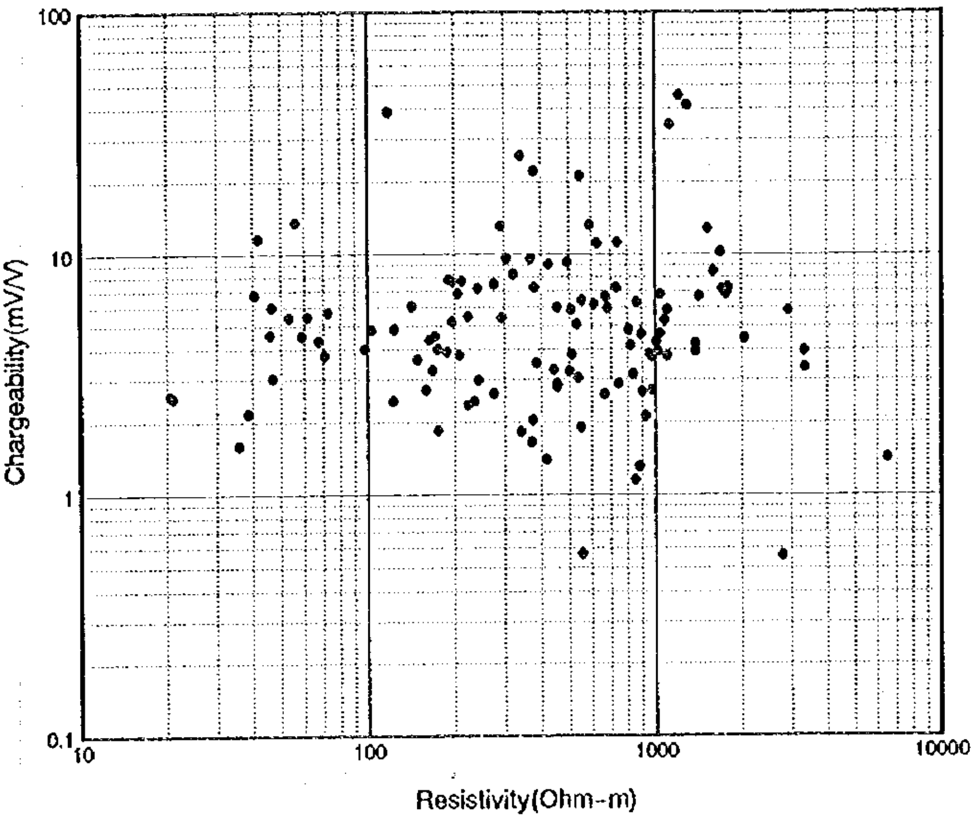


Fig.II-1-13 Crossplot of apparent resistivity against chargeability of core samples

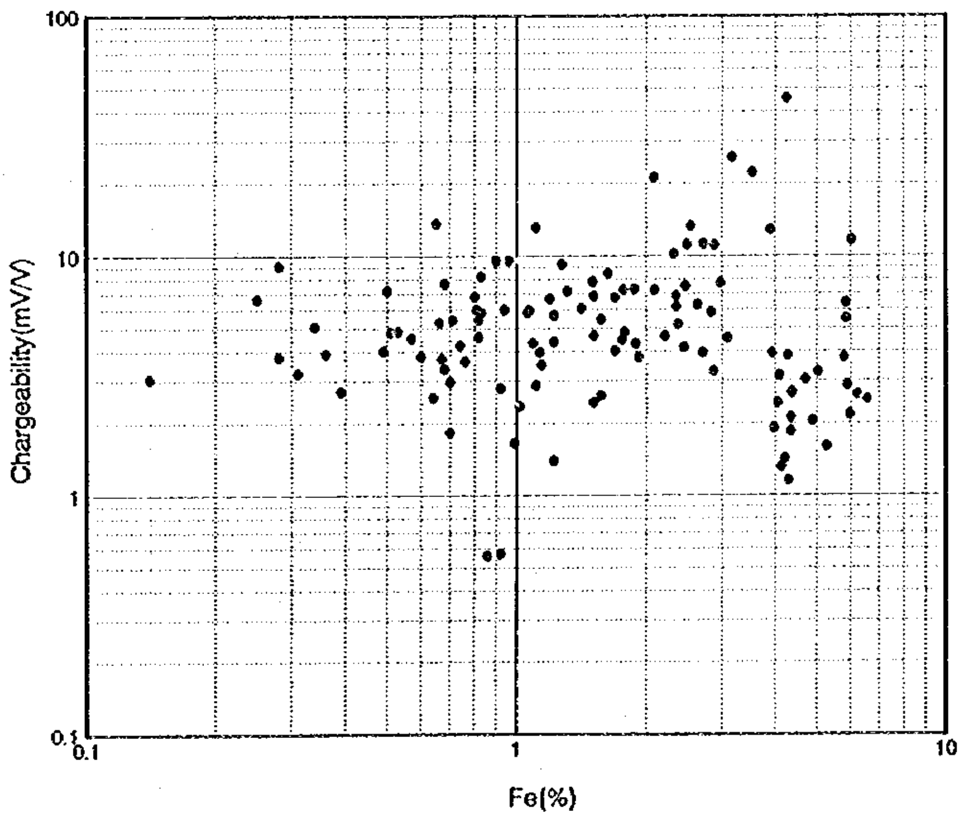


Fig.II-1-14 Crossplot of iron content against chargeability

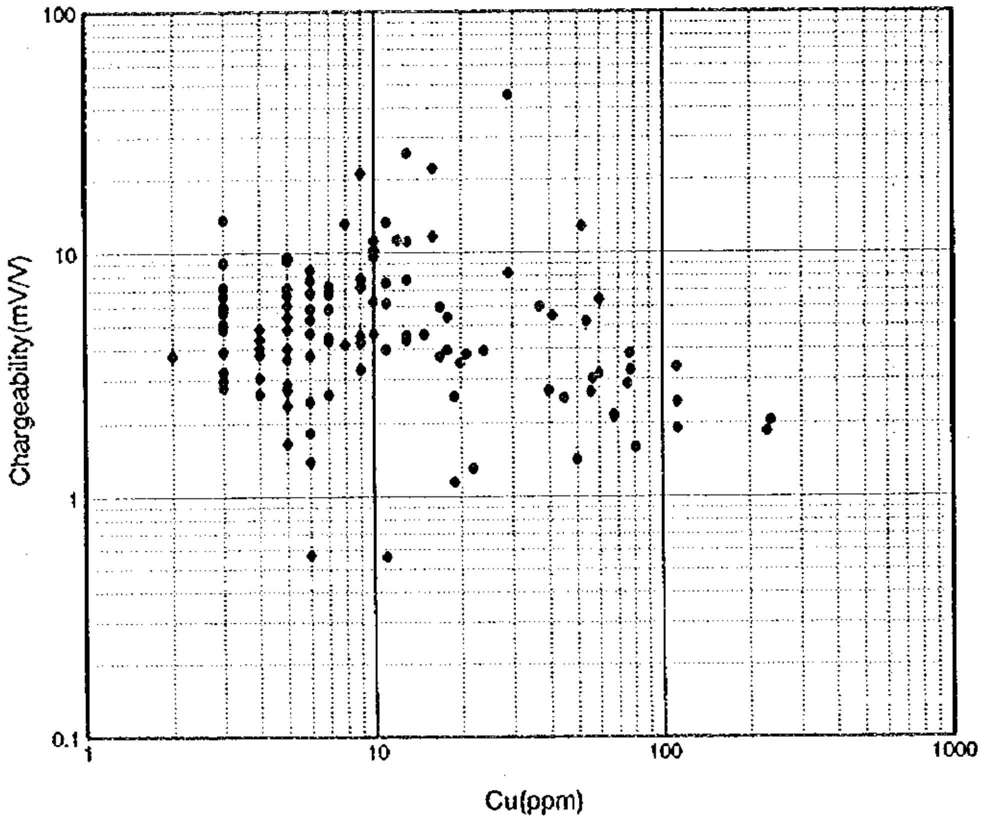


Fig.II-1-15 Crossplot of copper content against chargeability

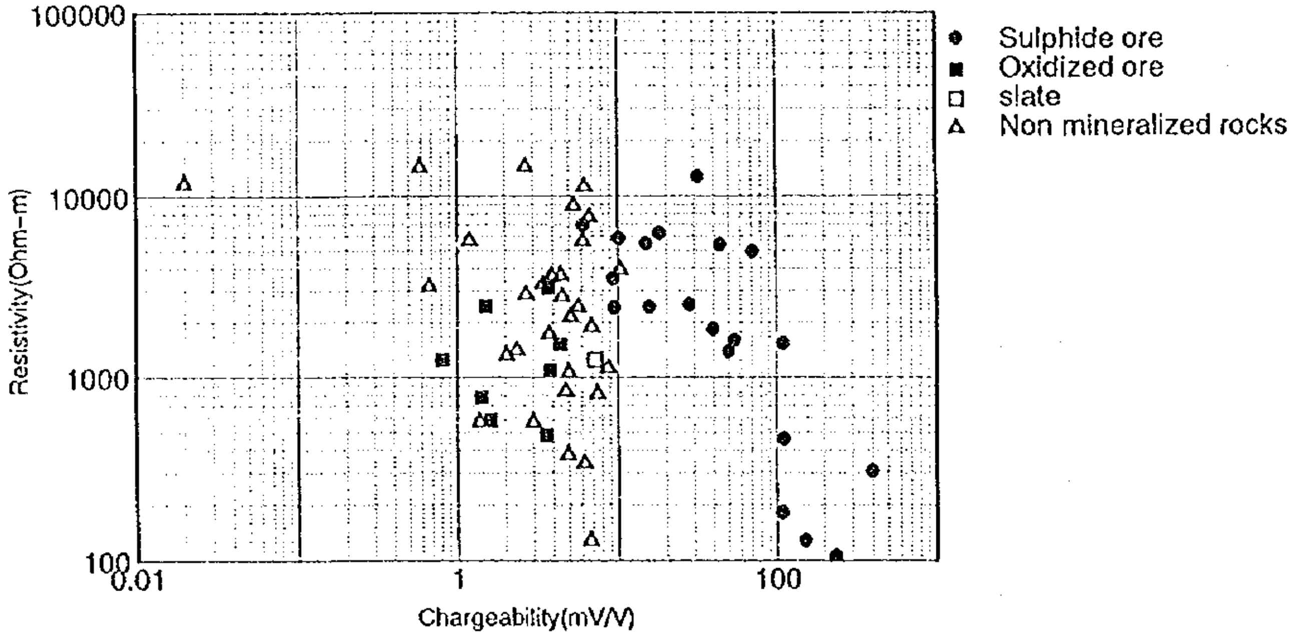


Fig.II-1-16 Crossplot of apparent resistivity against chargeability of rock and ore samples

(3) Clear relationship between iron, copper content and chargeability are not recognized.
(4) Samples with small crack by folding and vein show less than 200 ohm-meter.
(5) Chargeability more than 10mV/V are recognized in shallow portion less than 30m of MJZM-1, around 330m depth of MJZM-2 and 140m to 260m depth of MJZM-7.
(6) Samples showing more than 10mV/V of chargeability and 30 to 1,000 ohm-meter of resistivity are arkose with pyrite dissemination, dolerite and basaltic pyroclastics.

4.Data analysis

By the results of physical property test of samples collected from surface, rock and ore samples were separated at 10mV/V of chargeability. Crossplot of resistivity against chargeability of samples from surface are shown in FigII-1-16. On the other hand, by the same test of core samples, some of dolerite and basaltic pyroclastics also show more than 10mV/V to maximum 55mV/V.

Based on the result of physical property test of core samples, simulation analysis was carried out again on the survey line of Osc, Ys, Za. The results of simulation analysis are shown in Fig.II-17 to Fig.II-1-19.

As a result of simulation, even the model with comparatively low resistivity and chargeability corresponds to the results of field survey. Maximum chargeability of model is 60mV/V in this case.

Line Osc (Fig.II-1-17)
(1) Small vein of chalcopyrite and pyrite is observed in the sample at 88m.
(2) Samples of MJZM-5 generally show low chargeability less than 10mV/V.
(3) The IP anomalous pattern corresponds to assumption of a weak anomalous body with 30mV/V.
(4) Weak anomalous body of survey station No.8 to 9 may be extension of vein of chalcopyrite and pyrite.

Line Za (Fig.II-1-18)
(1) Samples of granite, dolerite and quartz vein with hematite was observed.
(2) Samples of MJZM-2 generally show low chargeability less than 10mV/V.
(3) Sample of quartz vein 329m depth accompany large quantity of hematite and extremely small quantity of pyrite, and shows 12mV/V.
(4) The IP anomalous pattern corresponds to assumption of two flat anomalous bodies. It is considered to be represented by the composite of dolerite dyke.

Line Ys (Fig.II-1-19)
(1) Samples of MJZM-7, especially basaltic pyroclastics at 140 to 260m depth and arkose with

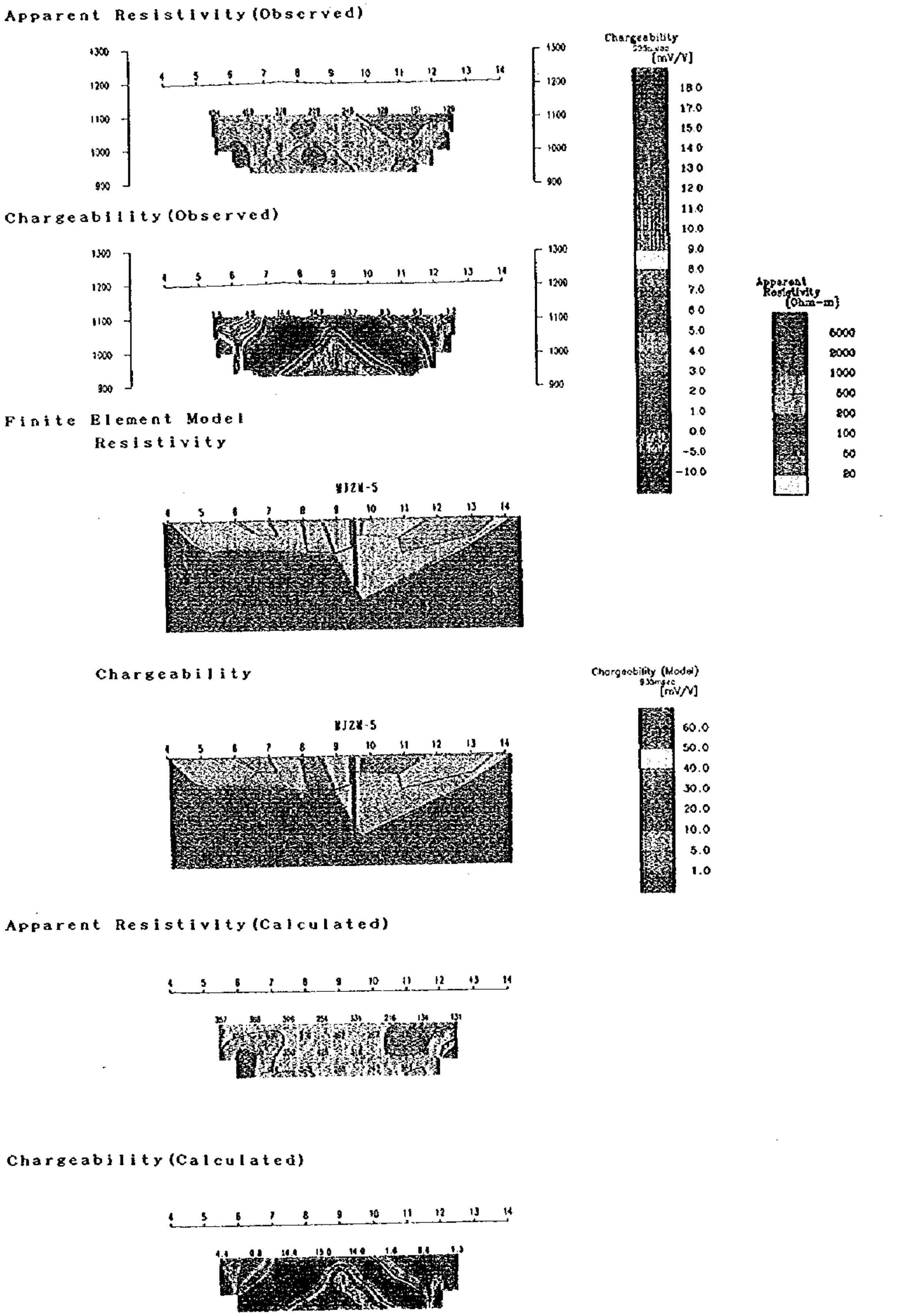


Fig.II-1-17 Results of simulation analysis (Osc line)

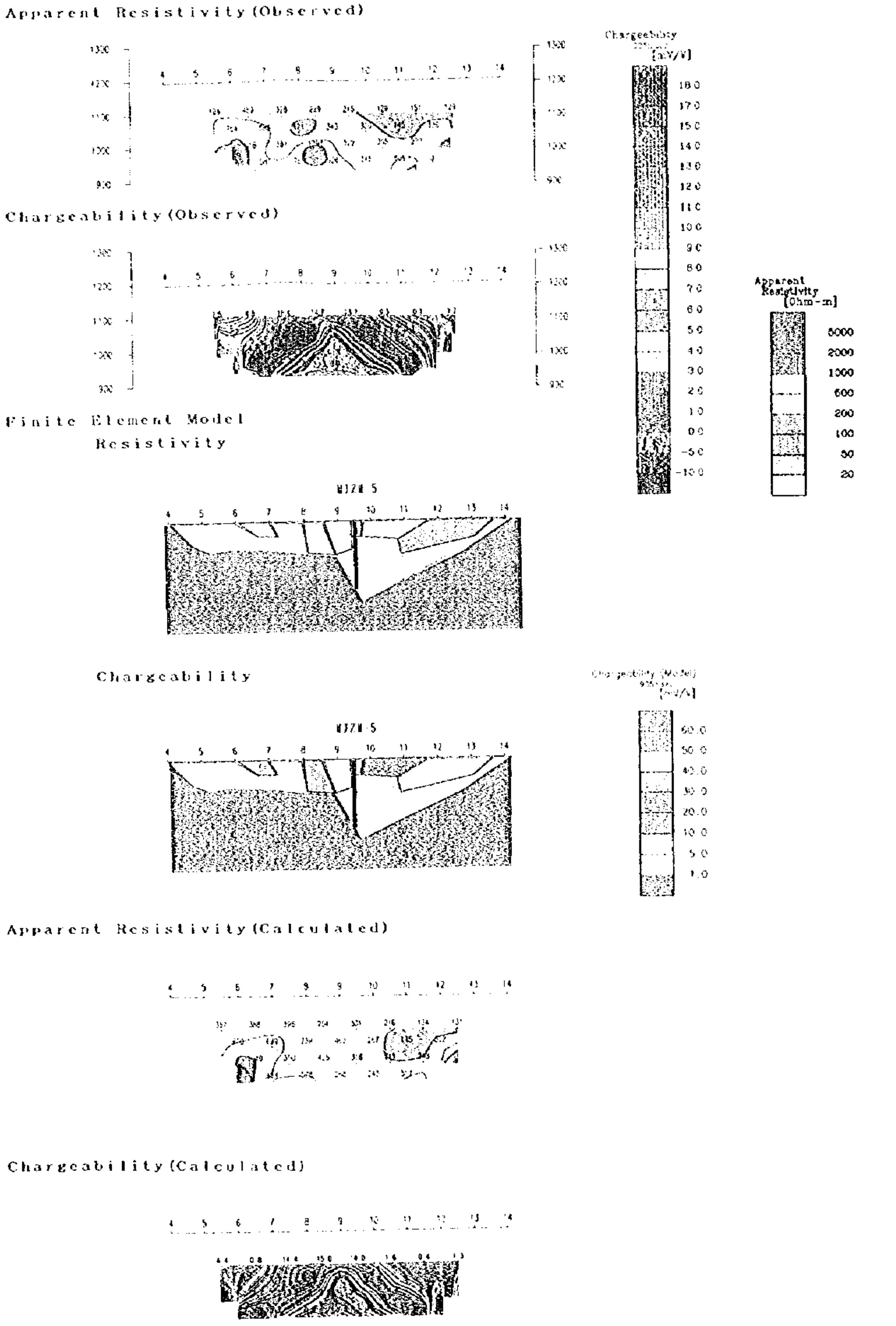


Fig.II-1-17 Results of simulation analysis (Osc line)

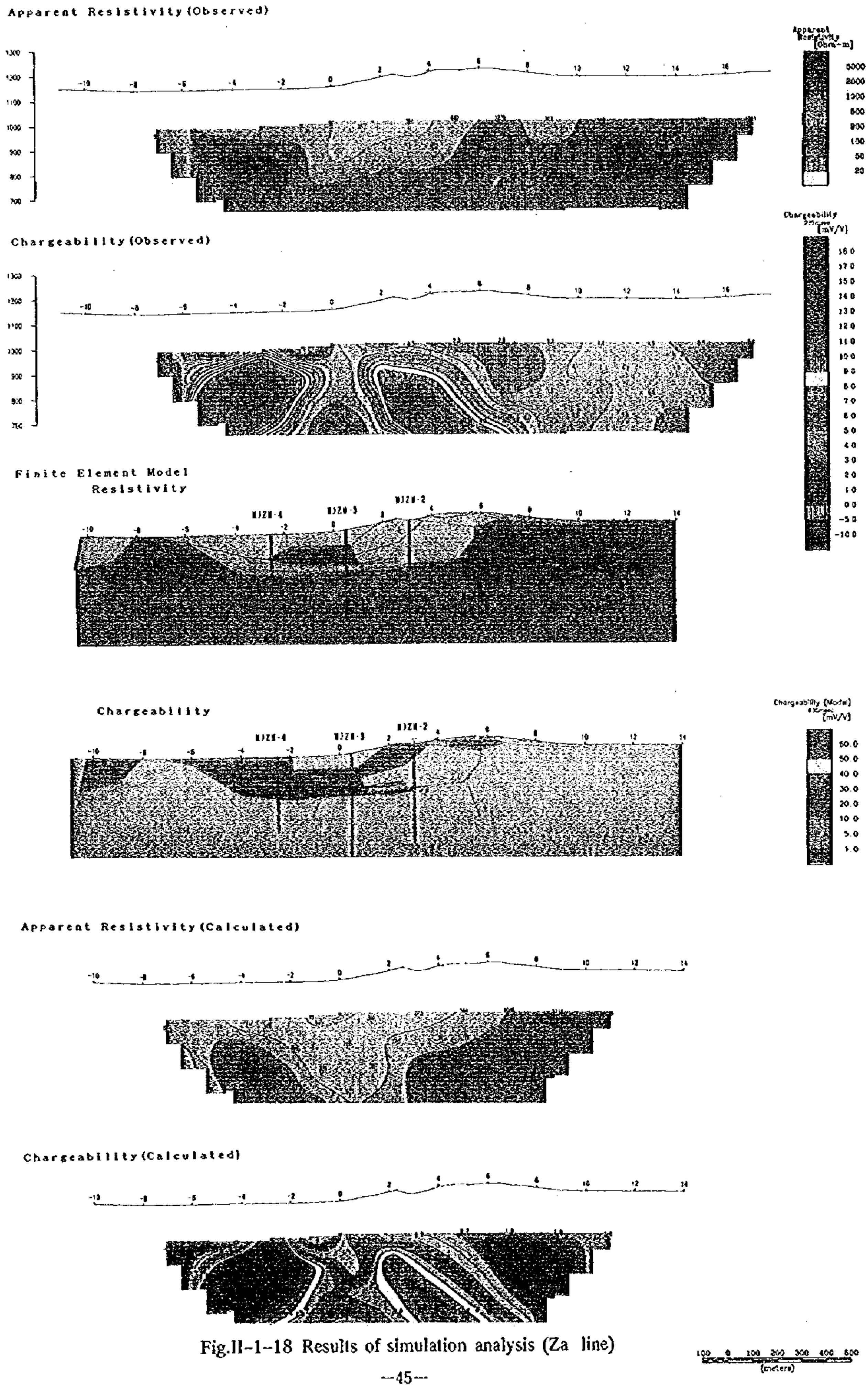


Fig.II-1-18 Results of simulation analysis (Za line)

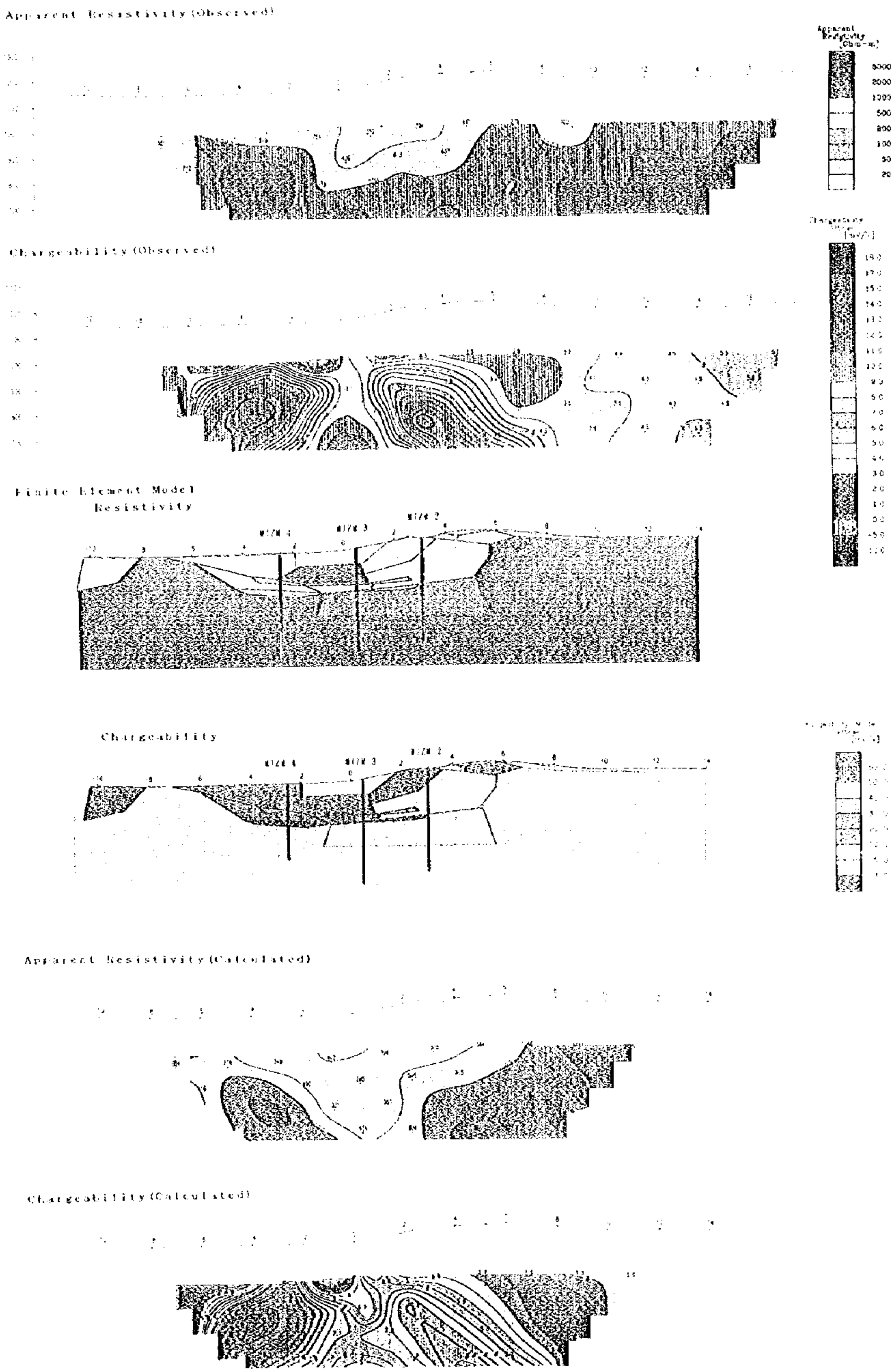


Fig.II-1-18 Results of simulation analysis (Za line)

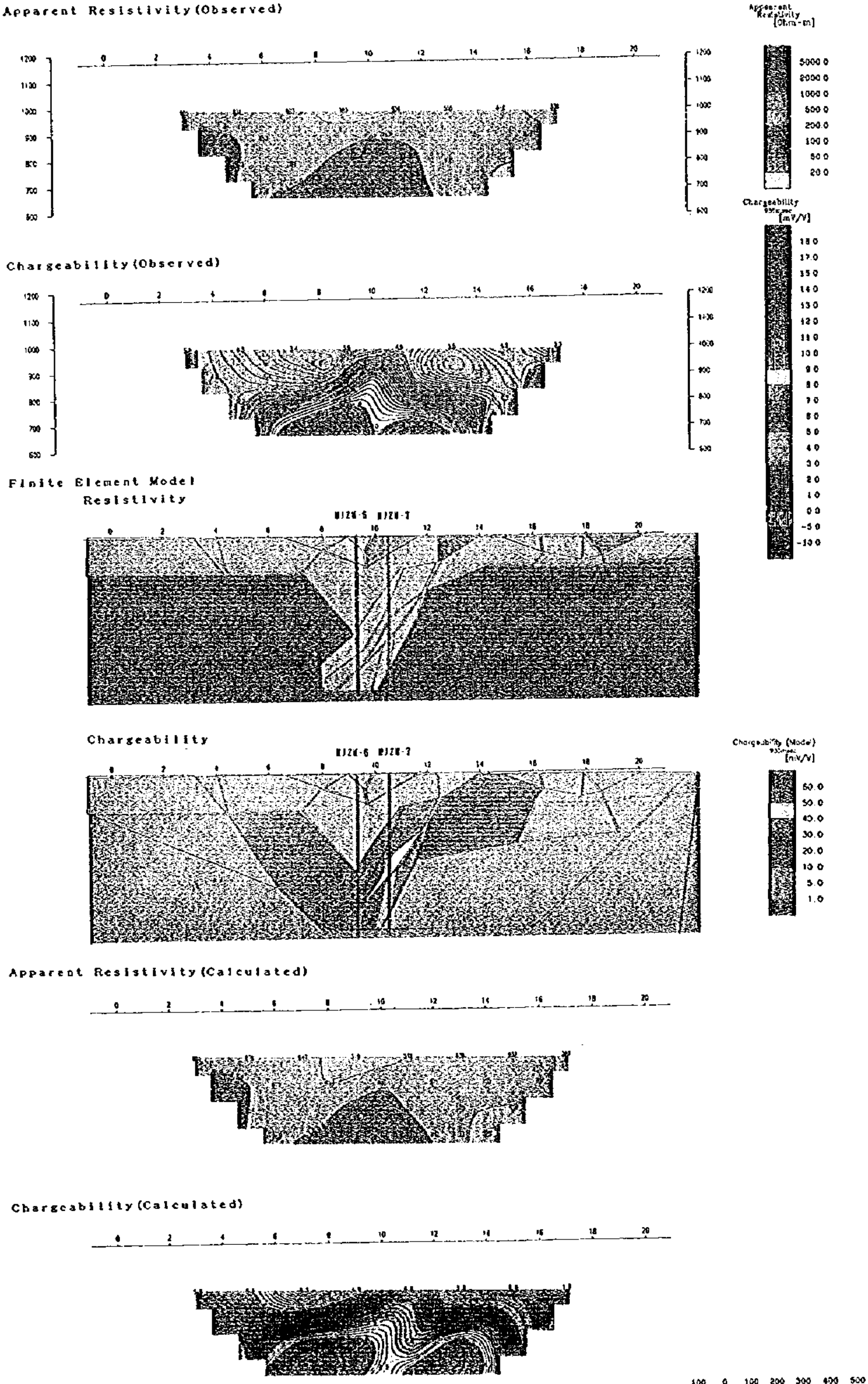


Fig.II-1-19 Results of simulation analysis (Ys line)

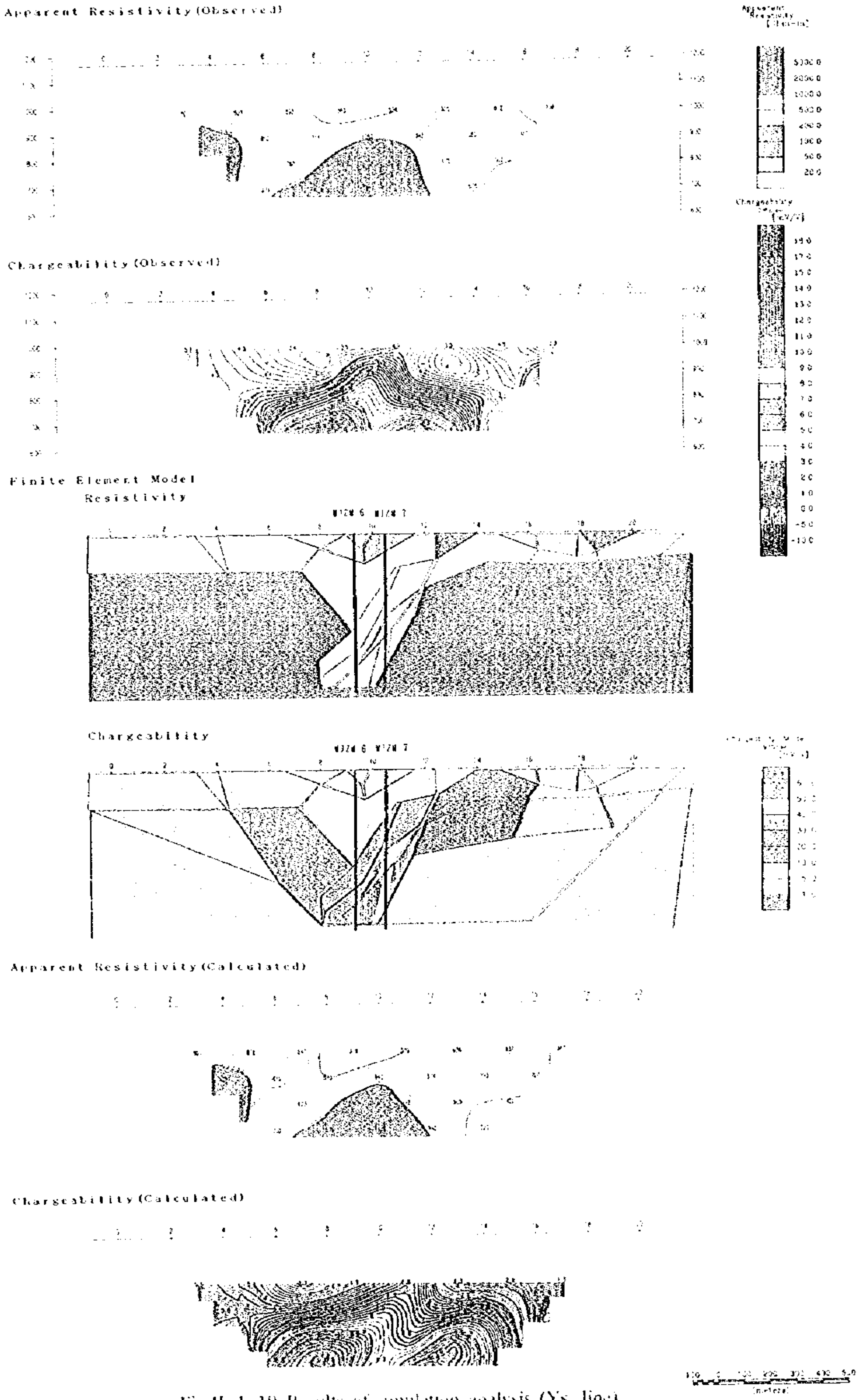


Fig.II-1-19 Results of simulation analysis (Ys line)

weak mineralization at about 300m depth show maximum nearly 50mV/V of chargeability.

(2) Samples of dolerite in MJZM-2 show maximum 55mV/V of chargeability.

(3) Samples of dolerite and basaltic pyroclastics have a variety of chargeability.

(4) The IP anomalous pattern corresponds to assumption of composite of flat anomalous body with steep inclination. It is considered to be effected by mineralized arkose and large quantity of basaltic pyroclastics.

5.Discussion

By the pre-survey above the known ore deposit(Avondale ore deposit, copper content of crude ore is 0.8%), comparatively clear IP pattern with 8mV/V of chargeability was observed.

Clear IP pattern with 25mV/V of chargeability was observed at the L, Os, Za and Ys line of field survey.

On the other hand, by the results of physical property test of core samples, some samples of dolerite and basaltic pyroclastics show near 55mV/V of chargeability, and is a little stronger IP effect than weak mineralized arkose and granite.

The results of simulation analysis based on the physical property test of core samples correspond to mineralization of chalcopyrite and pyrite at Osc line, and reflect the effect of both weak mineralization and dolerite and basaltic pyroclastics at Za and Ys line.

Through this study it become clear that this IP survey method extract clearly even the comparatively low IP body like weak mineralization and at the same time dolerite and basaltic pyroclastics is also extracted in this area.

Therefore, if weak and clear IP pattern with about 30mV/V of chargeability was observed in the fields survey, it is necessary to consider the effect of these dolerite and basaltic pyroclastics.

1-3 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.

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.

Chapter 2 Consideration of the survey result

2-1 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.

2-2 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)

2-3 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.

2-4 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

Through the study of results of Phase I and II surveys, 4 sites of geophysical IP anomalous bodies were selected. Drilling exploration was carried out to confirm that these IP anomalous bodies originate from mineralization.

Summary of drilling is as follows :

Area	No.of holes	Name of hole	Depth(m)
Greenfields(Chirombozi farm)	1	MJZM-1	202.60
Greenfields(Brenville farm)	3	MJZM-2,3,4	1,102.90
Inyati(Inyati farm)	1	MJZM-5	200.00
Angwa (Blackwood farm)	5	MJZM-6,7,8,9,10	2,552.00
TOTAL	10 holes		4,057.50

As a result of this drilling, MJZM-5 obtained a mineralization of small vein and dissemination mainly consisting of chalcopyrite and pyrite , which is concordant with the foliation of country rocks. MJZM-7 and 10 obtained a weak mineralization of dissemination mainly consisting of chalcopyrite, pyrite, bornite, chalcocite and sphalerite.

These mineralization are in similar ore horizon to known ore deposits (United Kingdom Mine and Hans Mine) and show similar mineral composition. It seems to be obtained from 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 is obtained.

By the results of physical property test of ore and rock samples collected at Phase I and II surveys, ore shows more than 10mV/V of chargeability and separated from rocks. On the other hand, by the results of same test of drilling core samples, some samples of basic rocks show near 55mV/V of chargeability, and has a little stronger IP effect than weak mineralized arkose and granite.

The results of simulation analysis based on the physical property test of core samples correspond to the results of field survey with the assumption of the existence of comparatively low IP body. Extracted IP anomalies of the Phase II survey are mainly considered to be the effect of basic rocks.

The results of physical property test of ores show that if high grade ore which can be developed is in underground, stronger anomalies may be formed in the fields than the effect of basic rocks. Extracted anomalies mainly caused by the effect of basic rocks suggest the low potentiality of the existence of unknown new ore deposits.

Though the drilling exploration was carried on to the IP anomalous body mainly effected by basic rocks. In spite of low grade the copper, mineralization was observed. This was due to the fact that the drilling site was selected on the geochemical anomalous area. By the result of MJZM-5 drilling, it becomes clear that if the mineralization is in the depth of less than about 100m, the existence of underground mineralization is detected by the geochemical survey.

By the result of MJZM-7 and 10 drillings, observed mineralization by drilling are in a little different place from geochemical anomalies. If mineralization is in deeper place, drilling sites have to be decided by using jointly geophysical IP exploration.

Existence of basic rocks which show a similar IP effect to weak mineralized rocks was confirmed in this area. therefore, as the theme for future, if the geophysical IP survey will be projected, enough collection of ore and rock samples and physical property test of samples will be carry out before IP survey, it will be necessary to able to separate the IP effect of ore and rocks.

Chapter 2 Recommendations for 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.

Reference

Japan International Cooperation Agency, Metal Mining Agency of Japan. (1993) : Report on the Mineral Exploration in the Makonde Area, The republic of Zimbabwe. (Phase I)

Japan International Cooperation Agency, Metal Mining Agency of Japan. (1994) : Report on the Mineral Exp'oration in the Makonde Area, The republic of Zimbabwe. (Phase II)

Master, S. (1991):Stratigraphy, tectonic setting, and mineralization of the early proterozoic Magondi supergroup, zimbabwe: a review. in Precambrian Sedimentary Basins of Southern Africa(compiled by P. G. Eriksson). TERRA Nova vol. 3, p. 21.

Simpson, H. (1990):Report on work done and recommended in the area from north of Mhangura to south of Alaska. Unpub. Rep. of ZMDC, 43pp.