THE REPUBLIC OF ZAMBIA

REPORT ON THE COOPERATIVE MINERAL EXPLORATION OF [illegible]

CONSOLIDATED REPORT

JANUARY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

THE REPUBLIC OF ZAMBIA

REPORT ON
THE COOPERATIVE MINERAL EXPLORATION
OF
KARENDA AREA

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PREFACE

The Government of Japan, in response to the request extended by the Government of the Republic of Zambia, agreed to conduct a metallic mineral exploration survey in the Karenda Area, and commissioned its implementation to the Japan International Cooperation Agency.

The agency, taking into consideration the importance of the technical nature of the survey work, sought the cooperation of the Metal Mining Agency of Japan to accomplish the task.

The Government of the Republic of Zambia appointed the Mineral Exploration Department of Zambia Industrial and Mining Corporation Limited (MINEX ZIMCO) to execute the survey as a counterpart to the Japanese team. The survey has been carried out jointly by experts of both Governments.

The collaboration survey for metallic mineral, which lasted three years, consists of geological, geochemical, and geophysical surveys, supported by drilling and laboratory work. This consolidated report hereby submitted summarizes results of the said survey.

We wish to take this opportunity to express our gratitude to all sides concerned in the execution of the survey.

January, 1987

Keisuke ARITA
President,
Japan International Cooperation Agency

Junichiro SATO
President,
Metal Mining Agency of Japan

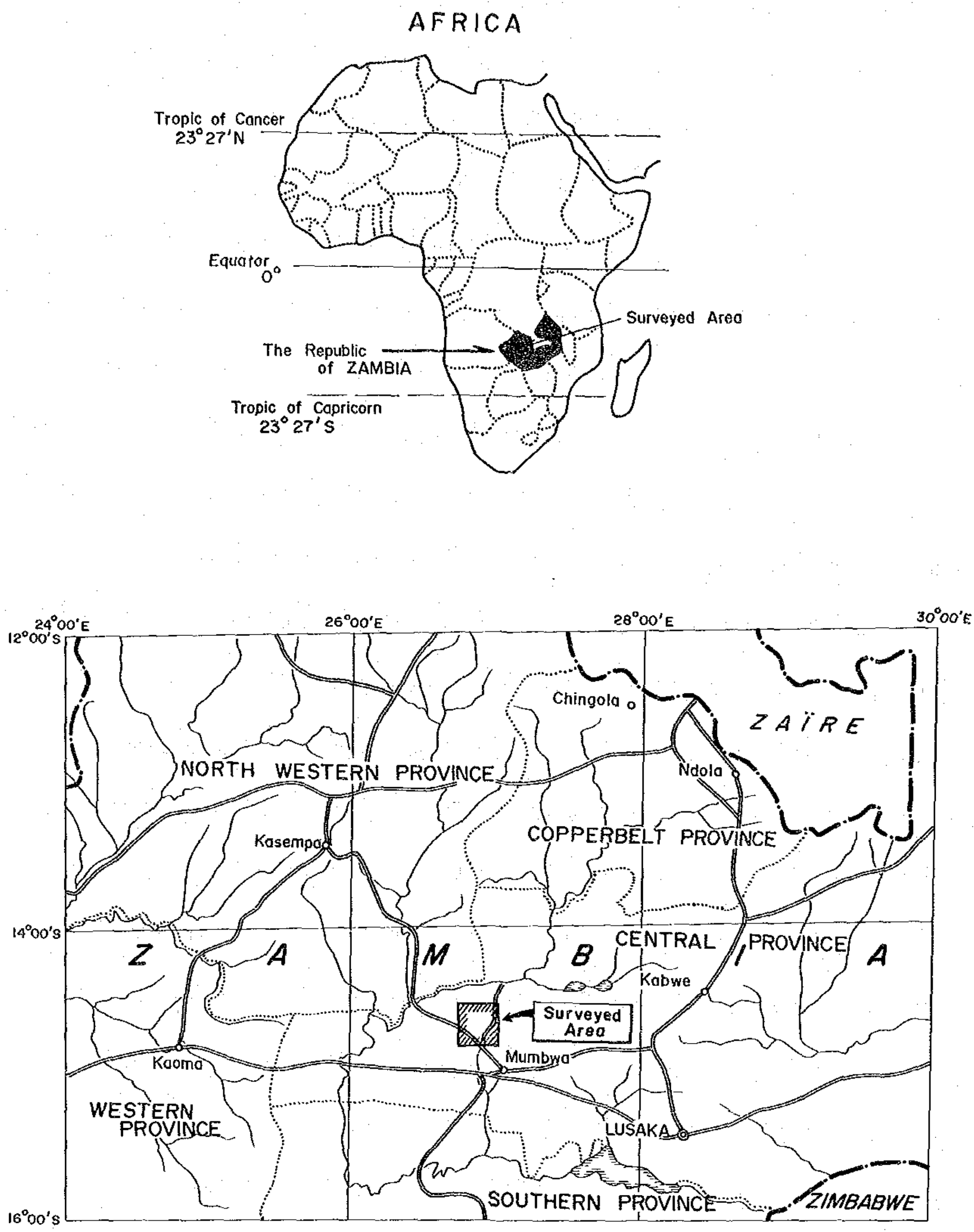

Fig. 1 Index Map of the Survey Area

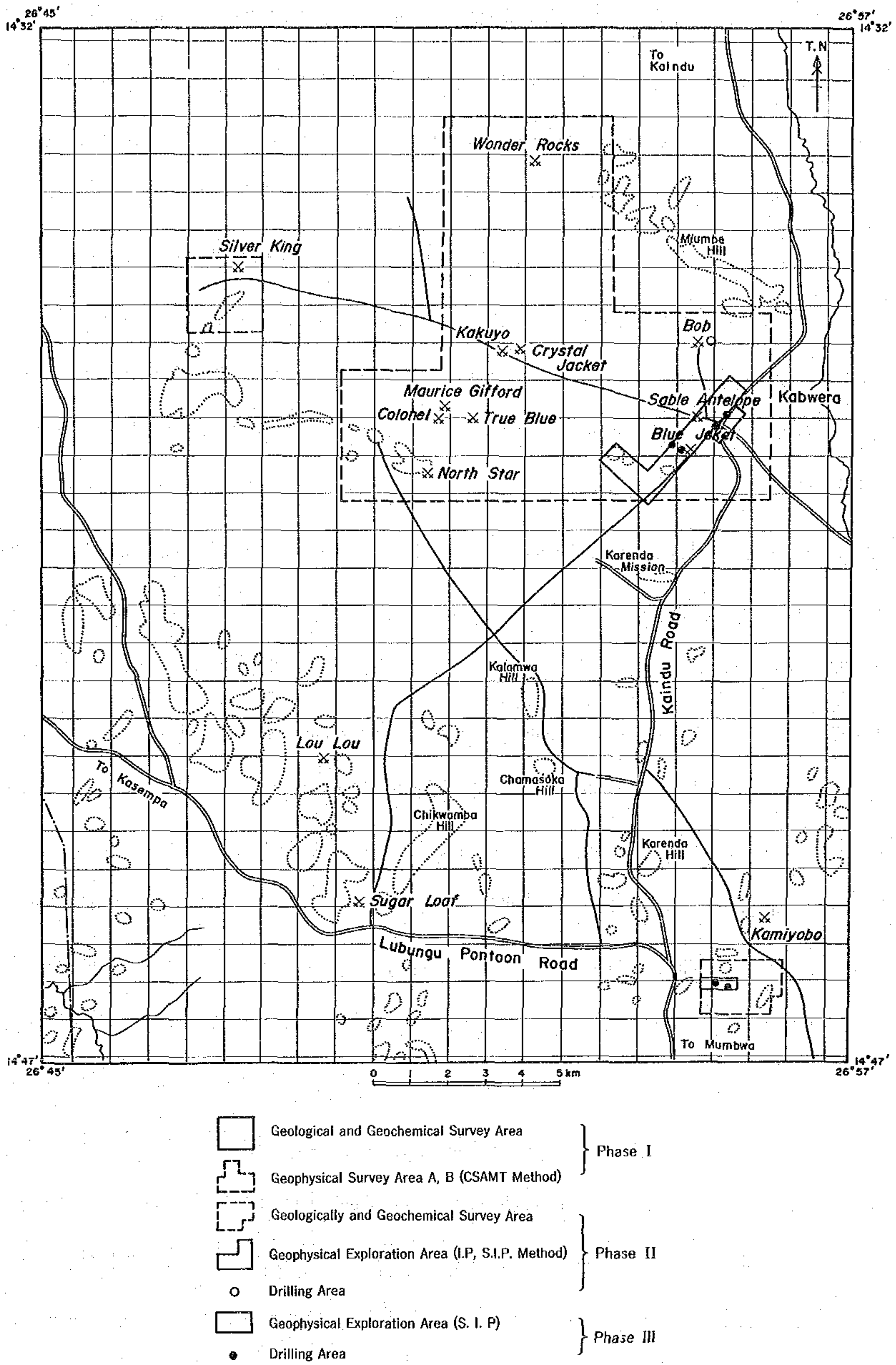

Fig. 2 Map of the Survey Area

SUMMARY

The investigation, which included geological, geochemical, geophysical and drilling surveys, was carried out from 1984 to 1986 with aim of elucidating the emplacement condition of the silver-copper-zinc-lead deposits in the Kareanda Area.

The results of the investigation is summarized as follows;

1. Kareanda Area (600 km^2)

The geology of this area consists of carbonate rocks and argillaceous-arenaceous rocks of Precambrian age, grouped into Kundelungu series, Catanga system, intrusive rocks including syenite, and quartz porphyry intruded in the Kundelungu formation, and Quaternary alluvial deposits.

The Area is divided into three blocks of Eastern, Northern and Southern by the major faults of N-S and E-W systems.

The formation in the northern block is folded in a monoclinic structure trending east-west, and carbonate rocks in the formation have usually been brecciated. These breccia-fractured zones are independently distributed, but are regionally distributed in the harmony with the tectonic line of E-W system and weak zone crossing perpendicularly the tectonic line.

The mineralization of main elements of copper and zinc is embedded mainly in the above-mentioned breccia-fractured zone, and locally in weak lines such as cracks and fissures in the argillaceous-arenaceous metasediments and the syenite rocks. These deposits form pipe, lens and vein in shape.

The re-investigation on the geochemical data compiled together with 500 samples of the present survey and 410 samples obtained through geochemical survey conducted by MINDECO-NORANDA have revealed that three attractive anomalous areas are extracted in the vicinity of Kamiyobo copper-mineralized zone, zinc-lead anomalous zone extending to the west, and Bob Zinc zinc deposit from many anomalous areas. In the north Area, geochemical anomalies are, in their existence, harmonious with the tectonic line trending east-west, and the weak line of N-S system crossing the tectonic line.

The geophysical survey (CSAMT method) conducted in A area (75km^2) and B area (4km^2) clarified resistivity distribution in the areas surveyed, and extracted several attractive geophysical anomalous zones distributing in the weak zone linking Blue Jacket - Sable Antelope - Bob Zinc areas, and in the areas around Crystal Jacket - Kakuyo and around Wonder Rocks.

2. Detailed Survey Area

1) Bob Zinc Area

Bob Zinc deposit is embedded in breccia-fractured zone existing in a massive dolomite - dolomitic limestone as bedded deposit accompanied by zinc silicate ore. The center of the breccia-fractured area has been undergone strong sideritization, while marginal part of the fractured zone has been subjected to weak alteration. A geochemical zinc-anomalous area is present in east of Bob Zinc deposit.

The drilling survey ascertained presence of weak-mineralization of zinc at two parts, namely one having 6.60m in vein-thickness and 0.31% of

Zn at 60m below ground surface of MJZ-5, other 12.70m in vein-thickness, 1.64% of Zn at 100m depth of MJZ-6.

The drilling indicates that, although concentration of zinc-silicate ore remains in shallow part, the ore in the deeper part deterionates very quickly. It is supposed that the deposit in massive carbonate area was subjected to erosion to deeper part, and contains poor primary-sulphide ore in the present.

2) Sable Antelope Area

(1) Vicinity of the Blue Jacket mineralized area

This area consists of shale in the lowest argellaceous-arenaceous rock formation and dolomitic limestone. A mineralized zone mainly of copper ore is observed in the sandstone, coming off and on along intraformational folding and breccia-fractured zone.

The No.3 IP-anomaly zone detected by high frequency effect and low apparent resistivity zone of geophysical survey is found in the vicinity of the Blue Jacket mineralized zone. The drilling reveals that the anomalous area results from pyrite-disseminated black shale.

Drilling MJZ-8 indicates that copper mineralized zone with 4.10m in thickness, 0.34% of copper below 75m from ground surface contains a massive ore accompanied by chalcopyrite and bornite in some part. Some amount of pyrite dissemination in black shale regards the mineralization as sedimentary origin.

(2) Vicinity of the Sable Antelope deposit

The Sable Antelope deposit is emplaced in marginal dolomitic part of fractured and brecciated zone of massive carbonate rocks. The mineralization of copper mainly occur in cement part of the brecciated dolomite, and the marginal part of the deposit has undergone silicification.

No.1 and No.2 IP anomalous zones founded by geophysical survey exist in the Sable Antelope deposit area. These zones show anomalous frequency effect, in spite of high apparent resistivity. The drilling survey indicates that the IP anomalies are caused by pyrite dissemination in the dolomitic sandstone. Pyrite dissemination zone caught by MJZ-11 is presumably present at marginal part of the deposit. Some pyrite ore seems to be sedimentary origin, and is accompanied by lead and zinc ores.

3) Kamiyobo Area

The geology of the area consists of bedded limestone of upper carbonates and sandstone, chart and conglomerate shale of argillaceous-arenaceous metasediments.

Although oxide iron ores are only croped out as showing of mineralization, a geochemical anomalous zone of copper-zinc-lead have been discovered at south-west part of the area through geochemical survey. The anomalous zones are distributed extending along anticlinal axis in above mentioned limestone, and also as vein in form. Both cross each other.

The geophysical survey was conducted on the center part of the above mentioned geochemical anomalous zone, and resulted in finding an extensive geophysical anomalous zone of high frequency effect and low resistivity.

The drilling survey reveals that the geophysical anomaly results from pyrite-disseminated black shale, and the geochemical anomaly is correspond to bedded copper-zinc-lead-bearing mineralization and also ore vein embedded in the black shale.

3. Synthesis of the investigation

1) As mentioned above, the investigation in the Area did not result in finding economically valuable deposit.

2) However the surveys have elucidated characteristics of mineralization, and characteristics of IP effect of geophysical survey in the Karenda Area. These knowledges are useful to investigate for similar field as this Area.

① The genesis and history of the mineralization in the Karenda Area are synthesized as following stages;

(a) Sedimentation of the carbonate rocks, and the precipitation of main minerals of lead, zinc and iron sulfide
(b) Sedimentation of the argillaceous-arenaceous rocks, and precipitation of main minerals of copper, zinc, lead and iron sulfide
(c) Folding movement and igneous activities
(d) Formation of brecciated and fractured zone (igneous activity and tectonic movement)
(e) Sulfide Mineralization (movement and accumulation of copper, lead, zinc and etc.)
(f) Folding, faulting
(g) Uplifting and erosion
(h) Formation and dispersion of secondary minerals

② Among IP anomalies detected by geophysical survey, someones result from pyrite-disseminated black shale. According to the result of laboratory test on drilling cores, many of black shales disseminated with chalcopyrite and pyrite show decreases in phase at a change of frequency from 0.125 to 0.375Hz. Many of ores from Sable Antelope show increases in phase in accordance with an increase of frequency from 0.125 to 0.375Hz. Therefore, it is pointed out that mineralization is distinguishable by phase characteristics in low frequency domain.

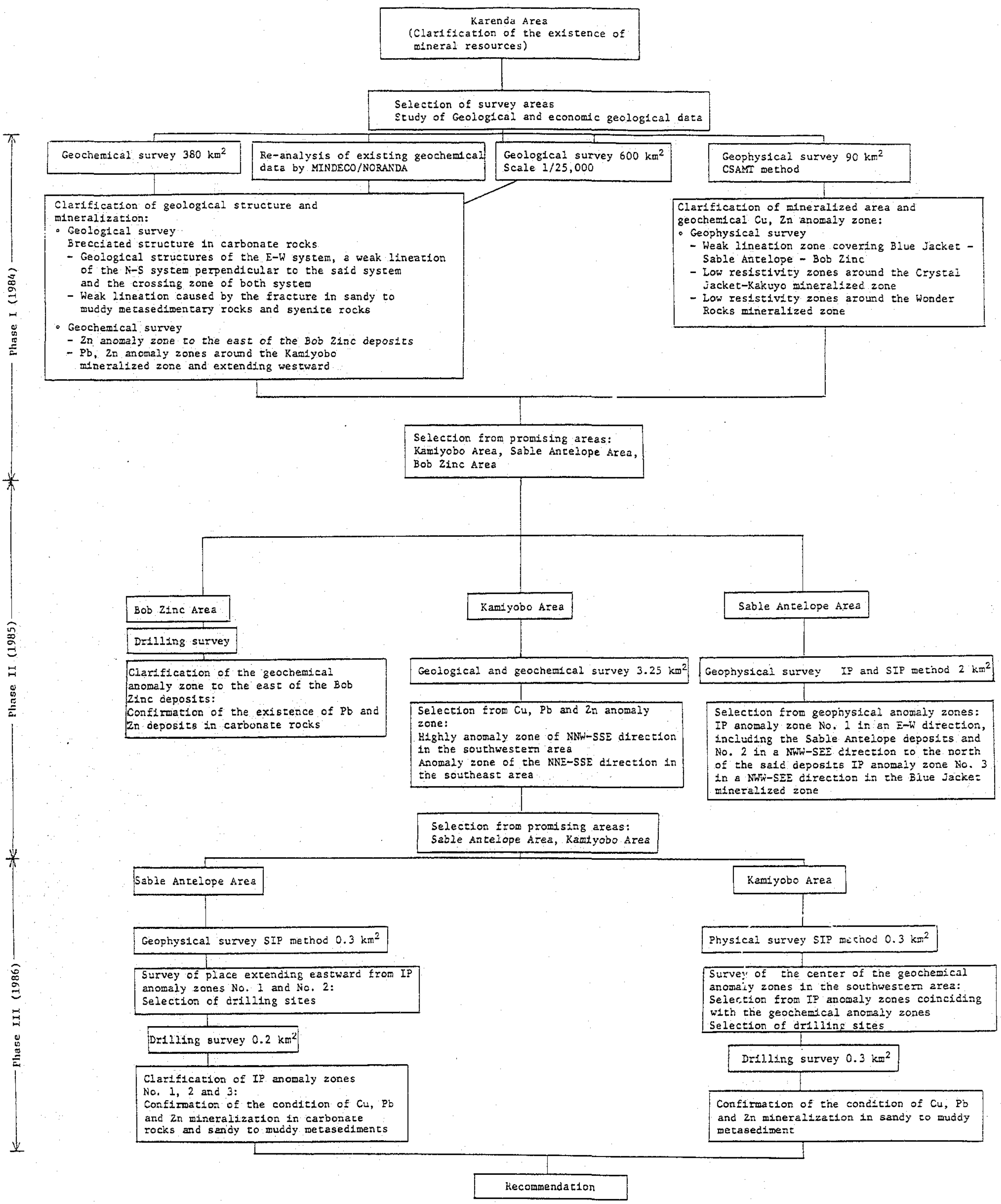

Fig. 3 Flow Sheet for the Selection of Promising Mineralized Area

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Part I Introduction

Chapter 1 Outline of the Survey

1-1 Survey Area and Survey Objective

The survey was conducted with purpose of clarifying the mineral resources in the Karenda Area, Republic of Zambia, through investigation of existing data and results obtained from the surveys during three years.

1) The Karenda Area

The location of the Karenda area is shown in the Location map of the Karenda Area (Fig. 1) and the Surveyed Area is shown in the Map of Survey Area (Fig. 2).

The Karenda Area is bounded by lines jointing the following longitude and latitude points. The dimention of the area is 600km^2.

Latitude	Longitude
14° 32' S	26° 45' E
14° 32' S	26° 57' E
14° 47' S	26° 57' E
14° 47' S	26° 45' E

2) Detailed Survey Area

a) Bob Zinc Area

The area is located approximately 2km north from the Stable Antelope Deposit in the north-east part of the Karenda Area, and covers an area of 0.1km^2. Big Zinc Deposit is existed in the area.

b) Sable Antelope Area

The area is situated at north-east part of the Karenda Area, and covers an area of 2km^2.

The Sable Antelope Deposit and Blue Jacket mineralized area are emplaced in the area.

c) Kamiyobo Area

The area is located at south part of the Karenda Area. The Kamiyobo mineralized area is present approximately 600m north of the area.

d) other areas

A area (75km^2) and B (4km^2) in deposit-distribution area including a) and b) areas of north part in the Karenda Area.

1-2 The Survey methods and Amount of Work

The survey was conducted for 3 years from 1984 to 1986. The survey methods and the survey amount by year are shown in Fig. 4.

1-3 Survey Period and Survey members

The survey period and the survey members by year are summarized in Table 1.

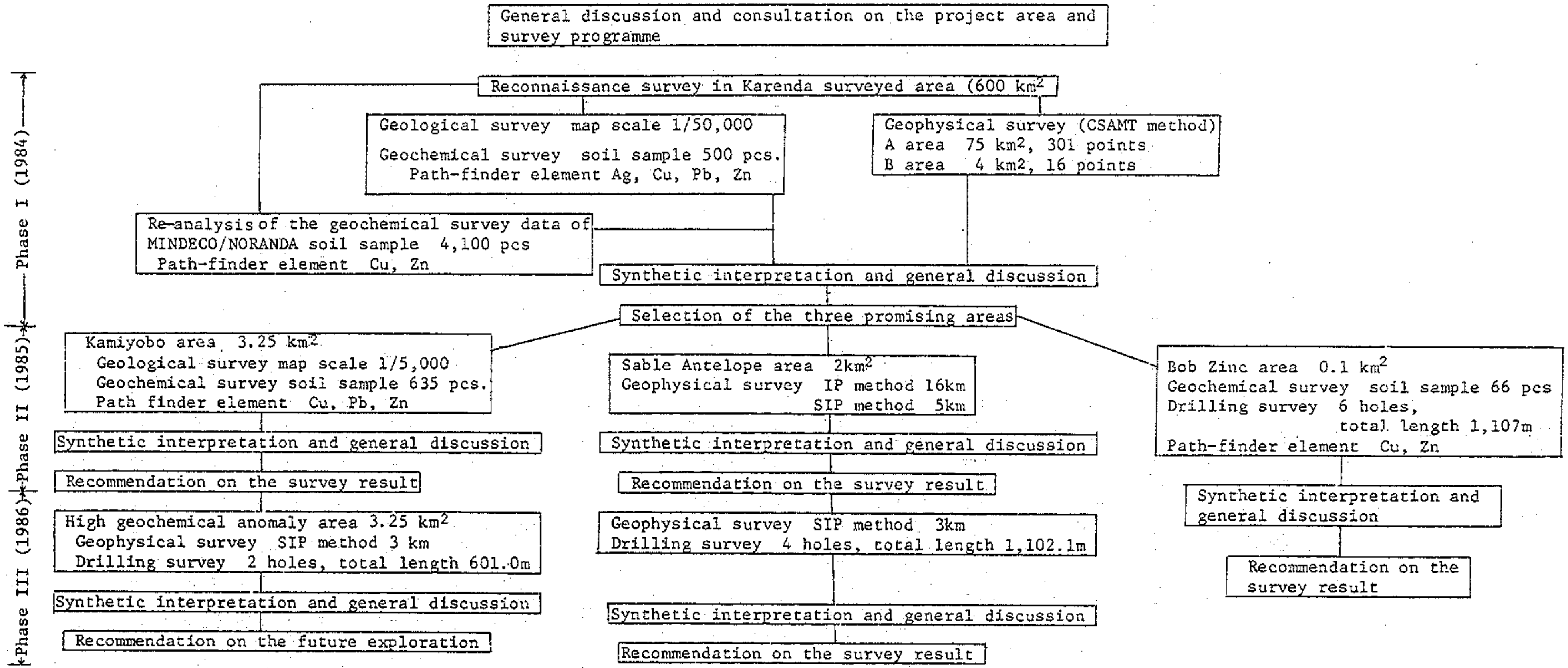

Fig. 4 Flow Sheet of Survey in Karender Area

Table. I Survey Period and Survey Members

Year	Survey	Survey Period	Survey Members: Japan	Survey Members: Zambia
Phase I (1984)	Survey Programing & Negotiation		Ken Nakayama Tadaaki Ezawa	S.N. Punukollu L. Borsch A.S. Sliwa G.R. Rao Elias Mbumba Simasiku Simasiku
	Geological Survey Geochemical Survey	Sep. 9, 1984 Nov. 15, 1984	Hiroyuki Fujioka Tetsuo Sato	
	Geophysical Survey	Aug. 8, 1984 Nov. 15, 1984	Harunobu Sumida Toshiaki Fujimoto Saburo Tachikawa	
Phase II (1985)	Survey Programing & Negotiation		Takahisa Yamamoto Yoshiyuki Kita	S.N. Punukollu L. Borsch W.B. Sikombe A.S. Sliwa G.R. Rao Elias Mbumba
	Geological Survey Geochemical Survey	Jul. 30, 1985 Oct. 29, 1985	Hiroyuki Fujioka	
	Geophysical Survey (CSAMT Method)	Jun. 12, 1985 Aug. 10, 1985	Harunobu Sumida Toshiaki Fujimoto Saburo Tachikawa	
	Drilling Survey	Jul. 30, 1985 Oct. 29, 1985	Yukio Kawamura Mitsuo Sasaki Hiroshi Ishikawa	
Phase (1986)	Survey Programing & Negotiation		Kohei Arakawa Takahisa Yamamoto Yoshiyuki Kita Kenji Sawada	S.N. Punukollu W.B. Sikombe L. Borsch A.S. Sliwa G.R. Rao Elias Mbumba Charles Muyovwe
	Drilling Survey	Jun. 27, 1986 Oct. 31, 1986	Makoto Kitami Yukio Kawamura Mitsuo Sasaki Hidemitsu Itoda	
	Geophysical Survey	Jul. 13, 1986 Aug. 15, 1986	Harunobu Sumida Toshiaki Fujimoto Saburo Tachikawa	

Chapter 2 Outline of the Surveyed Area

2-1 Geography

Topography; The region from Lusaka, Capital City of Zambia, to Karenda Area is relatively flat plateau with altitude ranging from 1,100 to 1,300m. Small hills are sporadically located in the Karenda Area with relative height of 50-200m.

Climate; The climate of the region including Lusaka is classified as Savanna climate. The dry season lasts from May to October, while rain season from November to April. The dry season has cold period (May-August) and hot (September-October). During cold period, the temperature reaches 21°C in the daytime, and drops to 4°C at night in July. October is the hottest time, but it is rare to exceed 35°C. Average annual precipitation is 810-1,020mm.

Vegitation; The region including Lusaka is savanna type vegitation consisting evenly of tall grasses with sporadic growing of small trees.

Access; Mumbwa is located 153km WNW of Lusaka, and can be reached in two hours by car on a paved two-lane road. The southeast corner of the Karenda Area is located 25km NNW from Mumbwa, and the access road from Mumbwa is unpaved. MINEX camp site at the north-east part of the Karenda Area is 25km further north along the above-mentioned road, and it takes about one hour by car from Mumbwa.

The accessible roads by vehicle are very sparse in the Area. There are two main roads in the Area, one branches off from the south-east corner, and extends northward along the eastern border of the Area to Kaindu (Kaindu road), other runs along the western border from the southern end of the Area to Kasempa (Lubungan Pontoon Road). Several branch roads from the main road are accessible only by four-wheel vehicle. During rain season, the road is sometimes inaccessible by car.
The vehicle can run slowly in whole savanna area after cleaning by slushing some trees and bushes.

Population; Several houses gather here and there in the Karenda village. The total population is less than 1,000. Mumbwa, second largest city of the Central Province, is the closest to the Area, and facilities such as bank, hospital, police, hotel, shop, power station, water supply, television broadcast station are there.

Industry; The key industry of Zambia is mining, but the Government is also laying emphasis on agriculture in recent year. Indian corn and cotton are harvested in various parts in the vicinity of the Karenda Area, and national service farms are also working there. Production of charcoal for fuel, hunting and fishing are other industry.

2-2 General Geology and Ore Deposits

The basement rocks of the area are divided into the lower basement rock consisting mainly of granite gneiss and granite-hybrid rocks, and the upper basement rock consisting of metamorphosed argillaceous-arenaceous rocks, quartzite, metacarbonates, and metavolcanics (Fig. 5).

The Pre-Cambrian Katangan System which overlies the basement unconformably is extensively distributed in the central part of the Karenda Area. This System is composed of the Mine Series and Kundelungu Series in the ascending order.

The Mine Series of the area consists mainly of quartzite, arkosic sandstone, shale, and conglomerate. It is stratigraphically lower than the country rocks of the Copper Belt ore deposit.

The rocks of the Kundelungu Series are carbonate and argillaceous-arenaceous metasediments. The carbonates are distributed intermittently in the Kabwe-Mumba-Karenda zone. The argillaceous-arenaceous rocks overlies the carbonates conformably throughout the Area.

The hook granite has intruded the above-mentioned rocks, and is distributed extensively to the west. Also syenites which are the satellite bodies of granite occur in the Karenda area.

The Kabwe (former Broken Hill) Deposit is only been operating in the Karenda Area. The geology near the Deposit consists of massive carbonates, bedded carbonates and metasediments in ascending order. The ores are embedded filling and replacing a part of the brecciated zone within the massive carbonates, and the major ore minerals are sphalerite accompanied by significant amount of copper mineral, mainly chalcopyrite. Willemite and zinc carbonate are also present.

Since the Kabwe Deposit is similar type to the Sable Antelope in the Karenda area, the zone of Kabwe-Karenda has been noted a target zone for lead-zinc exploration for many years.

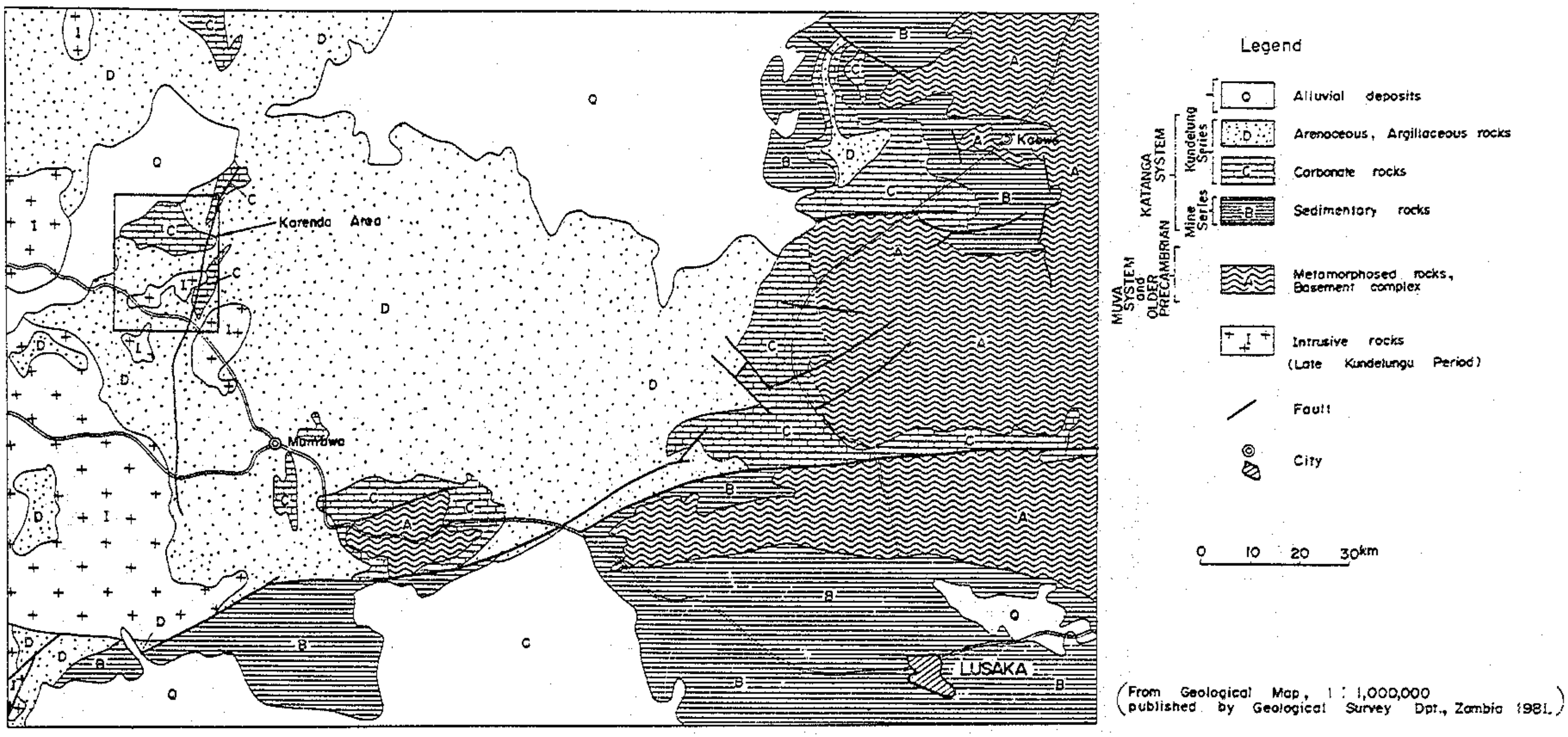

Fig. 5 Generalized Geological Map of the Area between Karenda and Kabwe

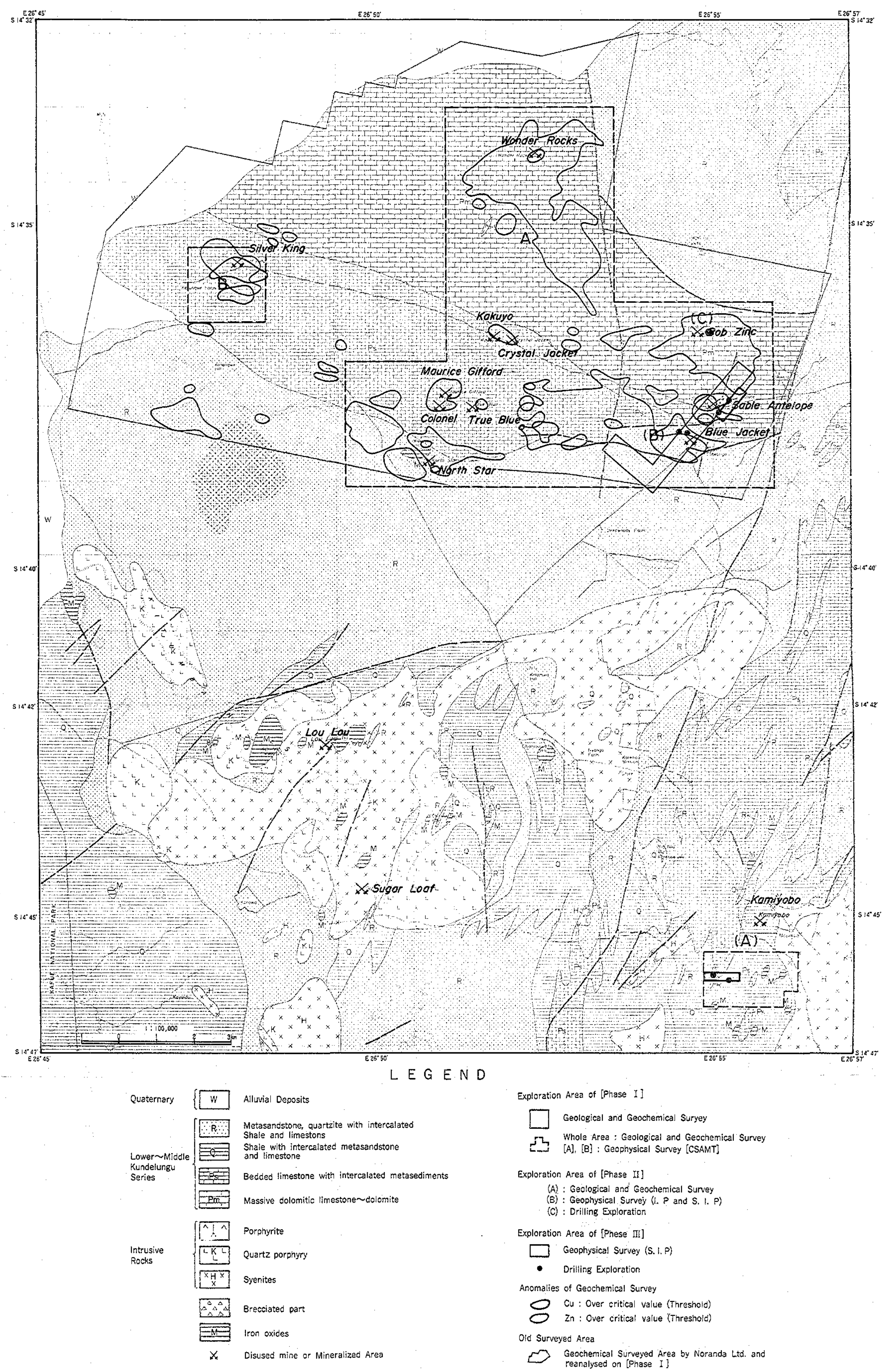

Fig. 6 Exploration Map of Karenda Area

PART Ⅱ

RESULT OF THE SURVEY IN THE KARENDA AREA

Part II Result of the Survey in the Karenda Area

1 General Geology

Outline of geology

The geology of the Karenda area consists of carbonates, argillaceous-arenaceous metasediments intruded by syenite, quarts porphyry and porphyrite, and alluvial sediments.

1-1 Stratigraphy

The geological map of the Karenda area is laid out in Fig. 7, and stratigraphy and the igneous activity in Fig. 8.

1-1-1 Carbonates

The carbonate rocks of the area are divided into the lower massive dolomite and the dolomite limestone, and the upper bedded limestone. The lower massive dolomite is widely distributed in the Sable Antelope to Wonder Rocks in the northern part of the Karenda area. The upper bedded limestone is distributed in the Silver King to Crystal Jacket in the northern part, and intermittently with north-south trend in the eastern part of the Karenda area.

The lower massive dolomite and the dolomite limestone occur together, and there are no clear boundaries. They both show white, grey, pale red color, and are medium to coarse-grained. Some rocks are recrystalline. The rocks in the mineralized zone are partly brecciated, sideritic, yellow-brown in color, and are hardened by silicification.

Metasandstones and shales of several millimeters in thickness are often intercalated in the upper bedded limestone. Limestone is grey to dark grey and fine-grained. Metasediments and shale are reddish brown, and they are either calcareous or siliceous. The metasandstone is fine-grained. The weathered surfaces of the bedded limestone show sea weed-like and banded texture, but the fresh rocks are homogenous, and have no pattern or texture on their surface. Pattern on the weathered surface are not along with any trends and bedding.

The bedded limestones are partly brecciated, sideritic yellow-brown in color, and hardened.

1-1-2 Agrillaceous-Arenaceous Metasediments

These rocks overlie the bedded limestone conformably and are distributed widely in the Karenda area except the north-eastern part. Argillaceous metasediments are predominant in the north, while both occur in similar amounts in the south part. The two rock units occur as alternations and also interfinger with each other. The argillaceous metasediments in the north contain more intercalation of arenaceous metasediments than the metasediments in the south.

The major constituents of the arenaceous metasediments are metasandstone, and quartzite with thin intercalations of limestone in the lower parts.

The argillaceous metasediments are composed mainly of shale, metamudstone and metasiltstone with thin intercalated beds of metasandstone.

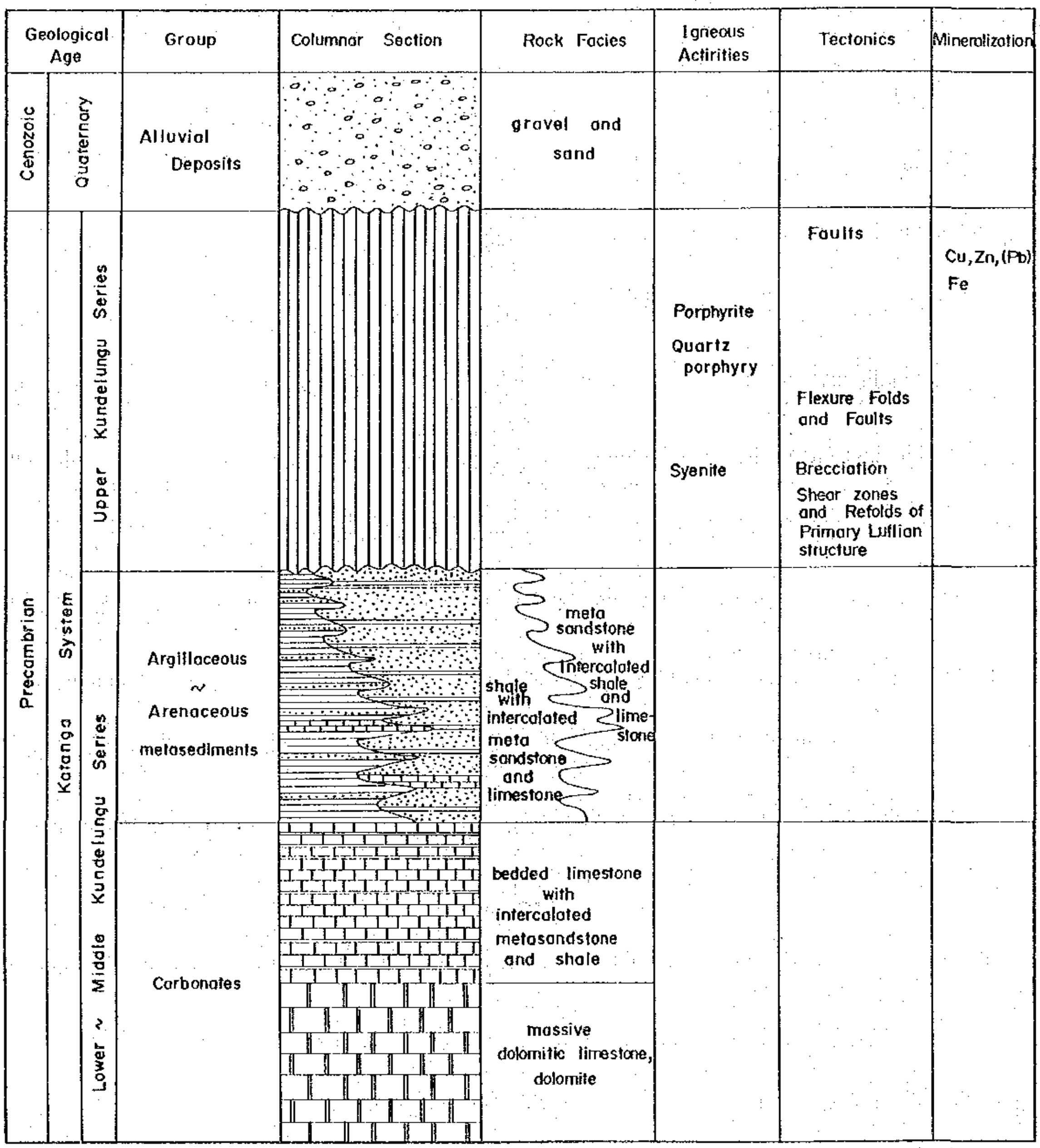

Fig. 8 Generalized Geological Column of Karenda Area

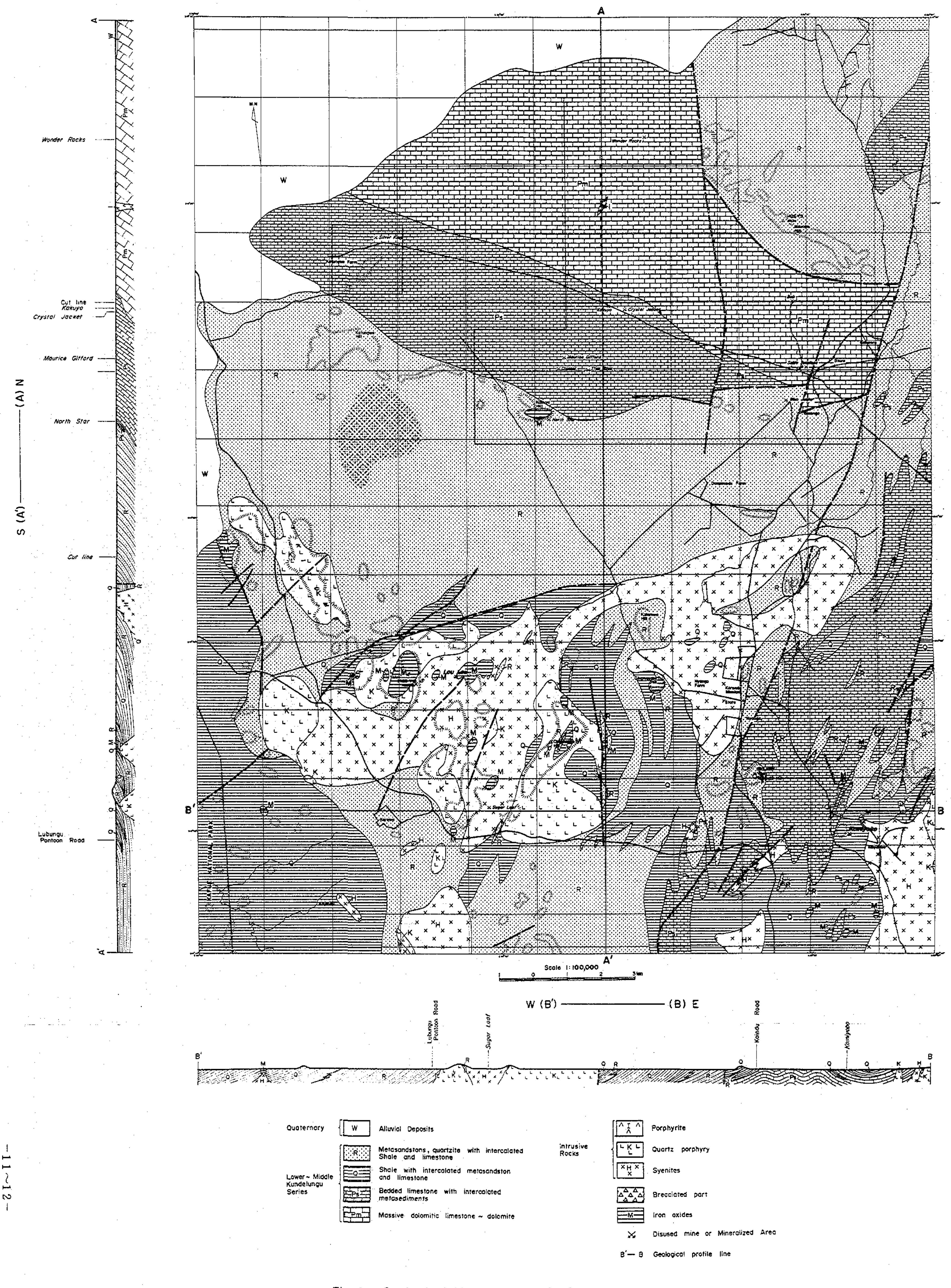

Fig. 7 Geological Map of Karenda Area

1-2 Intrusive Rocks

The intrusive rocks of the Karenda area are of syenite, quartz porphyry, and porphyrite.

1-2-1 Syenites

Syenites occur intruding the bedded limestone and argillaceous-arenaceous metasediments in the southern part of the Karenda Area. They seem to be large bodies. The detailed lithologic variation of the rock is not clear owing to strong weathered alteration, but it varies considerably such as syenite porphyry, quarts syenite porphyry, quartz diorite, diorite and monzonite.

1-2-2 Quartz Porphyry

Quartz porphyry occurs intruding the bedded limestones, *argillaceous-arenaceous metasediments and syenites in the southern* part of the Karenda Area.

1-2-3 Porphyrite

There is only one occurrence of porphyrite observed in Wonder Rocks in the north part of the Karenda Area. There, porphyrite intrudes massive dolomite as small dyke of 1 - 2m in width.

1-3 Geologic Structure

The geologic structure of the area is controlled by major faults of E-W and N-S systems, and this area is divided into three major blocks by these faults. E-W faults are cut by N-S faults.

The geologic units of the Eastern Block strike N-S, and are often folded with 50°-60° E or W dip.

Those of Northern Block strike E-W, with 30°-40° S dip in a monoclinic.

The bedding of the rock of the Southern Block is unclear, because of the weathering and intrusion of igneous bodies, but it is inferred from the distribution of the beds that they strike N-S and dip westward.

Brecciated structures occur frequently in the Northern Block. The mineralized zones in these carbonate area are all emplaced in these brecciated zones.

1-4 Mineralization

Mineralization found in the Karenda area are silver, copper, (lead), iron and phosphorous ore, but in the present survey, work was done mainly on silver, copper, lead, and zinc deposits. Mineral showings were found in the following 14 locality.

Of those showing, Sable Antelope, Silver King, and Crystal Jacket were mined. Prospecting including drilling were conducted at Bob Zinc, Wonder Rocks, Sugar Loaf and Lou Lou. Geological prospecting including geochemical survey, pitting and trenching works was carried out for other showings. Most of these mining and prospecting, however, were done many years back, and the presently available data are not sufficient for clarifing the details of mineralization. The silver, copper, (lead), zinc mineralization are generally embedded in brecciated fractured zones in massive carbonates, bedded carbonates, arenaceous metasediments, and syenites, forming pipe, lens and fissure-filling. Also alteration associated with the mineralizations is silicification.

The outcropes mainly consist of iron oxides and copper oxides. The lumped ores of the old mines are sulfides such as chalcopyrite, bornite, chalcopyrite, tennantite, and pyrite. Willemite is also found in drill cores.

Geological Block	Name of the Mineralized Area	Components	Mineralized Place
Northern B.	Sable Antelope	Ag, Cu, Zn	Brecciated Part in Massive Carbonates
〃	Bob Zinc	Ag, Zn	
〃	Wonder Rocks	Ag, Cu, Zn, Fe	
〃	Silver King	Ag, Cu, Fe	Brecciated Part in Bedded Carbonates
〃	Crystal Jacket	Ag, Cu	
〃	Kakuyo	Ag, Cu	
〃	Maurice Gifford	Ag, Cu	
〃	Colonel	Ag, Cu	
〃	True Blue	Ag, Cu	
〃	Blue Jacket	Ag, Cu	Fracture in Metasandstone
〃	North Star	Ag, Cu	
Eastern B.	Kamiyobo	Ag, Cu, Fe	Fracture in Shale
Southern B.	Sugar Loaf	Ag, Cu, Fe, P	Fracture in Syenites
	Lou Lou	Ag, Cu, Fe, P	

1-5 Previous Work

The area has been known as the "Big Concession", and geological survey and prospecting have been conducted since fairly older times. The first mining right was granted in 1895, and at that time the mineralization zones of Sable Antelope, Silver King, Crystal Jacket and others were already known. The production of Sable Antelope, and Silver King began in 1906 and continued until 1923.

Copper and Silver Production from the Big Concession

(after Brandt (1955) and Bishopp (1932))

Year	Copper (tons)	Silver (kg)
1911 - 12	2,646	-
1914	43	85.8
1915	192	354.4
1916	187	273.7
1917	130	136.8
1918	108	71.5
1919	204	273.2
1920	117	202.4
1921	206	300.1
1922	182	248.9
1923	139	223.2
1925	10	-
Total	4,164	2,169.9
Grand Total	4,230	2,170

Since 1955, prospectings and surveys has been conducted by Mineral Search for Africa (pty) (Rio Tint Zinc), United Nation during 1971-1972, NCC Broken Hill at 1975, MINDECO/NORANDA in 1977. At present, MINEX of ZIMCO is conducting detailed geological survey at Sable Antelope, detailed geological, geochemical surveys and trenching and pitting prospecting at Lou Lou and Sugar Loaf for phosphorus ore.

2 Geochemical Survey

2-1 Geochemical Survey on soil

2-1-1 Sampling

Sampling was conducted throughout the area with exception of the carbonates area in the northern part where detailed geochemical data have been obtained by MINDECO/NORANDA and the northwestern margin where thick alluvium covers the geologic units.

2-1-2 Indicator Element

On the basis of the characteristics of the mineralization known in the Karenda area, four elements, namely Cu, Pb, Zu and Ag were used as indicator element.

2-1-3 Statistical Treatment of Data

Very good correlation is observed between copper, lead and zinc, particularly high correlation exists for Pb-Zn and followed by Cu-Pb, and Cu-Zn. Silver was excluded from statistical process, because silver values over 1ppm are regarded as anomaly. Coefficient of correlation between elements is shown as follows.

Rock Unit	Amount of Samples	Elements	Coefficient of correlations
Argillaceous -Arenaceous metasediments	327	Cu-Zn Cu-Pb Pb-Zn	.695940 .766132 .861135
Carbonates	74	Cu-Zn Cu-Pb Pb-Zn	.338802 .573899 .624339
Intrusives	99	Cu-Zn Cu-Pb Pb-Zn	.445525 .563532 .756473

The analitical values were all converted into logarithmic values, and the mean value (M) and standard deviation were calculated as follows.

Rock Unit	Amount of Samples	Element	Mean(M)	Standard deviation(σ)
Argillaceous -Arenaceous metasediments	327	Cu Pb Zn	34 24 20	.479417 .231199 .349456
Carbonates	74	Cu Pb Zn	38 27 37	.266944 .167414 .333302
Intrusives	99	Cu Pb Zn	62 27 21	.433765 .146957 .325906
All unit	500	Cu Pb Zn	39 25 22	.455848 .210091 .354404

2-1-4 Determination of Anomalies

M+ , M+2 calculated from mean value (M) and standard deviation (t), and threshold reading from cumulative distribution curve for each lithologic unit are as follows.

Threshold values (t) of each lithologic unit were used as the minimum anomalies.

Rock Unit	Element	M+σ	M+2σ	Threshold Value(t)
Argillaceous -Arenaceous metasediments	Cu Pb Zn	105 40 45	317 69 102	305 73 90
Carbonates	Cu Pb Zn	71 40 80	132 60 173	137 62 185
Intrusives	Cu Pb Zn	169 38 46	460 53 98	395 49 62
All units	Cu Pb Zn	113 40 51	324 66 115	300 70 137

2-1-5 Extraction of anomalous zones

The anomalous zones extracted by equal anomaly line based on above-mentioned anomalous values and evaluation of these zones are shown in Fig. 9 and Table 2.

Anomalous zone in this case are defined as zones of anomalies of two or more elements or those which contained more than two anomalies.

The anomalies and anomalous zones extracted show some localization for each element. Namely the Cu anomalies are found in intrusives, Pb and Zn anomalies in the intrusives of the central part also in the direction of carbonate distribution. Ag anomalies are found over-lapping the zone of the other elements.

In these anomalous zones, Zn-Pb anomalous zone near Kamiyobo mineralization and Zn anomalous zone at west of Kamiyobo mineralization were evaluated as Rank A.

2-2 Re-analyze of existing Geochemical Data

Geochemical survey was conducted by MINDECO/NORANDA traversing interval distance of 400m between survey lines and sampling interval of 100m along the survey lines in the Karenda Area, and further detailed geochemical survey was conducted in the anomalous zone extracted along 100m traverse interval and 50m sampling interval. These data were re-processed by same method reported in above-mentioned data process. The results are

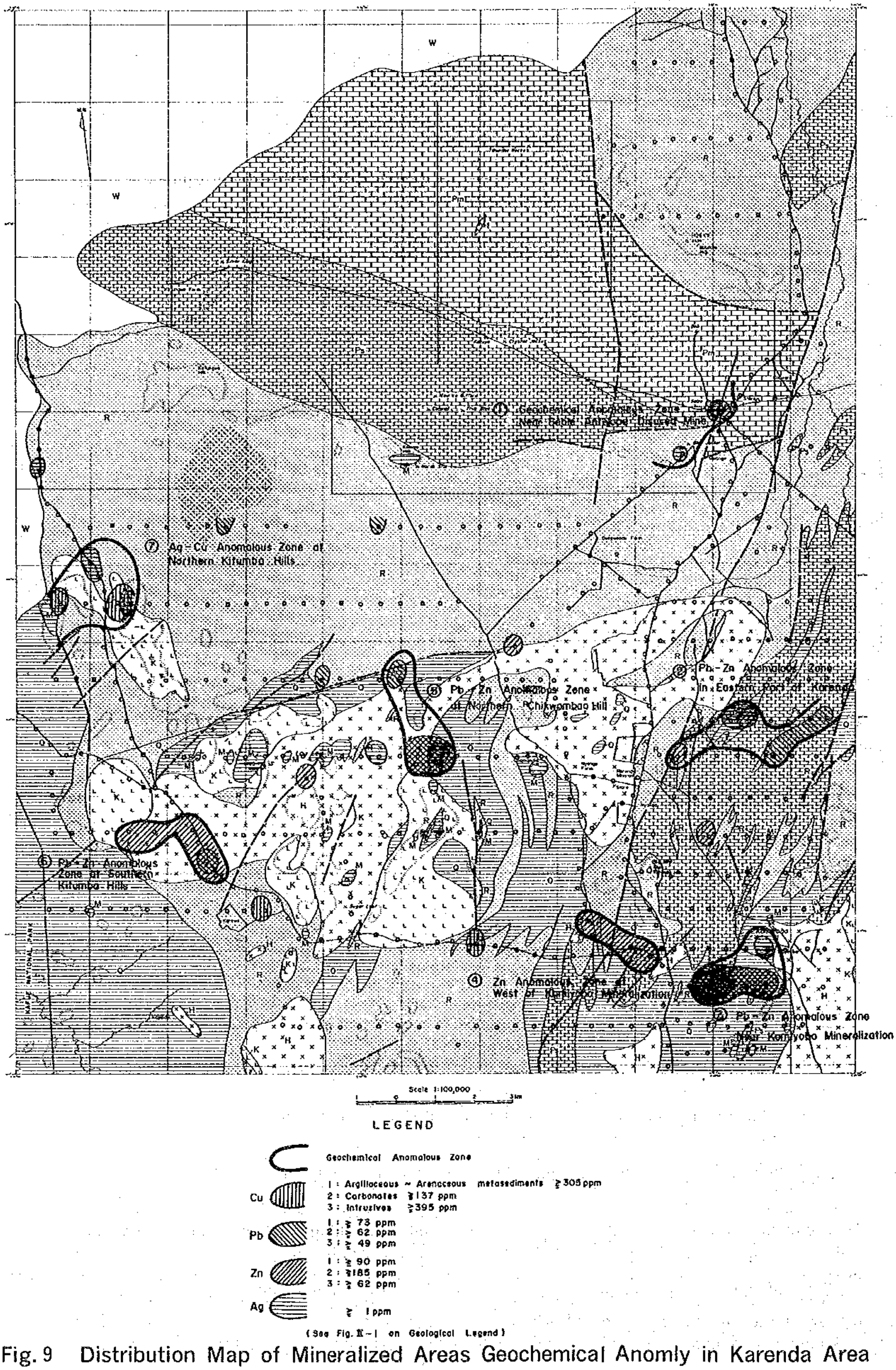

Fig. 9 Distribution Map of Mineralized Areas Geochemical Anomly in Karenda Area

Table. 2 The List of Geochemical Anomalous Zones in Karenda Area

No.	Anomalous Zone	Amounts of over Critical value(t)		Maximum value (ppm)	Extension of anomalous zone(km)		Rock unit	Evaluation
		element	≥t		High anomalous zone	Whole zone		
1	Geochemical Anomalous Zone Near Sable Antelope Disused Mine	Cu	-	(230)	-	1.0×0.5	Pm, Ps	-
		Pb	-	(59)	-			
		Zn	1	222	0.5×0.5			
		Ag	2	1	0.5×1.0			
2	Pb-Zn Anomalous Zone in Eastern Part of Karenda	Cu	-	(100)	-	2.0×4.0	Ps	B
		Pb	2	85	2.0×0.5			
		Zn	2	212	0.5×0.5			
		Ag	2	1	0.5×0.5			
3	Pb-Zn Anomalous Zone Near Kamiyobo Mineralization	Cu	-	(290)	-	1.5×2.0	Q, Ps	A
		Pb	3	253	1.0×2.0			
		Zn	3	523	1.0×2.0			
		Ag	3	1	0.5×0.5			
4	Zn Anomalous Zone at West of Kamiyobo Mineralization	Cu	-	(110)	-	0.5×2.0	Q, R	A
		Pb	-	(56)	-			
		Zn	3	147	0.5×2.0			
		Ag	-	1	-			
5	Pb-Zn Anomalous Zone at Northern Chikwamba Hill	Cu	-	(173)	-	3.5×1.0	Q,R, H	B
		Pb	3	90	1.0×1.0			
		Zn	2	197	1.0×1.0			
		Ag	1	1	0.5×0.5			
6	Pb-Zn Anomalous Zone at Southern Kitumba Hill	Cu	-	(260)	-	1.5×2.0	H,K	B
		Pb	1	77	0.5×0.5			
		Zn	6	181	1.5×2.0			
		Ag	-	1	-			
7	Ag-Cu Anomalous Zone at Northern Kitumba Hill	Cu	3	670	0.5×0.5	2.0×2.0	K,R	B
		Pb	-	69	-			
		Zn	-	140	-			
		Ag	3	2	0.5×0.5			

( ): less than critical value
* A: *detailed geochemical survey necessary*
B: to be studied after the results of A

shown in Table 3. Geochemical anomalous zones extracted based on the values are shown in Fig. 9 and also similar map for Bob zinc mineralized zone based on Zn values are laid out in Fig. 12.

From these two maps, Cu anomalous zones coincides with emplacement of ore deposits, mineralized zones and showings. Cu anomalous zone extends continuously in N70°-80° W direction from Sable Antelope Deposit and Blue Jacket mineralized zone to Silver King Deposit via Kakuyo-Crystal Jacket, Mourice Gifford, Colonel, North Star mineralized zone, and it also shows harmonious distribution along with geological structure.

The Zn anomalous zones show good continuity in E-W direction, distributing in harmony with boundary of carbonate and argilaceous-arenaceous metasediments.

An independent anomalies of Wonder Rocks is existed trending mainly in N80 E direction with minor elongation in N20° W direction. At the Bob Zinc mineralized zone, an anomalous zone extends mainly in N70 W with the addition of N-S direction continuing from Sable Antelope mineralized zones.

The re-studying indicates that 2 anomalous zones of Bob Zinc Area are most promising.

3 Geophysical Survey (CSAMT method)

3-1 Survey Area and Survey Method

Geophysical survey with the CSAMT method in the first year was conducted over two areas. The area A covers 75 km^2 in the periphery of Sable Antelope mine, and the area B covers 4 km^2 in the vicinity of Silver King mine (Fig. 6). These mines are not in operation, and details of lithological distribution, geological structure and occurrence of ore deposits or zones of mineralization are not known. Due to a broad distribution of highly resistive limestones, the CSAMT method was applied to extract a zone of low resistivity and to delineate its property.

Survey points were set on the grids of 400m intervals in an east-west direction and 600m separations in a north-south direction, comprising 301 points in the area A and 16 points in the area B. Frequencies employed are of 2048, 1024, 512, 256, 128, 64, 32, 16, 8 and 4 Hz. Obtained data are shown in the following figures.

(1) Plans of apparent resistivity (AR) at 10 frequencies from 2,048 to 4 Hz.
(2) Sections of apparent resistivity and of resistivity (Sections No. 1 to No. 11).
(3) Plans of resistivity at depths of 0, -100, -200, -300 and -400m.

3-2 Survey Results and Analysis

The AR at 2,048 Hz (Fig. 10) ranges broadly from 10 to 20,000 ohm-m, characteristically indicating a large contrast in resistivity. High values of AR more than 1,000 ohm-m are wide-spread almost over an entire area of A and low values of AR less than 100 ohm-m are only seen in the south-eastern parts of the area.

In general, AR is high in a field of limestones and low in a field of meta-sandstones or shales. A contour line of 1000 ohm-m runs approximately on a boundary between an area of limestones and an area of meta-sandstones and shales.

Table.3 Statistical Date of Geochemical Samples in Northern Part of the Surveyed Area

		Class	Frequency	Cumulative frequency
Cu	1	14000.00000 - 8247.40000	1(0.02%)	1(0.02%)
	2	8247.40000 - 4858.55000	1(0.02%)	2(0.05%)
	3	4858.55000 - 2862.17000	0(0.00%)	2(0.05%)
	4	2862.17000 - 1686.11000	0(0.00%)	2(0.05%)
	5	1686.11000 - 993.28900	8(0.19%)	10(0.24%)
	6	993.28900 - 585.14700	22(0.54%)	32(0.78%)
	7	585.14700 - 344.71000	34(0.83%)	66(1.61%)
	8	344.71000 - 203.06900	135(3.28%)	201(4.89%)
	9	203.06900 - 119.62800	397(9.66%)	598(14.55%)
	10	119.62800 - 70.47300	551(13.41%)	1149(27.96%)
	11	70.47300 - 41.51570	868(21.12%)	2017(49.08%)
	12	41.51570 - 24.45690	1201(29.22%)	3218(78.30%)
	13	24.45690 - 14.40760	650(15.82%)	3868(94.11%)
	14	14.40760 - 8.48752	175(4.26%)	4043(98.37%)
	15	8.48752 - 5.00001	67(1.63%)	4110(100.00%)
Zn	1	12000.00000 - 7142.23000	2(0.05%)	2(0.05%)
	2	7142.23000 - 4250.95000	0(0.00%)	2(0.05%)
	3	4250.95000 - 2530.10000	2(0.05%)	4(0.10%)
	4	2530.10000 - 1505.88000	2(0.05%)	6(0.15%)
	5	1505.88000 - 896.28000	24(0.58%)	30(0.73%)
	6	896.28000 - 533.45300	57(1.39%)	87(2.12%)
	7	533.45300 - 317.50400	112(2.73%)	199(4.84%)
	8	317.50400 - 188.97400	174(4.23%)	373(9.08%)
	9	188.97400 - 112.47400	392(9.54%)	765(18.61%)
	10	112.47400 - 66.94310	799(19.44%)	1564(38.05%)
	11	66.94310 - 39.84360	1161(28.25%)	2725(66.30%)
	12	39.84360 - 23.71440	633(15.40%)	3358(81.70%)
	13	23.71440 - 14.11450	528(12.85%)	3886(94.55%)
	14	14.11450 - 8.40072	195(4.74%)	4031(99.29%)
	15	8.40072 - 4.99999	29(0.71%)	4110(100.00%)

Element	Population	Maximum value	Minimum value	Mean(M)	Standard deviation (σ)	M+σ	M+2σ	M+3σ	Threshold value (t)
Cu	4110	ppm 14000	ppm 5	44	.38771	109	266	650	250
Zn	4110	ppm 12000	ppm 5	54	.415258	140	366	953	129

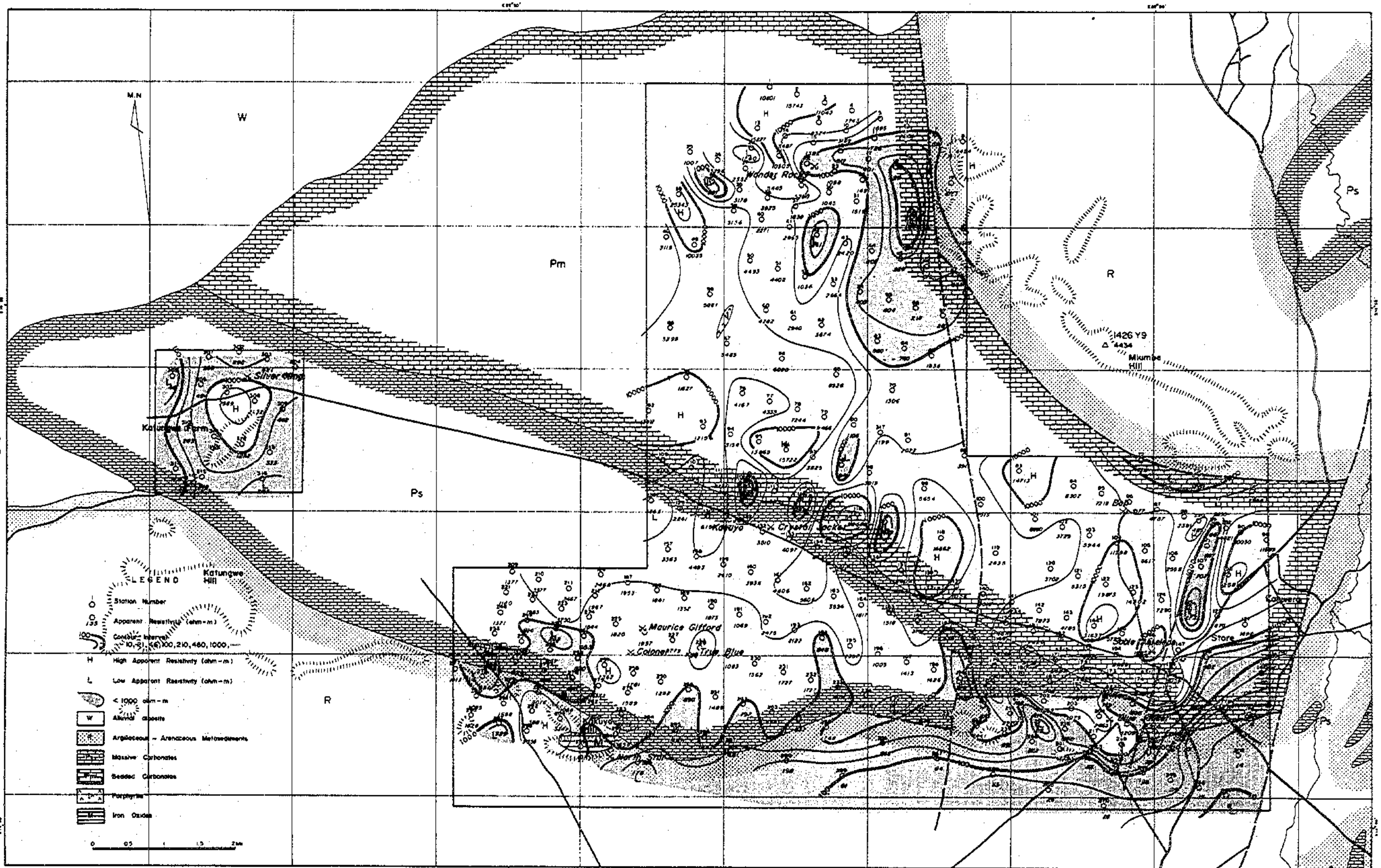

Fig.10 Apparent Resistivity Map(2048Hz)

Zones of low resistivity delineated by analysis are listed in Table 4. The resistivity in these zones ranges from 30 to 100 ohm-m in limestones and from 0.2 to 100 ohm-m in meta-sandstones and shales. Resistivity in ore deposits is considered, in general, to be less than 10 ohm-m in massive sulphide deposits and less than 100 ohm-m in disseminated deposits. From the zones in Table 4, zones of less than 100 ohm-m in the field of high background values in limestones and zones of less than 10 ohm-m in the field of low background values in meta-sandstones and shales were extracted as anomalous zones in resistivity and were given in Table 5. From these data, the following areas of geophysical anomalies were considered to be followed by investigations from next year onward (Fig. 11).

Table. 4 The List of CSAMT Anomalies

Station No.	Section No.	Resistivity (ohm-m)	Depth (m)
32	5	35	0 to 61
		6	61 to 91
42	5	99	79 to 143
112	3	85	119 to 196
114	3, 7	33	177 to 207
125	3, 13	93	0 to 42
		37	more than 459
178	8	1	44 to 55
215	10	0.3	126 to 242
242	11	0.2	95 to 125

(1) East and southeast of the area A covering points 125, 215 and 242, Sable Antelope, Blue Jacket and Bob Zinc.
(2) Central part of the area A covering points 58, 112 and 114, Crystal Jacket and Kakuyo.
(3) Northern part of the area A covering points 32 and 42 and Wonder Rocks.

The geophysical survey in the second year were conducted over the areas at the east and southeast of A.

Table. 5 List of Low Resistivity Zone

Type	Area	Station No.	Geology
Deep Fractured Zone	North-east of Sable Antelope	71,89,107,125	Massive Limestone
	East of Crystal Jacket	117	Massive Limestone
	South-west of Blue Jacket	242	Metasandstone, ahale
	1 Km West of Blue Jacket	215	Metasandstone, shale
	2 Km West of Blue Jacket	199	Bedded Limestone
	South-eastern part of A area	206,219,244	Metasandstone, shale
Low Resistivity Zone (1,000 > >100 ohm-m)	East and West of Wonder Rocks	16,17,18,22,34	Massive Limestone
	North-east of Crystal Jacket	58	Massive Limestone
	West of Colonel	255,256,etc.	Bedded Limestone
	North of Blue Jacket	183,184	Metasandstone, shale
	2 Km South-south-east of Crystal Jacket	194,233	Bedded Limestone
	South of True Blue	260,262	bedded Limestone
	North-east of Bob Zinc	72,73	Massive Limestone
Low Resistivity Zone (100 > >10 ohm-m)	South and South-east of Wonder Rocks	32,42	Massive Limestone
	North-west of Crystal Jacket	112	Massive Limestone
	North-east of Crystal Jacket	114	Massive Limestone
	East of Crystal Jacket	117	Massive Limestone
	North-east of Sable Antelope	89,107,125	Massive Limestone
	South-eastern Part of A area	177,207,208,245,246	Metasandstone, shale
Low Resistivity Zone (< 10 ohm-m)	1 Km West of Blue Jacket	215	Metasandstone, shale
	South-west of Blue Jacket	244	Metasandstone, shale
	South-eastern Part of A area	178,208,247	Metasandstone, shale
	Southern Part of A area	266,267,268,269,270	Metasandstone, shale
	Western Part of B area	305,310,315	Bedded Limestone

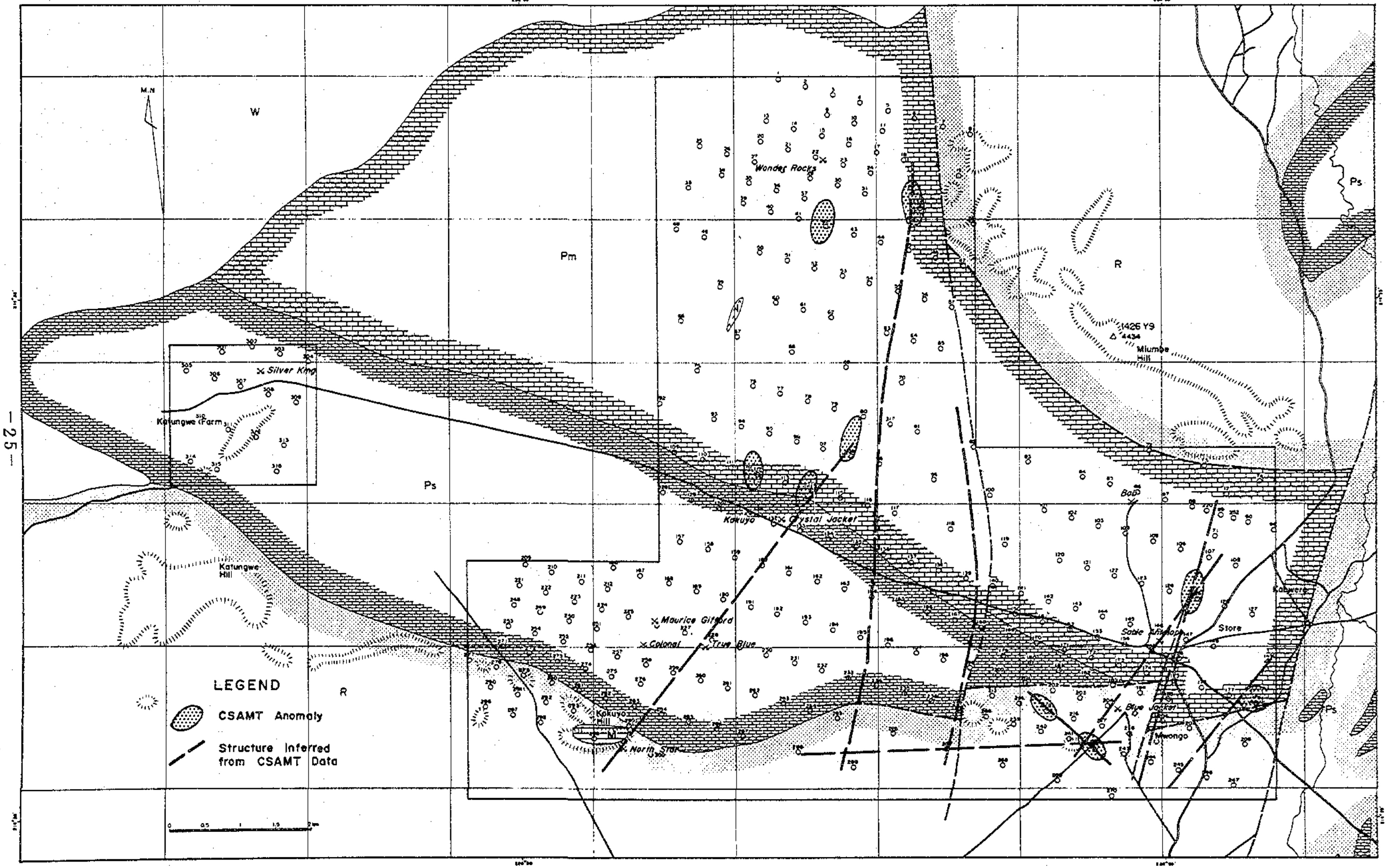

Fig.11 CSAMT Interpretation Map

PART Ⅲ

RESULTS OF THE DETAILED SURVEY AREA

Part III Results of the Detailed Survey Area

Chapter 1 Bob Zinc Area

1-1 Geology and Mineralization

The geology of this area consists of massive dolomite-dolomite limestone belonging to the lower part of the carbonate rocks. The rocks have been recrystallized into marble or saccharoidal limestone in some parts.

The Bob Zinc deposit and east part from the deposit are emplaced in the brecciated and fractured zone (Fig. 12).

The brecciation is strong in the central part, while weak sideritization is observed in the visinity of the brecciated dolomite. The strong sideritized parts are independently located in the Bob Zinc deposit area and the geochemical anomalies to the east. The former is approximately 300m x 200m in scale, while the latter approximately 250m x 150m in scale. The strongly sideritized zone extends in E-W direction pararelling to the strike of the Bob Zinc Deposit.

A total of 18 holes were drilled in 1957 and 1964. Of these drilling, 8 holes have reached the Bob zinc ore Body. It was reported on the basis of these works, that this was a bedded ore body consisting or zinc silicate ores. The Deposit is estimated reserves of 305,000t at an average grade of 164g/t Ag and 11.6% Zn on the basis of strike length of 109m, average thickness of 12m and depth to 106m.

Strike of the Bob Zinc Deposit is approximately E-W with 70-80m at surface 80-100m at 50m depth, width of 10-20m shooting to ESE. The deposit becomes a pipe form with maximum diameter of 30m in maximum diameter at 80m depth according to the drilling data.

1-2 Geochemical Survey

The results of the geochemical detailed survey and the shallow percussion drilling conducted by MINDECO/NORANDA in 1977 were re-interpreted during the first year. In the result, Zn high anomaly zones are located well harmonizing with the Bob Zinc Deposit. An Zn-anomaly zone with similar formed distribution was found as the result of the geochemical survey newly taking sample of 66 soils at the east of Bob Zinc Deposit. The anomaly area was recommended for drilling survey.

Cu, Pb, B, Ni, Zn, Ag, Cr, Co, V, Mn, Ti were detected by spectrometry of the soil (laterite) samples of this area. Of those elements, Cu, Ni, Cr, Co, Mn, Ti were richer in soil than in the drill core samples of the mineralized zone.

1-3 Drilling Survey

1-3-1 Purpose and Amount Conducted

The drilling was carried out to confirm deep part of the mineralization suggested by high Zn-anomaly area locating east of the Bob Zinc Deposit.

The drill locations are shown in Fig. 12, geological section of drilling Fig. 13.

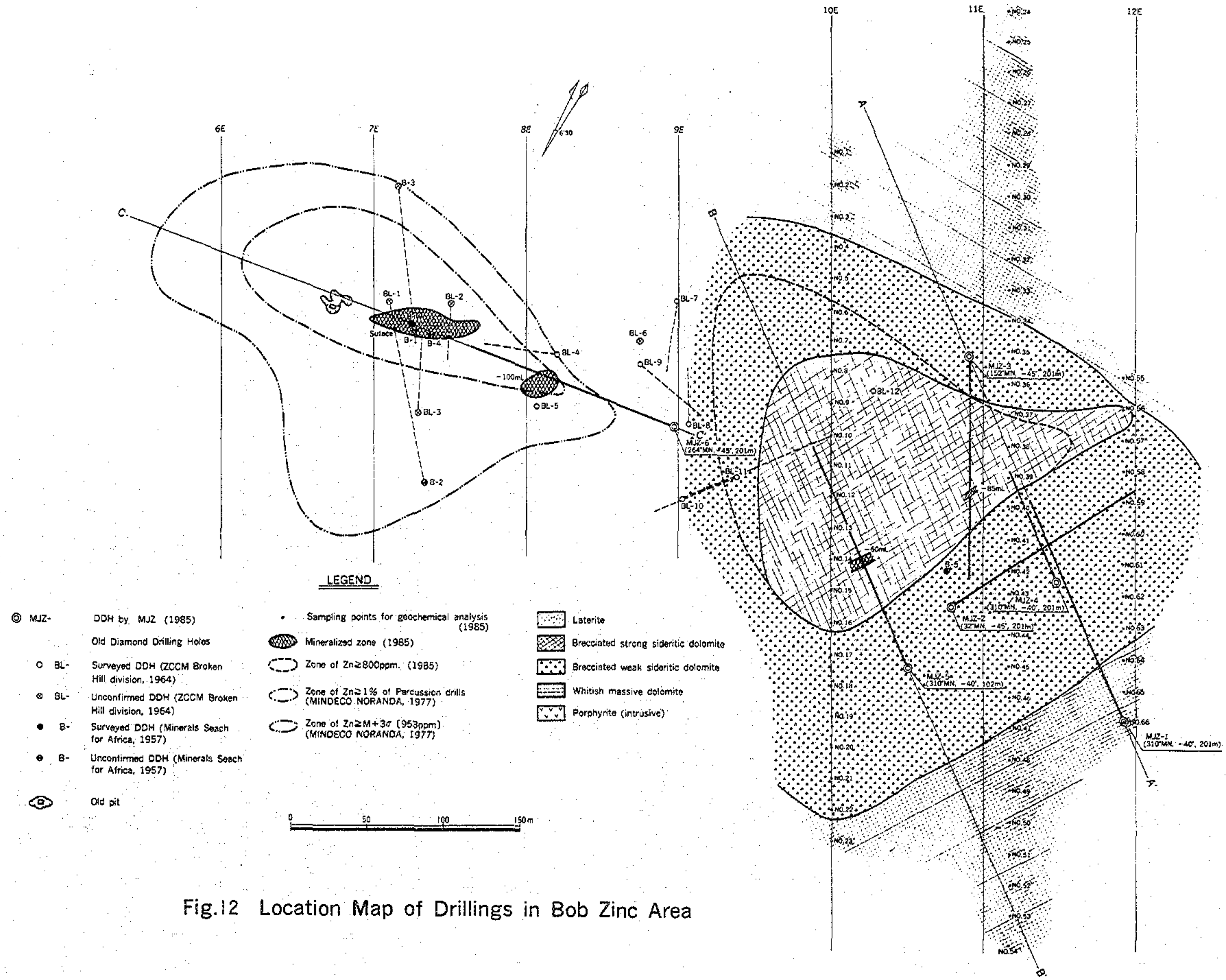

Fig.12 Location Map of Drillings in Bob Zinc Area

1-3-2 Survey Period and Survey Amount

The drilling survey was conducted in second phase. Each drilling period and drilling depth are as follows.

Drill Hole No.	Depth (m)	Inclination	Bearing (M.N)	Depth of Laterite (m)	Length of Core (m)	Core recovery (%)	Term		Exploration Target
							Starting	Completion	
MJZ-1	201.0	-40°	N50°W	11.5	186.9	98.6	24 Aug.	1 Sep.	East Zinc Geochemical Anomaly
MJZ-2	201.0	-45°	N32°E	14.0	183.0	97.9	5 Sep.	9 Sep.	Ditto
MJZ-3	201.0	-45°	S28°E	27.6	170.6	98.4	16 Sep.	21 Sep.	Ditto
MJZ-4	102.0	-40°	N50°W	14.8	85.9	95.5	8 Oct.	12 Oct.	Ditto
MJZ-5	201.0	-40°	N50°W	23.3	175.6	98.8	15 Oct.	22 Oct.	Ditto
MJZ-6	201.0	-45°	S84°W	20.0	176.3	97.4	27 Sep.	4 Oct.	Ditto

$$\text{Core Recovery} = \frac{\text{Length of Core}}{\text{Depth - Depth of Laterite}} \times 100$$

1-3-3 Relationship among geology, geological structure and mineralization

Zinc mineralizations have been found in MJZ-5 and MJZ-6 holes as follows:

Hole	depth(m)	Width(m)	Zn(%)
MJZ-5	91.90- 98.50	6.60m	0.81
	91.90- 93.3m	1.40	0.58 (highest grade)
MJZ-6	124.60-137.30	12.7	1.65
	134.30-137.30	0.60	5.97 (highest grade)

The former mineralization is located 60m below from the surface, and the latter 100m below from the surface. The latter mineralization improves in shallower parts according to old drilling data. Thus it is possible that the former mineralization in shallower part might be also better than ore of the depth at MJI-5, but the size of the ore body seems to be not promising.

Ore minerals are mainly secondary smithonite and willemite. Minute grains of pyrite and chalcopyrite are observed microscopically as remnant minerals.

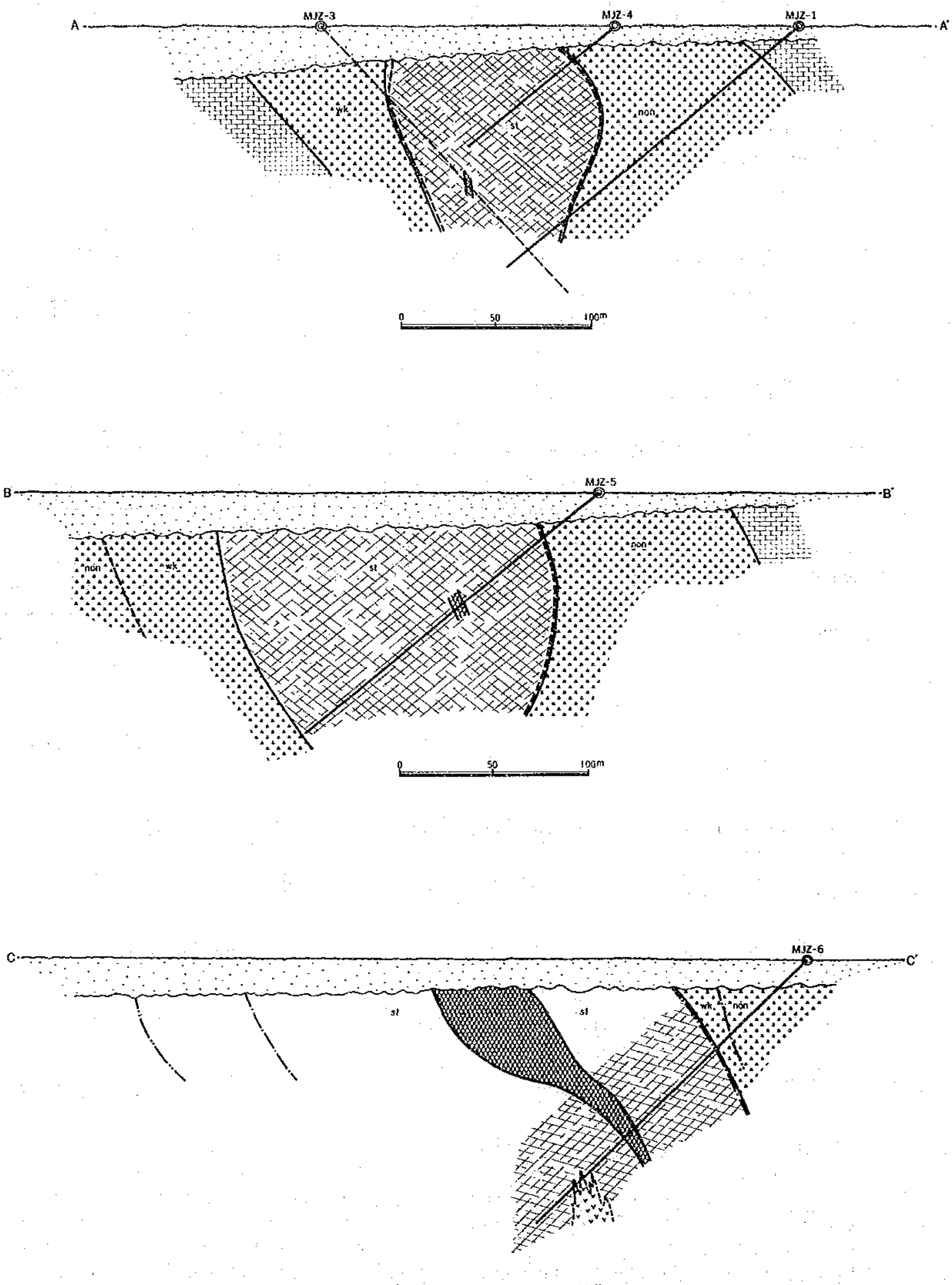

Fig.13 Geologicl Section in Bob Zinc Area

Secondary zinc minerals are concentrated in the weathered parts of the fractured zones, and also several thousand ppm of Zn is frequently contained in the host rock, brecciated sideritic dolomite, where small fractures are formed.

It is supposed that the Bob Zinc mineralized zone could be formed along fracture line, then eroded, weathered and formed secondary minerals.

1-3-4 Geochemical Anomalies and Mineralization

At the geochemical anomalies to the east of the Bob Zinc Deposit, Zn mineralization is recognized, but is not regarded as economical ore deposit.

Chemical analysis on the cores collected from the drilling conducted during second year at this geochemical anomalies reveals that several hundred to several thousand ppm of Zn was determined from the strong-sideritized dolomite, while several ten to several hundred ppm from weak-sideritized brecciated dolomite. The analysis of soil samples resulted with 200-300ppm Zn for most of those from the massive dolomite area, 400-600ppm for weak-sideritized brecciated dolomite area, and over 800ppm for strong-sideritize. The maximum value was 1,800ppm.

Thus it is suggested that the geochemical anomaly area locating at east of the Bob Zinc Deposit is caused by high content of Zn in strong-sideritized and brecciated dolomite.

It is suggested to investigate in detail the relation of geochemical anomalies higher than (M+3) value and strong-sideritized brecciated zone in order to analyse and interpret geochemical anomaly distributed along the boundary of bedded limestone and argillaceous-arenaceous metasediment.

Chapter 2 Sable Antelope Area

2-1 Geology and Ore deposit

The geology of the area consists mainly of massive dolomite-dolomitic limestone and massive-bedded limestone belonging to carbonates, but massive-bedded dolomitic sandstones of argellaceous-arenaceous metasediments of upper formation are distributed at south-west marginal part of the area. Sandstone, shale, and limestone are intercalated in the sandstones (Fig. 14).

(1) Blue Jacket Deposit Area

Grayish bedded limestone of upper Carbonates and shale, dolomite, and limestone of lower Argilaceous-Arenaceous Metasediments are distributed in the south-west marginal part of the area.

The shale is gray-brown in color owing to decoloring on the surface. The bed thinning to west and thicking to east is generally 100m-150m in thickness.

The dolomitic limestones are divided into two types of well-bedded and massive beds.

The formations strike WNW-ESE, dip 80-90° S, showing monoclinic structure. Some part of sandstone beds are infraformationally and irregularly folded, and a mineralization is emplaced cutting these folding structure.

The Blue Jacket Deposit and adjacent mineralization are mostly embedded in dolomitic limestone, but some in sandstone.

The deposits consist mainly of chalcopyrite, and are accompanied by bornite and tetrahedrite. They form ore-disseminated dolomitic calcite veinlets or networks, but generally come off and on as lens form. Siderite and sideritic calcite veinlets occur extensively within the mineralization. The mineralized part has generally undergone dolomitization.

(2) Sable Antelope Deposit

The central and north-east parts of the area consist of grayish limestone as upper horizon, and pinkish or gray limestone containing much mixed materials as lower horizon. The former intercalates compact and massive sandstone which thickens remarkably to east.

Though geological structure is unclear, these formations are inferred to be in monoclinic structure, striking WNW-ESE and dipping 60° S. The upper bedded limestone has been fractured and brecciated, especially to east part. The fractured and brecciated zone has undergone strong dolomitization, but the dolomitization is weakened to west.

The Sable Antelope Deposit is emplaced along margin of the brecciated dolomite part. Main ore body presumably extends 100m to N60° W direction, dipping 80-90° S with 2-10m in thickness. The deposit is embedded in cement part of the brecciated dolomite, and is accompanied with siderite and ankerite. The mineralized part has undergone strong silicification. The mineralization and silicification reach to the breccia part.

Siderite and ankerite are regionally distributed at several places.

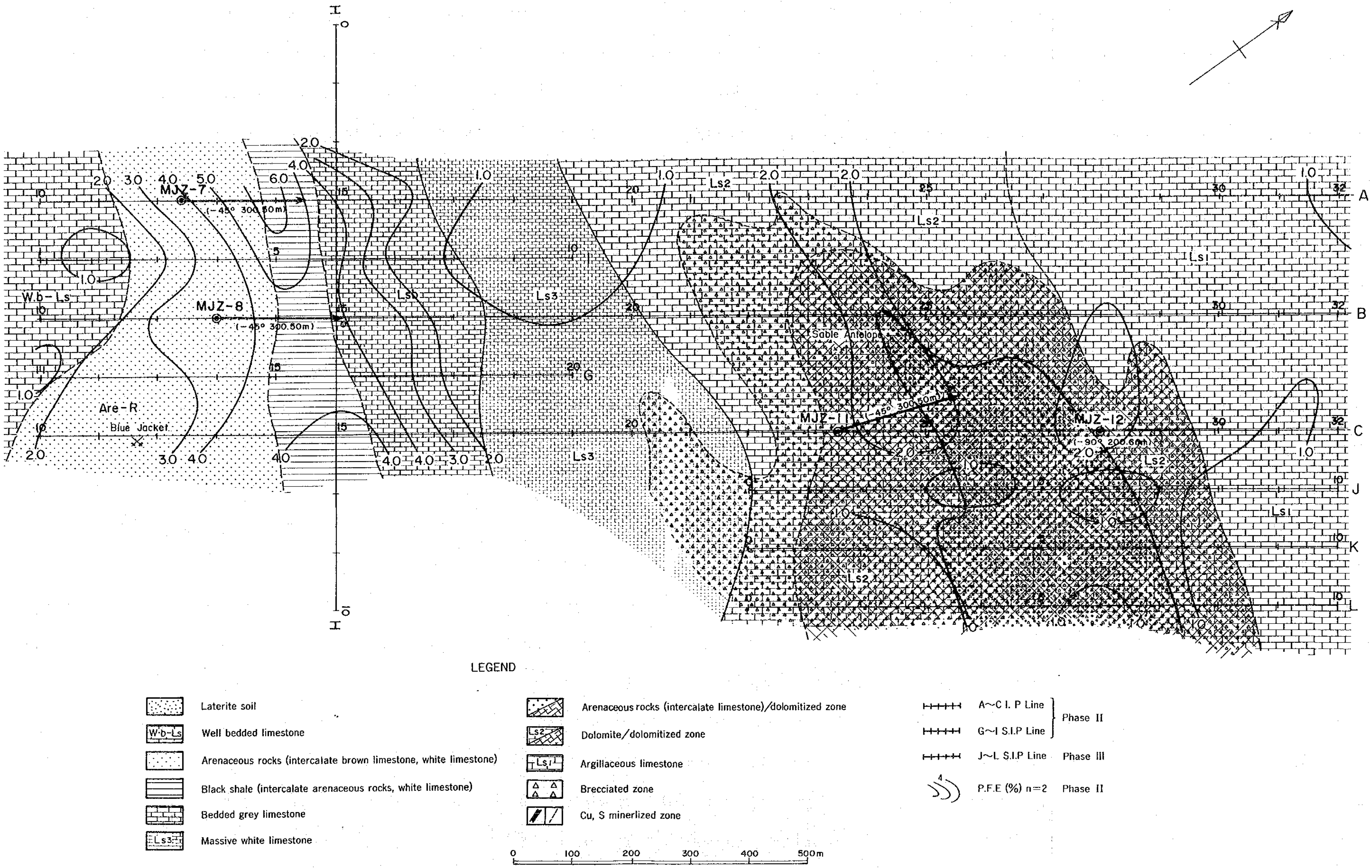

Fig. 14 Location Map of Drillings in Sable Antelope Area

2-2 Geophysical Survey (IP and SIP methods)

2-2-1 General

The area of present target is of some 2 square kilometers covering the zone of low resistivity delineated by the CSAMT method in the first year, old mines in Sable Antelope and the mineralized zone at Blue Jacket. In the second year, five anomalous zones were found by the IP method on lines A to E totalling 16km and the SIP method on lines F to I totalling 5km (Fig. 15). Among these, two drill holes were sunk in the third year on anomaly No.3, which was considered to be most promising. Anomalies No.1 and No.2 were expected to extend toward east, and an area of about 0.3 square kilometers adjoining to the east was covered by the SIP method in the third year on lines J, K and L, comprising 3 km in total.

The employed IP method is of frequency domain which gives a change in apparent resistivity at 0.125 and 1.0 Hz as the percent frequency effect (PFE).

The spectral induced polarization (SIP) method measures the induced polarization phenomena over a broad range of frequencies to present the results as figures of phase spectra and magnitude spectra, and as the Cole-Cole diagrams. A peculiarity of the SIP method is that the method has a possibility to discriminate types of mineralization and to eliminate an effect of electromagnetic coupling by analysis of frequency spectra of IP phenomena. In this survey, the Harmonic System, developed by Zonge Inc., USA, was applied. The system uses three standard waves of 0.125, 1.0 and 8 Hz and results of measurements are analyzed by the fast Fourier transform (FFT) method to calculate frequency responses on 3-, 5-, 7-, 9- and 11-harmonics of standard frequencies. Thus, the IP spectra are obtained over the range from 0.125 to 88 Hz.

2-2-2 Survey results

Five anomalous zones have been obtained by IP and SIP surveys in the second year being from No.1 to No.5 (Fig. 15). Characteristics of each zone are as follows.

(1) Anomalies No.1 and No.2 are located in limestones and both extend in a WNW-ESE direction. Especially, No.2 crosses over Sable Antelope deposits with 2 to 3%PFE and 5,000 to 10,000 ohm-m of apparent resistivity (AR) in the anomalous zone suggesting that the zone is of silicified mineralization with the top less than 100m deep.

(2) Anomaly No.3 is situated on meta-sediments in limestones or on a boundary of these rocks, with an elongation of a WNW-ESE direction. The PFE in the anomalous zone ranges from 4 to 6% with the AR of 300 to 800 ohm-m. Simulation gives the resistivity of some 100 ohm-m in the anomalous zone. The phase spectra have a similarity with data of physical properties of ore samples, indicating an existence of mineralized zone. A depth of the top of mineralized zone is estimated at about 100m.

(3) The anomaly No.4 is in metasediments with 4 to 7%PFE and 10 to 100 ohm-m in AR. The anomalous zone consists of an anomaly along a tectonic line in an E-W direction and an anomaly at the southern end. As these anomalies are situated in a broad zone of low resistivity,

electromagnetic coupling is involved, especially being strong on the anomaly at the southern end. Consequently, the anomaly along the tectonic line is more preferred.

(4) The anomaly No.5 is located in the vicinity of boundary between limestones and metasediments, with 3%PFE and 1,000 to 2,500 ohm-m in AR. The high resistivity suggests an origin in limestones. A depth may exceed more than 200m.

The SIP survey in the third year was carried out on the area east of anomalous zones No.1 and No.2 delineated in the second year. The values of PFE were less than 2% and anomalous values in the second year had a tendency to decrease. As a result, the maximum anomalies were of the line C in both the zones of No.1 and No.2 (Fig. 16).

The phase values were deemed to be useful in the fields of low frequencies of 0.125 to 3 Hz. The phase value on the line I of SIP which crossed the anomalous zone No.3 standed at -30 to -40 mrad and decreased in accordance with a change of frequency from 0.125 to 0.375 Hz (Fig. 17). Drill holes have penetrated black shales disseminated with chalcopyrite and pyrite.

The phase values in anomalous zone No.3 on line G were separated in two cases, an increase in the field to the southwest of No.15 and a decrease in the field to the northeast of No.15 at a change of frequency from 0.125 to 0.375 Hz. A part of field of increase became to a field of decrease at a change of frequency from 1 to 3 Hz. This feature in phase is similar to that of ore from Sable Antelope. It is noteworthy that a zone of IP anomaly can be divided into two fields depending on phase characteristics.

2-3 Drilling Survey

2-3-1 Purpose and locations of Drilling Sites

The drilling was performed to elucidate mineralization in the geophysical anomaly area found high I.P. effect at the Blue Jacket mineralized zone and in the neighbor of Sable Antelope Deposit.

These locations are shown in Fig. 14, and drilling geological profile is illustrated in Fig. 18.

2-3-2 Survey Period and Survey Amount

The drilling survey was conducted in the third phase. Each drilling period and drilling depth are shown in the following.

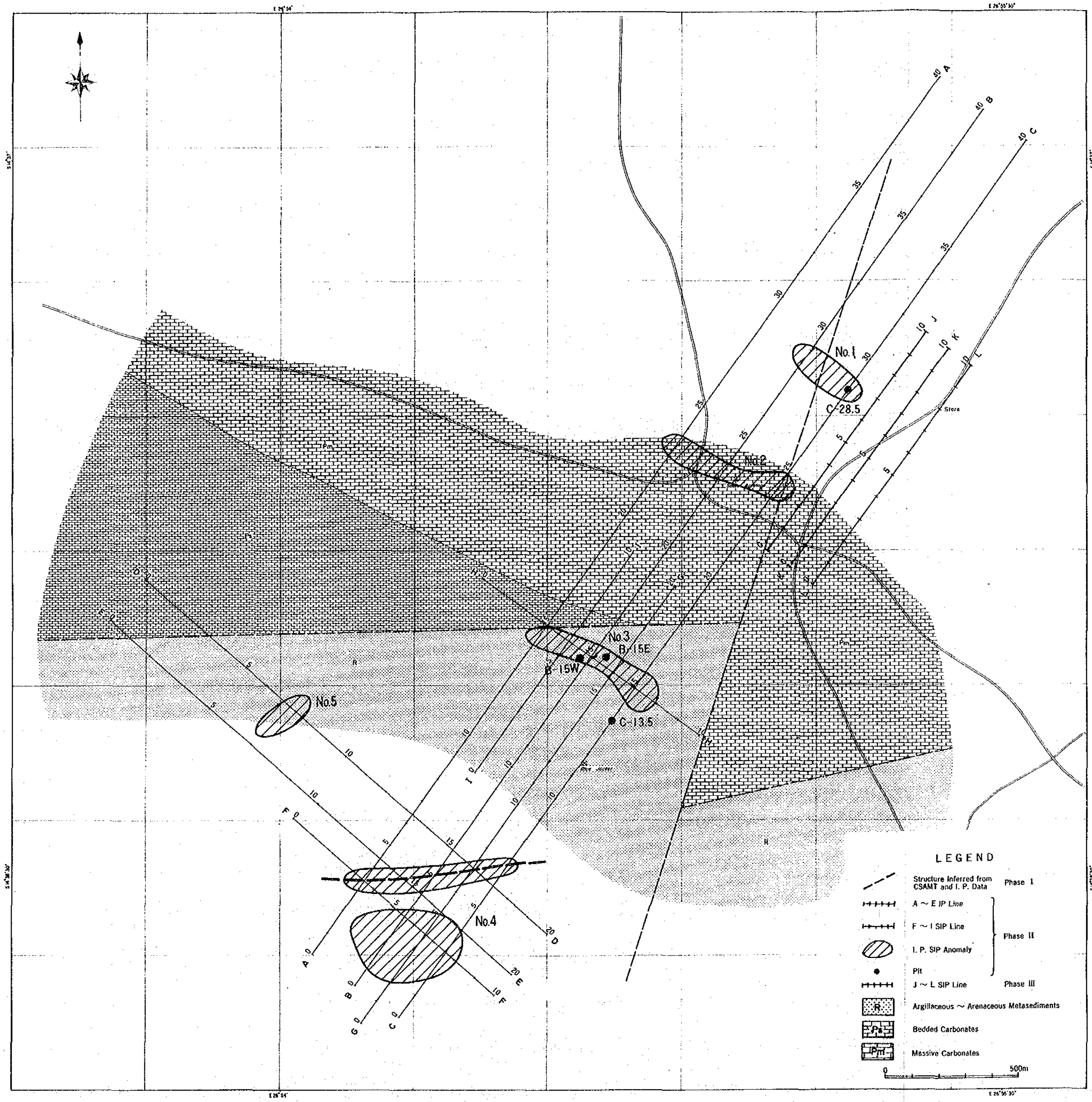

Fig.15 IP,SIP Anomalies in Sable Antelope Area

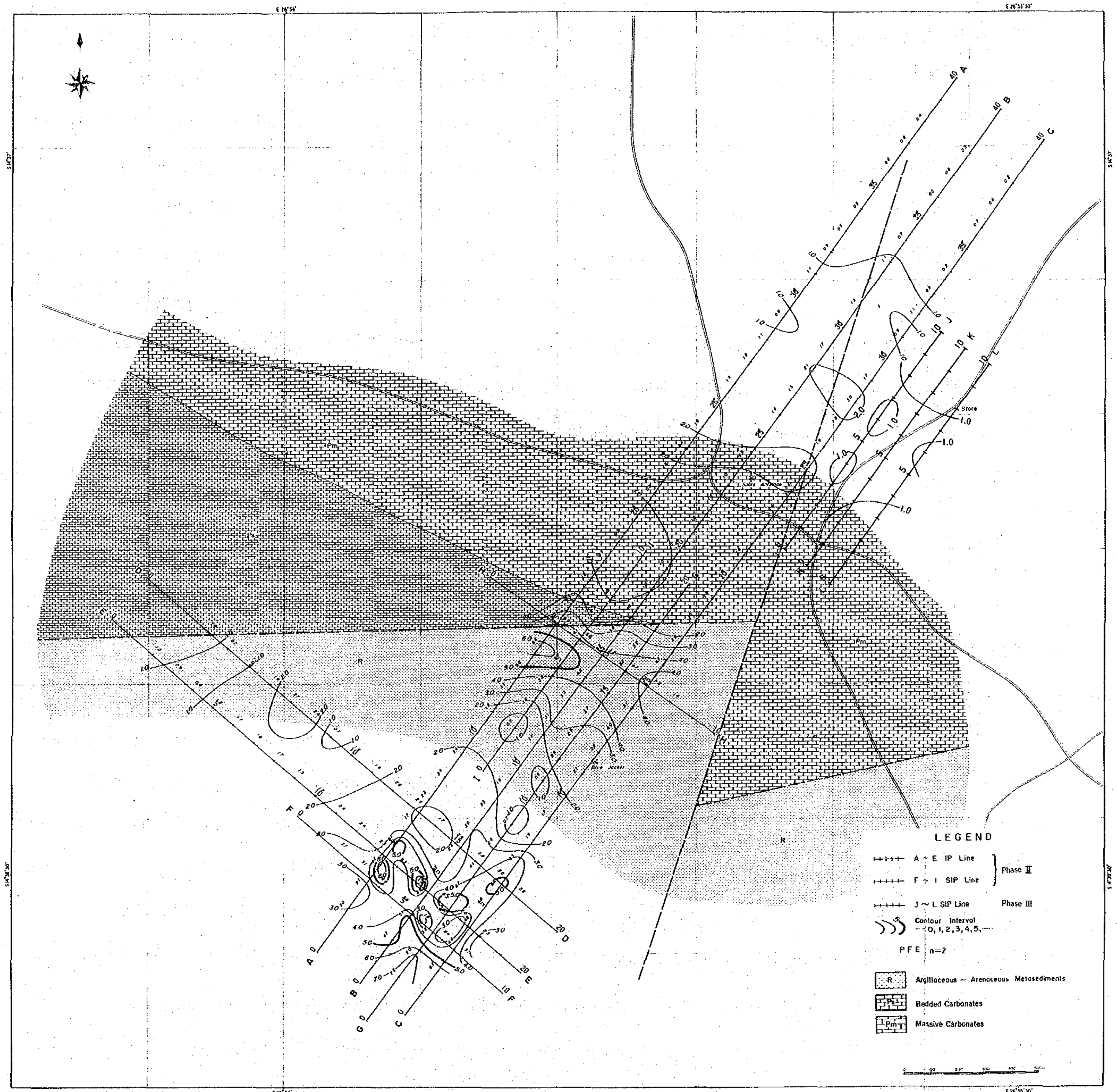

Fig.16 Plan Map of PFE in Sable Antelope Area (n=2)

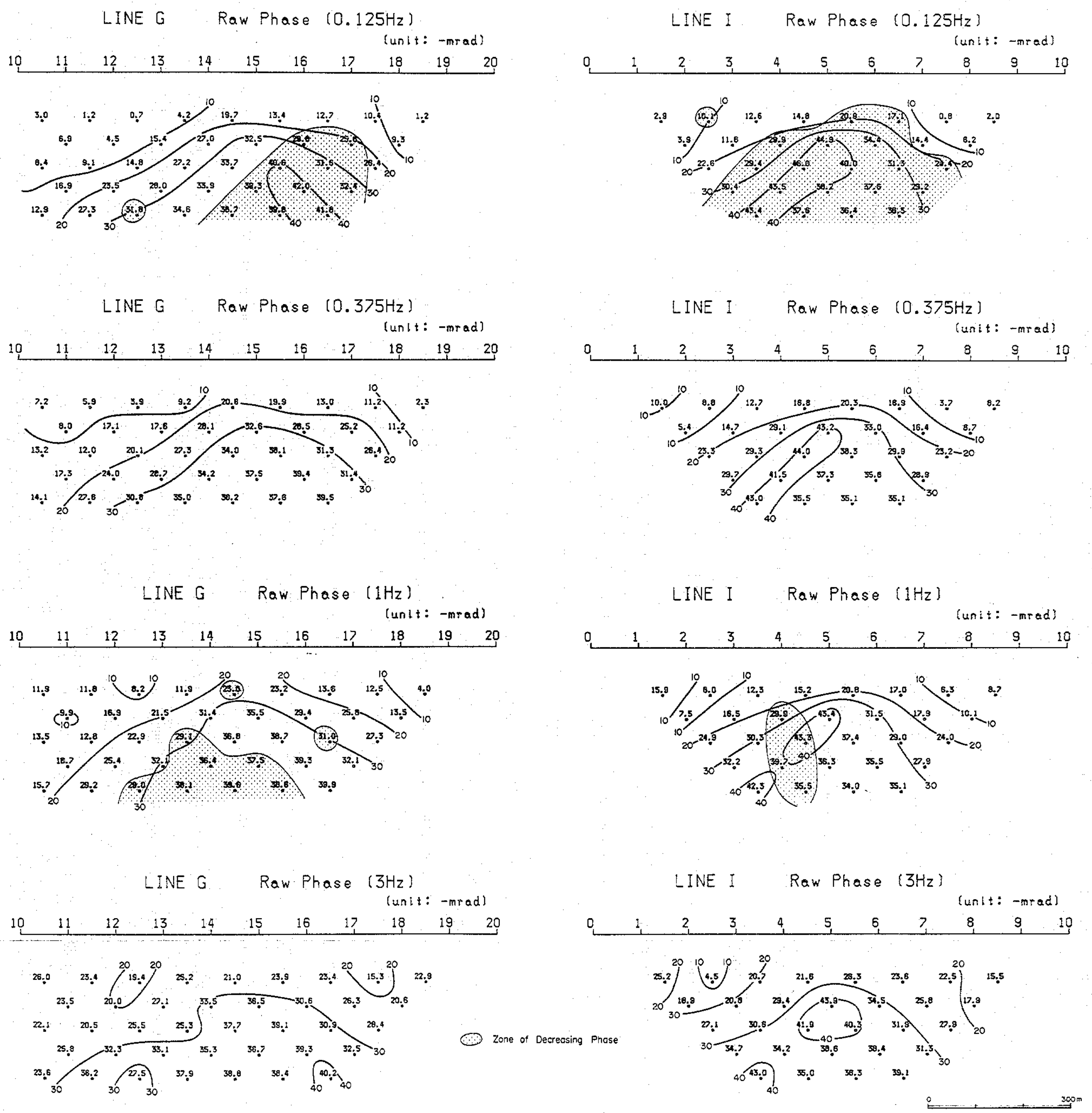

Fig.17 Phase Characteristics in the Low Freguency Range Line G, I

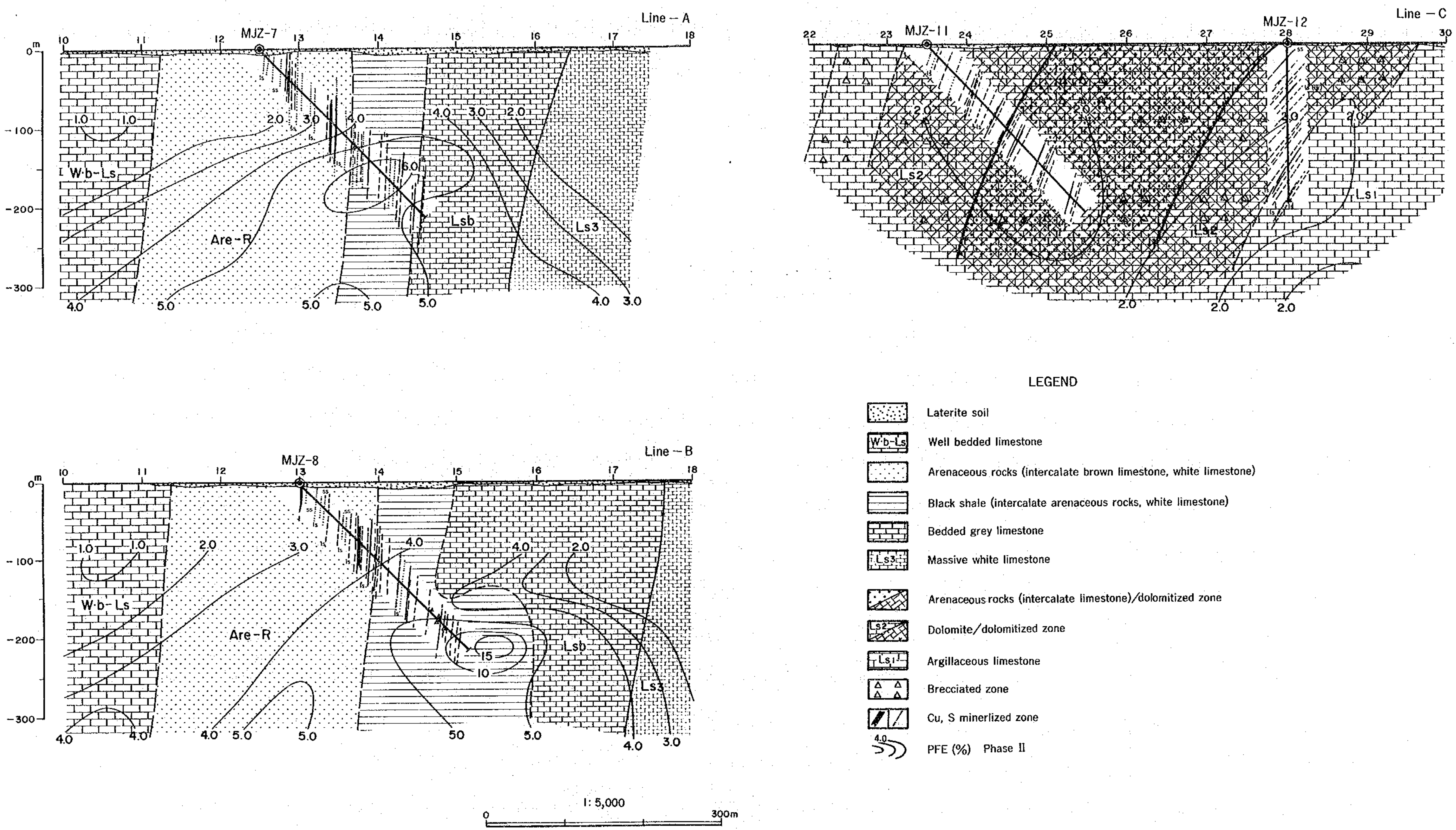

Fig. 18 Geological Section in Sable Antelope Area

Drill Hole No.	Depth (m)	Inclina-tion	Bearing	Depth of Laterite (m)	Length of Core (m)	Core recovery (%)	Term		Explora-tion Target
							Start-ing	Comple-tion	
MJZ-7	300.5	-45°	36°	10.4	283.8	97.8	1 Aug.	11 Aug.	IP anomaly zone, No. 3
MJZ-8	300.5	-45°	36°	2.7	281.3	94.4	12 Jul.	25 Jul.	Ditto
MJZ-11	300.5	-45°	20°	1.5	285.1	95.3	21 Sep.	29 Sep.	IP anomaly zone, No. 2
MJZ-12	200.6	-90°	-	1.0	198.5	99.4	4 Oct.	9 Oct.	IP anomaly zone No. 1

$$\text{Core Recovery} = \frac{\text{Length of Core}}{\text{Depth - Depth of Laterite}} \times 100$$

2-3-3 Geology, Geological Structure and Mineralization

(1) Blue Jacket Deposit Area; Mineralization was confirmed at MJZ-7 and MJZ-8.

At MJZ-8, mineralization occurs over a length of 4.10m between 104.80m-109.50m depth, and its average is 0.34% of Cu, 11g/t of Ag. Within the ore zone, the part between 107.00m-107.10m is high grade of 13.75% Cu, 480g/t Ag.

At MJZ-7, weak pyrite dissemination occurs a length of 3.20m between 128.88m-132.67m, and weak Pb-Zn mineralized part in a 0.9m in thickness between 280.56m-281.63m.

(2) Sable Antelope Deposit Area; At MJZ-11, weak Pb-Zn mineralizations were found at two places, in 1.1m of width between 125.75m-127.50m, and 0.8m in width between 212.40m-213.70m.

As mentioned above, even though these mineralizations are not enough in grade, these mineralizations have following characteristic, namely the Blue Jacket Deposit is characteristically vein type, mostly network type, while the Sable Antelope deposit is embedded in brecciated fracture zone.

Copper mineralization is most common in the deposits, and is embedded in sandy and argillaceous rocks. Pyrite dissemination occurs as marginal facies of the copper mineralization, and is embedded especially in argillaceous rock. Lead-zinc mineralization is also emplaced in carbonates as marginal facies of the copper mineralization, referring to deeper part from 280m at MJZ-7 and at MJZ-11 and MJZ-12.

MJZ-8 drilled at center of the mineralization confirmed massive vein, and though it is thin vein of 10cm in width, it is accompanied by chalcopyrite and bornite. The deposit might be vein type coming off and on as lens form in fine-grained sandstone, and the ores could be formed at high temperature according to microscopic observation of ore texture.

At MJZ-7, the mineralization is accompanied by more pyrites than that at MJZ-8, and also tends to increase slightly content of Pb and Zn toward deep part, but it is wholly weak mineralization.

MJZ-11 conducted at east extention part of the Sable Antelope found network-disseminated pyrite-dominant mineralization. The mineralization is emplaced in dolomite and fine-grained sandstone, but is entirely poor grade. Ore minerals are not observable through naked eye, but analytical result detected comparatively much Pb and Zn grade, comparing Cu grade. Thus the mineralization might be formed at low temperature.

The ore caught by MJZ-7 is a part of north-west margin of the Blue Jacket Deposit, and the ore by MJZ-11 is a part of east margin of the Sable Antelope Deposit. The ore at MJZ-8 is regarded as high-temperature facies owing to observation of exsolution texture of chalcopyrite and bornite. On the other hand, the mineralization at MJZ-7 is small ratio of Cu/Pb and Zn/Pb, and the fact suggests that the mineralization is of low-temperature facies.

It is supposed that the mineralizations at MJZ-11 are also marginal facies of the Sable Antelope Deposit, similar to that at MJZ-7.