REPORT ON THE MINERAL EXPLORATION OF KARENDA AREA, THE REPUBLIC OF ZAMBIA

PHASE II

JANUARY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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METAL MINING AGENCY OF JAPAN

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 this survey, sought the cooperation of the Metal Mining Agency of Japan in order to accomplish the contemplated 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 is being carried out jointly by experts of both Governments.

The third phase of the collaboration survey consists of geophysical surveys and diamond drilling for metallic mineral exploration.

This report summarizes results of the third phase of the survey, and it will also form a portion of the final report that will be prepared with regard to the results to be obtained from the completed 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

Keisuke ARITA
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Japan International Cooperation Agency

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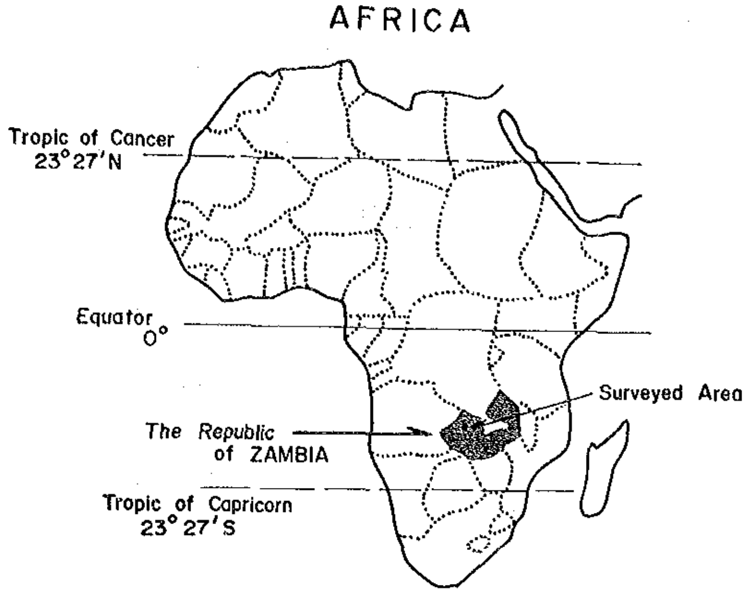

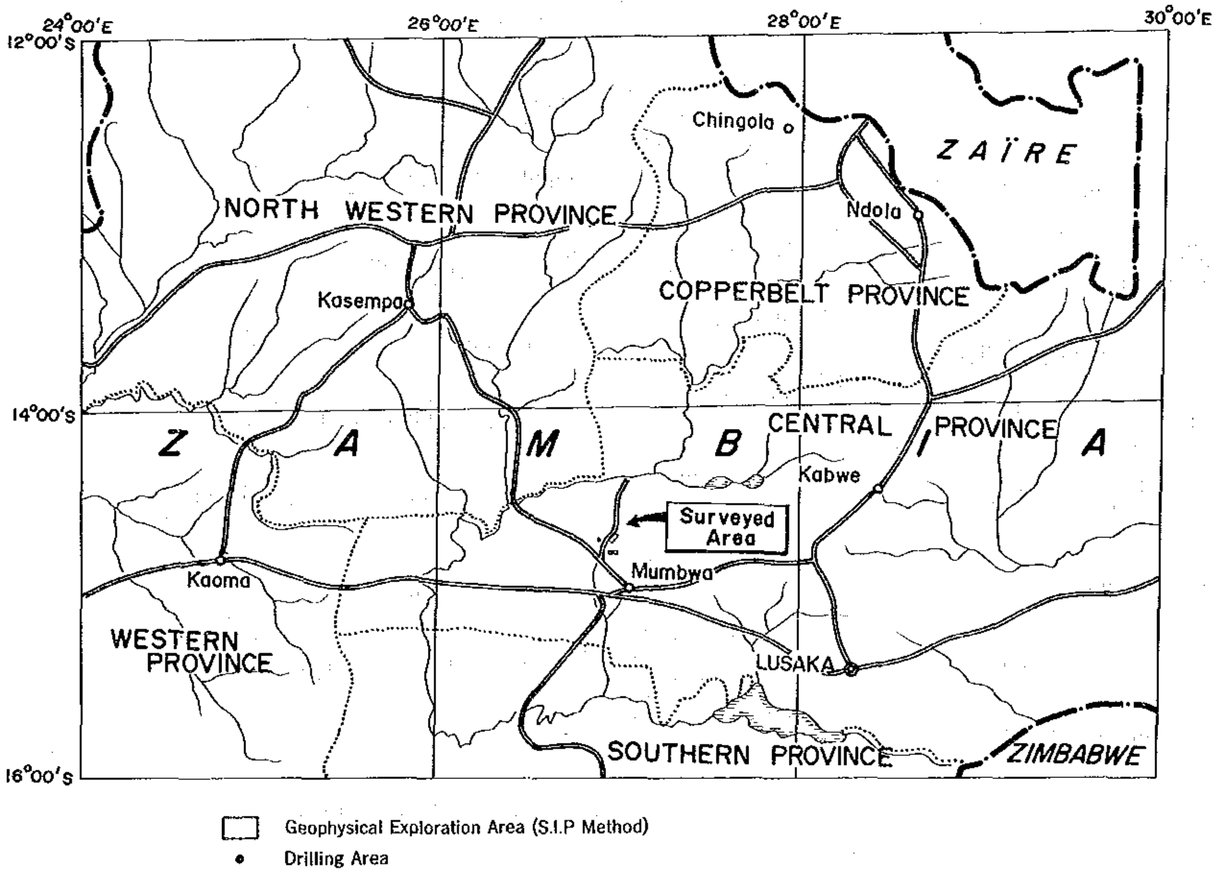

Fig. 1 Index Map of the Survey Area

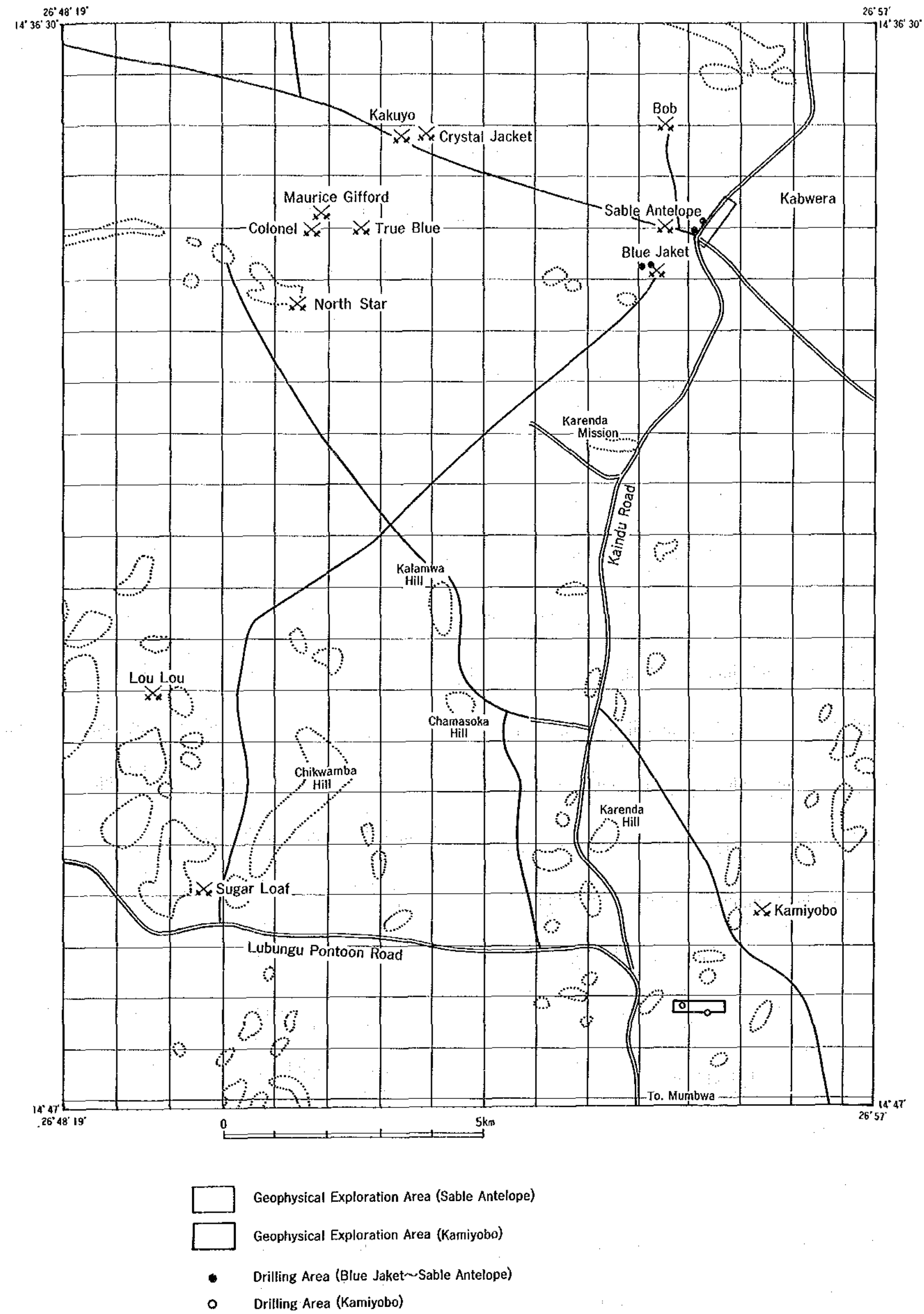

Fig. 2 Map of the Survey Area

SUMMARY

The survey is the third phase to unravel emplacement condition of silver, copper lead and zinc mineralization in the Karenda Area.

Following recommendation was proposed for the third phase survey as a result of the second phase survey;

(1) Sable Antelope Area - Blue Jacket Area

Drilling survey is carried out to unravel emplacement condition of mineralization in mainly No.3 IP anomalous area, involving No.1 and No.2 IP anomalous zone, discovered by geophysical survey.

(2) Kamiyobo Area

Drilling survey is carried out to confirm mineralization condition of center part in the geochemical copper-zinc-lead anomalous zone.

Prior to performing the drilling, geophysical survey is carried out to delineate the mineralization area, and actual programme of the drilling is made plan.

On the basis of the recommendation, geophysical survey (SIP method, 6 survey lines with total line length of 6km) and drilling survey (6 holes with total drill length of 1,703.1m) were conducted in the above-mentioned 2 Areas.

1) Sable Antelope Area - Blue Jacket Area

Drilling of two holes were carried out targeting No.3 IP anomaly of geophysical survey. As a result, the drilling reveals that the anomaly results from pyrite-disseminated black shale.

The MJZ-8 has discovered several network-mineralized zones. In the mineralized zones, a massive ore vein is observed at 107.00m in depth, being accompanied by chalcopyrite and bornite with 10cm in width, 480g/t of silver, 13.75% of copper and 0.44% of zinc. Sedimentary-origined pyrites are frequently scattered in black shale. It is unraveled that the mineralizations are continuously present between MJZ-8 and MJZ-7, because of existence of similar mineralization in MJZ-7.

It is also confirmed by the drilling that No.1 and No.2 IP anomalies of geophysical survey result mainly from pyrite dissemination in sandstone.

MJZ-11 found pyrite-disseminated mineralization associated with zinc, lead and copper in the No.2 IP anomaly. The mineralization is embedded in breccia-fractured zone of dolomite or dolomitic sandstone, but it is presumably situated at marginal part of Sable Antelope deposit.

2) Kamiyobo Area

Drilling of two holes, MJZ-9 and MJZ-10, was performed on the IP anomaly detected in the center part of geochemical anomaly through geophysical survey. The result indicates that pyrite-disseminated black shale causes IP anomaly in the area. The mineralization consists of alternated zones of thin sedimentary-origined pyrite and black shales containing network veins disseminated by chalcopyrite, pyrite and galena, and ore veins. The sedimentary-origined pyrites are extensively embedded in conglomeratic part of the black shale, and also in the limestone bed.

In spite of existence of high grade Cu-Pb-Zn geochemical anomaly, the mineralization under the surface contains rich copper, poor zinc and

lead in the deeper part. From the fact it may be infered that zinc-lead-rich part was eroded out.

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PART I

INTRODUCTION

PART I INTRODUCTION

CHAPTER I OUTLINE OF THE SURVEY

1-1 Survey Area and Survey Objectives

The preliminary geological, geochemical and geophysical (CSAMT) surveys in the first phase of this project were conducted in 1984 with the objective of understanding the nature of metal concentration in the Karenda survey area, the Republic of Zambia.

Based on the results of this work, the detailed geological and geochemical surveys in Kamiyobo, the geophysical surveys (IP, SIP) in Sable Antelope and the drilling survey in Bob Zinc were conducted in 1985, as the second phase of this project.

The work of the third phase in the Karenda survey area, based on the results of the previous phase, was conducted in Sable Antelope and Kamiyobo.

1-2 Survey Method and Amount of Work

The area surveyed is shown in Figs. 1 and 2. The Amount of work conducted was as follows:

Sable Antelope:	SIP traverse 3km
	Drilling 4 hole 1,100m
Kamiyobo:	SIP traverse 3km
	Drilling 2 hole 600m

1-2-1 Geophysical Survey

(1) Sable Antelope

Two anomalous zones were delineated in the IP geophysical survey of the second phase. These zones cover the area and vicinity of the Sable Antelope ore bodies which are of copper dissemination with some massive quantities of ores, associated with strong silicification. Expected to extend towards the east, the extension of these anomalous zones was investigated by the SIP survey. Three traverses each being 1km in length were applied in this survey. The traverse interval was 100m and the station interval 100m.

(2) Kamiyobo

A zone of geochemical anomaly was delineated in the geological and geochemical prospecting at the second phase, and includes a number of high values in Cu, Pb and Zu. The elongation of the central part where these values are more than $M+3\sigma$ stands at about 300m.

Three traverse lines of SIP survey set at a length of 1km each were crossed over the central part of the geochemical anomaly zone. The traverse interval was 100m and the station interval 100m.

1-2-2 Drilling Survey

(1) Sable Antelope Area

The anomaly (No.3) which was detected by the geophysical survey of the second phase is located in the vicinity of the Blue Jacket mineralized zone. This zone has a high frequency effect with a low resistivity, and was interpreted to dip steeply to the south, continuing in a WNW-ESE direction.

(Two holes with a depth of 300m each were sunk into these anomalies.)

Another geophysical anomalies (No.1 and No.2) which were detected in the second phase are located in the vicinity of the Sable Antelope ore body and to the northeast of the ore body.

One hole with a depth of 300m and another hole 200m deep were drilled into each anomaly after the geophysical prospecting which was conducted in the east of anomalies No.1 and No.2 this year.

(2) Kamiyobo Area

Two drill holes of 300m in depth each were designed for the two peak trend zones of the geochemical anomalies found in the second phase, and for the geophysical anomaly, obtained by the geophysical prospecting of this third phase.

1-2-3 Laboratory Work

For the electrical property measurements or for the mineralization and alteration of the drilling core, samples were prepared.

Laboratory work is shown as follows:

	samples
(1) electrical properties of rocks and ores	32
(2) Microscopic observations of ore polished sections	20
(3) X-ray diffraction analyses of rocks and ores	30
(4) chemical assay of ores (Ag, Cu, Pb, Zn)	77

Ore samples of the drilling core were split with a diamond cutter, and a quarter of them were collected for chemical assay.

1-3 Survey Period and Survey Team Members

1-3-1 Period of the Survey

The survey of this year was conducted from June 27, 1986 to January 20, 1987, and carried out with the cooperation of the Japanese survey team of the Metal Mining Agency of the Japanese and Zambian counterparts of the Mineral Exploration Department of the Zambian Industrial and Mining Corporation Limited.

Field work was as follows:

(1) Drilling survey
From June 27, 1986 to October 31, 1986

(2) Geophysical survey
From July 13, 1986 to August 15, 1986

1-3-2 Members of the Survey Team

(1) Japanese Members

(a) Survey programing and coordination

Kohei Arakawa	(Metal Mining Agency of Japan)
Takahisa Yamamoto	(")
Yoshiyuki Kita	(")
Kenji Sawada	(")

(b) Leader

Makoto Kitami	(Nikko Exploration & Development Co., Ltd.)
Harunobu Sumida	(")
Toshiaki Fujimoto	(")
Saburo Tachikawa	(")
Yukio Kawamura	(")
Mitsuo Sasaki	(")
Hidemitsu Itoda	(")

(2) Zambian Members

General supervisor

Dr. S.N. Punukollu	(Director, MINEX, ZIMCO*)

Coordinator

W.B. Sikombe	(Acting Director, MINEX, ZIMCO)
Dr. L. Borsch	(Chief Chemist, MINEX, ZIMCO)
A.S. Sliwa	(Exploration Supervisor, MINEX, ZIMCO)
G.R. Rao	(")

Field supervisor

Elias Mbumba	(Project Geologist, MINEX, ZIMCO)
Charles Muyovwe	(Project Geophysicist, MINEX, ZIMCO)

Field survey

Albert Mutuma	(Senior Field Assistant, MINEX, ZIMCO)
Lazarus Tembo	(")
Isaac Mwanza	(")
Lashiki Patson	(")

* MINEX ZIMCO: Mineral Exploration Department of the Zambia Industrial and Mining Corporation Limited

CHAPTER 2 OUTLINE OF THE SURVEYED AREA

2-1 Geography

Topography: The general area from the capital city of Lusaka to Karenda is a relatively flat plateau with altitudes ranging from 1,100m to 1,300m. Small hills are scattered throughout the area with relative heights of 50-200m.

Climate: The climate of the general area including Lusaka is classified as that of a savanna, and has a dry season (May - October) and a wet season (November - April). The dry season has a cold period (May - August) and a hot (September - October) period. During the cold period, the temperature reaches 21°C during the day, but drops to 4°c at night in July. October is the hottest month, but the temperature rarely exceeds 35°C. Average precipitation is 810-1020mm/year.

Vegetation: The general area including the area around Lusaka consists of savanna vegetation with small trees and tall grasses. There is a varying ratio of cultivated areas.

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 surveyed area is 25km NNW from Mumbwa and can be accessed on an unpaved road. The MINEX camp at the northeast part of the area is 25km further north along the above road, and the travel time is about one hour by car from Mumbwa. The roads accessible by vehicles are few and far between in this area. There are two main roads in the area, one branches off from the southeast corner and extends northward along the eastern border of the area to Kaindu (the Kaindu Road), while the other runs along the western border from the southern end of the area to Kasempa (the Lubungu Pontoon Road). There are several roads which branch out from these two main roads, and they are accessible only by four-wheel drive vehicles. Although only at slow speeds, the whole area will become accessible to four-wheel drive vehicles after clearing trees and bushes.

Population: Several houses belonging to the Karenda Village are gathered here and there in the area. The total population is less than 1,000. Mumbwa is the city closest to this area. This is the second largest city of the Central province, and facilities such as a bank, police station, hospital, hotel, shops including supermarkets, electric power, running water and television reception are available.

Industry: The key industry of Zambia is mining, but the government has also been laying emphasis on agriculture in recent years. Sorghum, millet and cotton are grown in various parts in the vicinity of the surveyed area, and there is a National Service Farm. These are the main activities of the area. Others include the production of charcoal for fuel, hunting and fishing.

2-2 General Geology and Ore Deposits

2-2-1 Karenda Area

The geological units of this area consist of carbonate and sandy to muddy metasedimentary rocks of the Kundelungu Series belonging to the Precambrian Katanga System, syenites, porphyrites and other igneous rocks intruding into these formations, and rocks of the Quaternary System. The carbonates are mostly massive in the lower part and bedded in the upper horizons, while the transition between the above two types is gradual. The sandy metasediments are mostly fine-grained quartz metasandstones, and the muddy metasediments are mostly shale. The relation between these metasediments is alternations and gradual transition. They conformably overlie the bedded limestone.

The geological structure is largely controlled by large E-W and N-S fault systems. The area to the west of the N-S faults and north of the E-W faults (northern block) consists predominantly of carbonate rocks which show a monoclinic structure with a 30°-40°S dip. Many ore deposits including Sable Antelope and Bob Zinc Deposits occur in this block. The area to the east of the N-S faults (eastern block) consists mainly of upper carbonate rocks and the sandy to muddy metasedimentary rocks. These units run in a N-S direction and are frequently folded. The Kamiyobo mineralized zone occurs in this block. The area to the west of the N-S faults and south of the E-W faults consists mainly of intrusive rocks, and is not included in the present work.

Brecciated structures are frequently found in the carbonates of the northern block. These structures are circular to oblong in shape at the surface, and range from tens to several hundreds of meters in size. Each brecciated fractured part is independent, but they are distributed in zones harmonious with the E-W geological structure, as well as along the weak lines perpendicular to the E-W structure.

Fourteen deposits and mineralized zones are known in this area. Some of these have been worked in the past, but many of them have not yet been completely mined out. The deposits are pipe to lens-shaped disseminations, with veins which are partly massive in nature. Mineralization is observed in the brecciated fractured zones in the northern carbonates, and along the fissures and weak zones in other areas.

The ore minerals observed in the outcrops are iron and copper oxides, but the mineral composition of the drill cores, mined ores and dumps differ by locality. For example, the mineralized zones of Wonder Rocks and Bob Zinc in the north have been eroded to the lower part of the mineralized zone, and in these zones only copper, zinc oxides and carbonates are found without sulfides. On the other hand, the Sable Antelope, Crystal Jacket and Silver King deposits have been mined. These deposits and the mineralized zone to the south contain chalcopyrite, pyrite and other sulfide minerals. Chalcocite, bornite, chalcopyrite, tetrahedrite and pyrite are found in the mined wastes of the Sable Antelope Deposits.

2-2-2 Surveyed Area

The area surveyed during the course of the present work was selected upon consideration of the results of the past two years. The outline is as follows:

(1) Sable Antelope Area

The geological units constituting this area are massive dolomite, massive to bedded limestone, bedded to massive dolomitic sandstone, shale and others.

Sable Antelope deposits have been mined, and Blue Jacket mineralized zone and also other mineralized zones are located at south-west of Sable Antelope deposits, are known in this area.

The Sable Antelope deposits occur in the brecciated zone of the massive dolomite. It was small massive sulphide lens surrounded by stockwork and disseminated zone. Ore minerals are chalcopyrite, malachite, azurite, chalcocite, bornite, tennantite and pyrite in the mineralized zone. The grades of some samples are; strongly mineralized zone, Ag 22g/t, weakly mineralized zone, Ag 5g/t and Pb, Zn contents were minor in both zones.

The Blue Jacket mineralized zone consists of malachite veinlet-stockwork - dissemination and malachite-calcite veins with chalcopyrite, bornite and tennantite in bedded to massive dolomitic arenaceous rock. The grade of the malachite-rich parts is 17.5g/t Ag with minor Pb and Zn.

The geochemical prospecting data which were obtained by MINDECO-NORANDA many years back were analyzed and interpreted during the first year. The results show that the Sable Antelope deposits and the Blue Jacket mineralized zone belong to different Cu and Zn anomalous zones (Fig.3)

Several geophysical anomalies were observed by CSAMT during the first year along the N-S weak lineation from the Sable Antelope deposits to the Blue Jacket mineralized zone.

IP anomalous zones in the vicinity of the Sable Antelope deposits and Blue Jacket mineralized zone were detected according to geophysical (IP, SIP) survey in the second year. Pitting was done in these zones, and high Cu anomaly in laterite and Zn anomaly in iron oxides were obtained from the pits.

(2) Kamiyobo Area

The geological units are bedded limestone, sandy to siliceous rocks, shale and small intrusive bodies similar to syenite porphyry.

The Kamiyobo mineralized zone is located approximately 600m north of this area. The exposure shows a malachite-iron oxides vein which fills a fissure in shale. It overlies bedded limestone. The grade at the shallow part below the surface is 3.60% Cu, with a very minor amount of Ag, Pb and Zn.

Pb-Zn anomalies were detected during the geochemical work of the first year and the geological and geochemical detail surveys were followed up in the second year. The result was that a geochemical anomaly zone elongating widely was detected in the south-western area. The effect of weathering is relatively weak because magnetite still remains in the vicinity of the anomaly zone. The possibility of the occurrence of primary sulphide deposits was considered to be high.

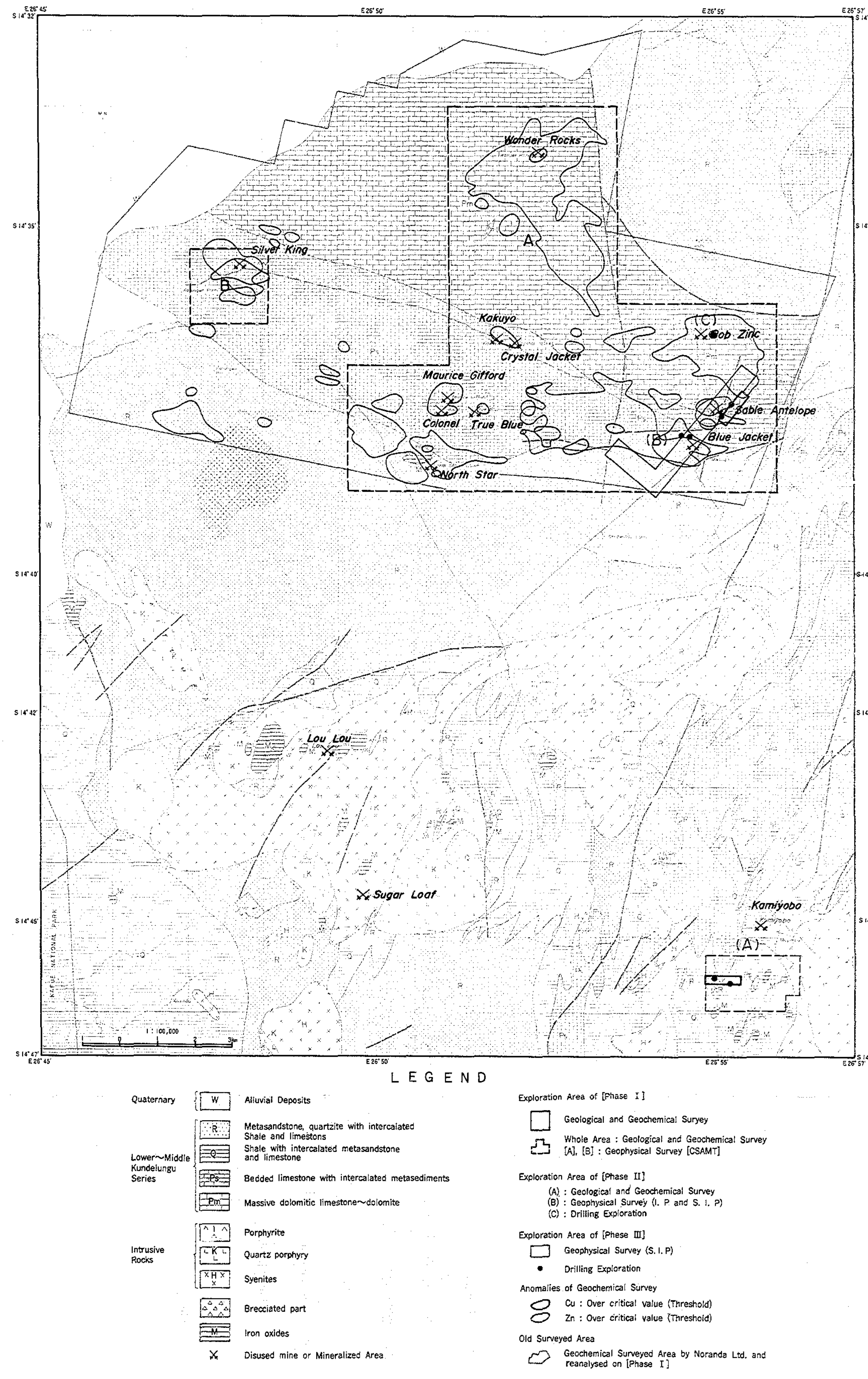


Fig. 3 Exploration Map of Karenda Area

PART II

RESULTS OF THE SURVEY

PART II RESULTS OF THE SURVEY

CHAPTER I SABLE ANTELOPE AREA

1. Geophysical Survey

1-1 Purpose and Area of the Survey

In the area of Sable Antelope, five anomalies from No.1 to No.5 have been delineated by the geophysical prospecting of IP and SIP methods conducted in the second year. Among these, anomalous zones of No.1 and No.2 were deemed promising and possibilities to extend to the east were expected.

In this year, the SIP method was conducted over the areas in the east of anomalies No.1 and No.2 to delineate overall patterns of these anomalies, centres of which might be selected as targets to be drilled.

An area of some 0.3 km^2 adjoining to the anomalies Nos.1 and 2 is shown in Fig.4. Three traverse lines of J, K and L of one kilometre each were laid down.

Each content regarding method and parameter of SIP survey, field equipment, data processing and its analysis, laboratory work, is shown as appendices.

1-2 Survey and Analysis

The anomaly No.2 covers the area of Sable Antelope ore deposits and the anomaly No.1 has been found in the vicinity of the deposits. Both anomalies are located in limestones. The anomalous values of PFE are rather weak in the order of 2%, and No.1 extends in a NWW-SEE direction and No.2 in an E-W direction. Apparent resistivity of these anomalies is high, ranging from 5,000 to 10,000 ohm-m and is assumed to indicate zones of mineralization and silicification.

1-2-1 Sections of PFE and AR (Fig.5)

The percent frequency effect (PFE) stands at less than 2% on lines of J, K and L, suggesting a decrease of anomalous values obtained in the second year.

The maximum PFE value of Line J stands at 1.4%, being smaller than the anomaly on line C, which is one of IP lines in the second year and adjoins to the west of Line J. A similarity of patterns of PFE contours is hardly recognized between Lines C and J. The apparent resistivity (AR) of Line J ranges from 700 to 22,000 ohm-m, being higher in the middle between No.4 and No.5 with a value of more than 10,000 ohm-m, and lower between No.6 and No.7 with a value of less than 1,000 ohm-m. A similarity of patterns between two lines is seen. The structure of resistivity in the Line J may be similar to that of Line C. A negative PFE (electromagnetic coupling) occur in the vicinity of No.6 where AR changes suddenly its value.

The maximum PFE on Line K stands at 1.8% and a weak anomaly of more than 1.5% extends from a shallow part of No.2 and No.3 to a depth between No.5 and No.6. The AR ranges from 800 to 24,000 ohm-m, and a zone of high AR beyond 1,000 ohm-m is detected over an area from Nos.3 and 4 to Nos.5 and 6, which accords with the zone of weak anomaly of PFE.

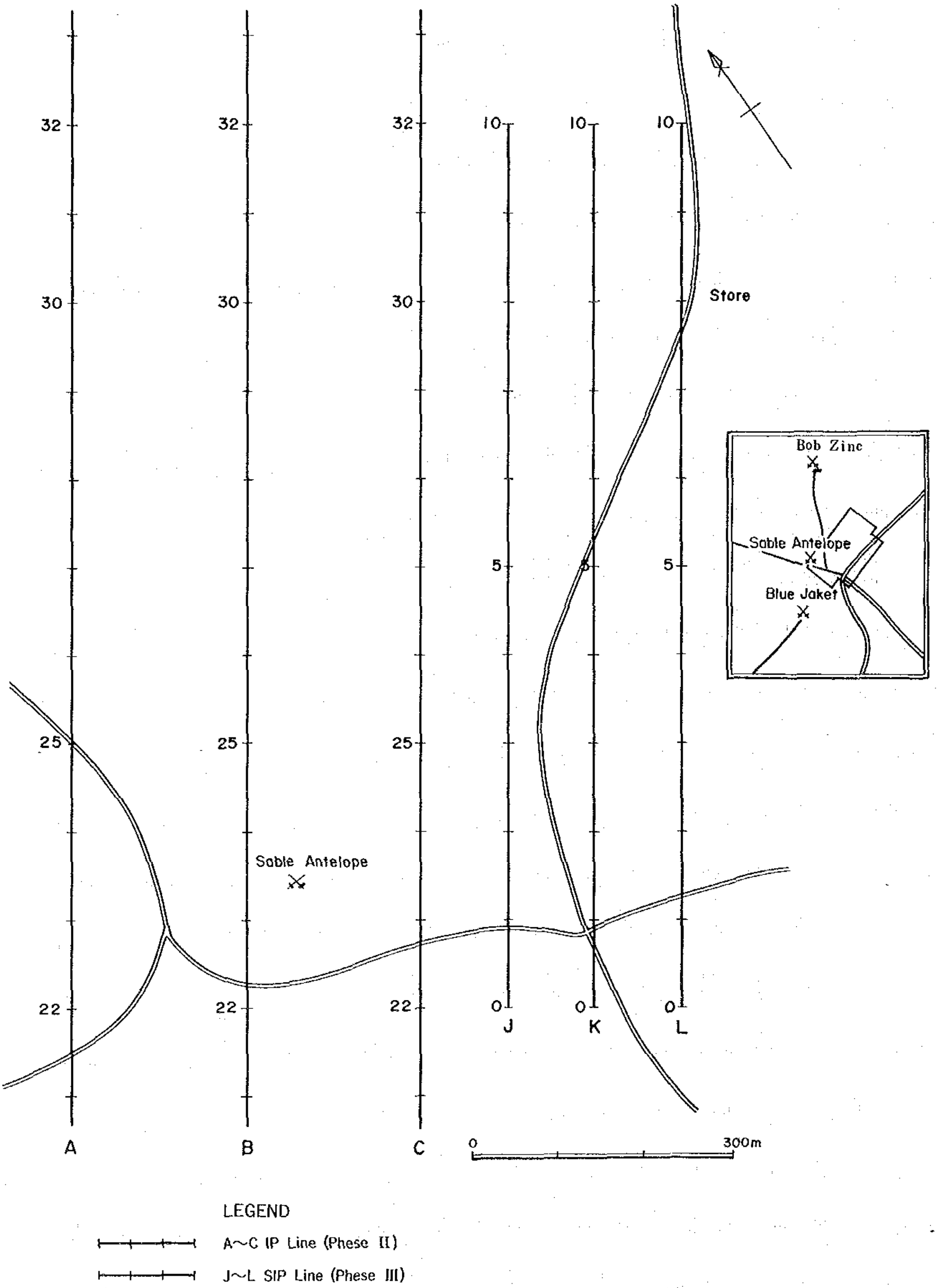


Fig. 4 Location Map of SIP Survey Line in Sable Antelope Area

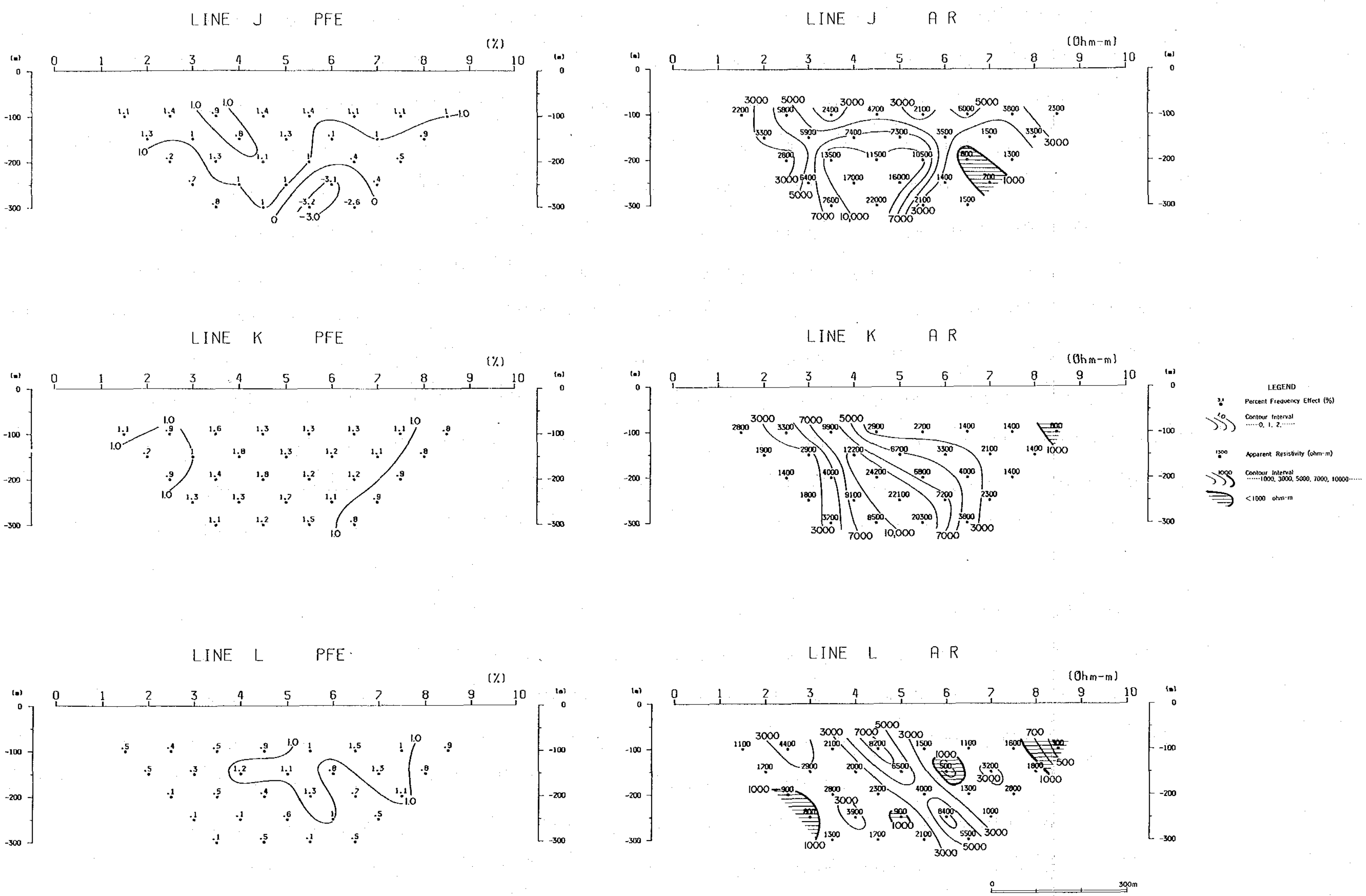


Fig. 5 Pseudo–Section of PFE & AR Line J, K, L

The values of PFE in Line L are very small being less than 1% and anomalous values are rare except a shallow part between No.5 and No.8 where PFE reaches a maximum value of 1.5%. A zone of high AR beyond 5,000 ohm-m is observed from Nos.4 and 5 to Nos.5 and 6, and several zones of low AR below 1,000 ohm-m have been delineated in a depth of south end or in a shallow part of north end.

1-2-2 Plans of PFE and AR (Figs.6 & 7)

No extension of the anomalies No.1 and No.2 to the east has been detected as illustrated in the plans of PFE at n=2, 3, etc. Although these anomalies in the previous year were surrounded by contours of 2%, the PFE in the east of these anomalies did not exceed this value of 2%.

A zone of high AR ranging from 7,000 to 10,000 ohm-m with an associated PFE anomaly was continuous to the east, though its extent was decreasing.

1-2-3 Phase sections (Figs.8 to 10)

Phase sections at five frequencies of 0.125, 0.375, 0.625, 1 and 3 Hz were drawn on each of lines. The phase value at 0.125 Hz is maximum at -10 to -12 mrad which corresponds to 1.4 to 1.8% PFE. In general, phase values become larger in accordance with an increase of frequency, but a small difference can be observed in each line. For example, when the frequency is turned from 0.125 to 0.375 Hz, the phase on Line J decreases in the depths between No.2 and No.3 and between No.5 and No.8. The Phase on Line K consistently increasing except a depth between No.3 and No.4 where its value becomes smaller. According to the laboratory investigation of samples, background values of phase is generally small as to PFE and increases in accordance with frequency, but a phase value in a disseminated zone of pyrite is generally high and has a tendency to decrease against an increase of frequency.

No discrimination can be made in values of PFE on Lines J and K in the sections of PFE. But these two lines are apparently different in change of phase. That is, an effect of pyrite dissemination can be seen in a part of Line J, as represented by a decrease of phase value against an increase of frequency, but no effect is observed in Line K at all.

Phase sections after decoupling are also attached.

1-2-4 Diagrams of various spectra (Figs.11 to 13)

Pseudosections were provided for phase spectra, magnitude spectra and Cole-Cole diagrams. These diagrams give the characteristics in a whole range of frequency from 0.125 to 88 Hz.

In the range of low frequency, most spectra of phase increase in accordance with an increase of frequency, but slanting-down spectra were noted in parts of Lines J and L.

In the range of high frequency, phase spectra are usually of an ascending type with a high inclination and a positive phase is observed between No.5 and No.7 of Line J.

In accordance with an increase of frequency, only small decreases of magnitude spectra were observed in each line.

1-2-5 Decoupling (Figs.8 to 14)

As explained in annex, Hallof et al classified electromagnetic couplings into two groups, one being related to homogeneous earth and another being due to a conductor. The former is a normal electromagnetic coupling which provides an increase of negative phase and a decrease of magnitude in accordance with increase of frequency.

The electromagnetic coupling due to a conductor gives increases in positive phase and magnitude in accordance with increase of frequency. This sort of coupling is often observed in a place where AR suddenly changes its value laterally or vertically due to an existence of a zone of low resistivity. This has been found in the vicinities of No.6 of Line J and No.7 of Line K.

Correction of various spectra was made by decoupling, but it is likely that a part of IP response in the field of low frequency has been lost. This is indicated, for example, by increases of all phases in the phase section after decoupling compared in cases of 0.125 and 0.375 Hz.

1-2-6 Simulation (Fig.15)

Due to weakness of anomalies on lines J, K and L, and as the anomalies of No.1 and No.2 are most prominent on the Line C, a simulation was conducted on anomalies of Line C. Zones of mineralization are assumed to be situated in both sides of a zone of high AR in a central part of the line.

2. Drilling Survey

2-1 Outline of the drilling survey

2-1-1 Location of the drill holes and the condition of drilling

In this area, 2 holes (MJZ-7 and MJZ-8) were drilled in the vicinity of the Blue Jacket mineralized zone, and 2 holes (MJZ-11 and MJZ-12) were drilled in the vicinity of the Sable Antelope deposits.

The locations and geological section of the drill holes are shown in Figs.16 & 17, and the drilling condition in Table 1.

Table 1 The List of the Drillings (Sable Antelope Area)

Drill Hole No.	Depth (m)	Inclination	Bearing	Depth of Laterite (m)	Length of Core (m)	Core recovery (%)	Term Starting	Term Completion	Exploration Target
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

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

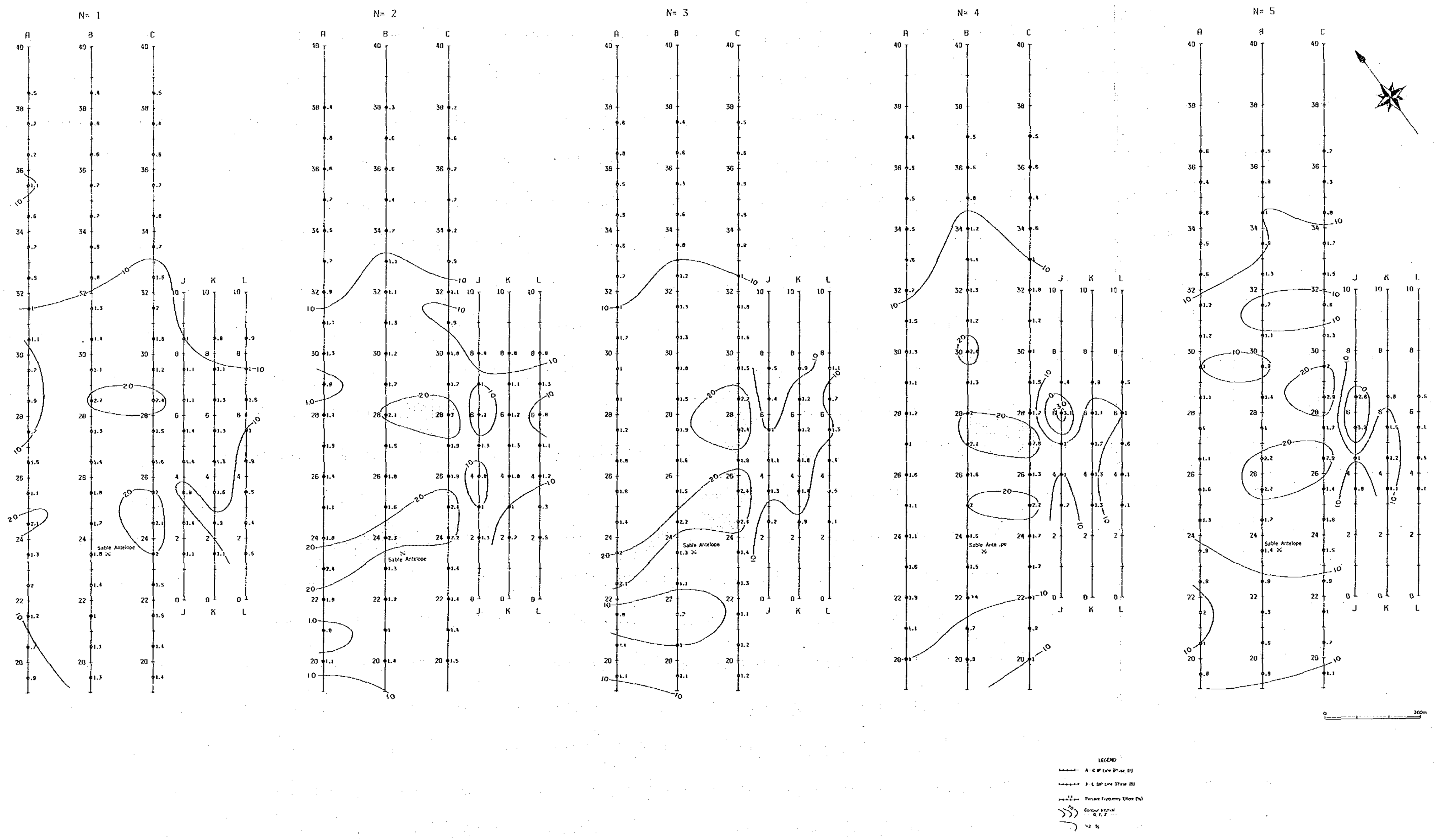


Fig. 6 Plan Map of PFE (0.125-1.0Hz) (n=1~5)

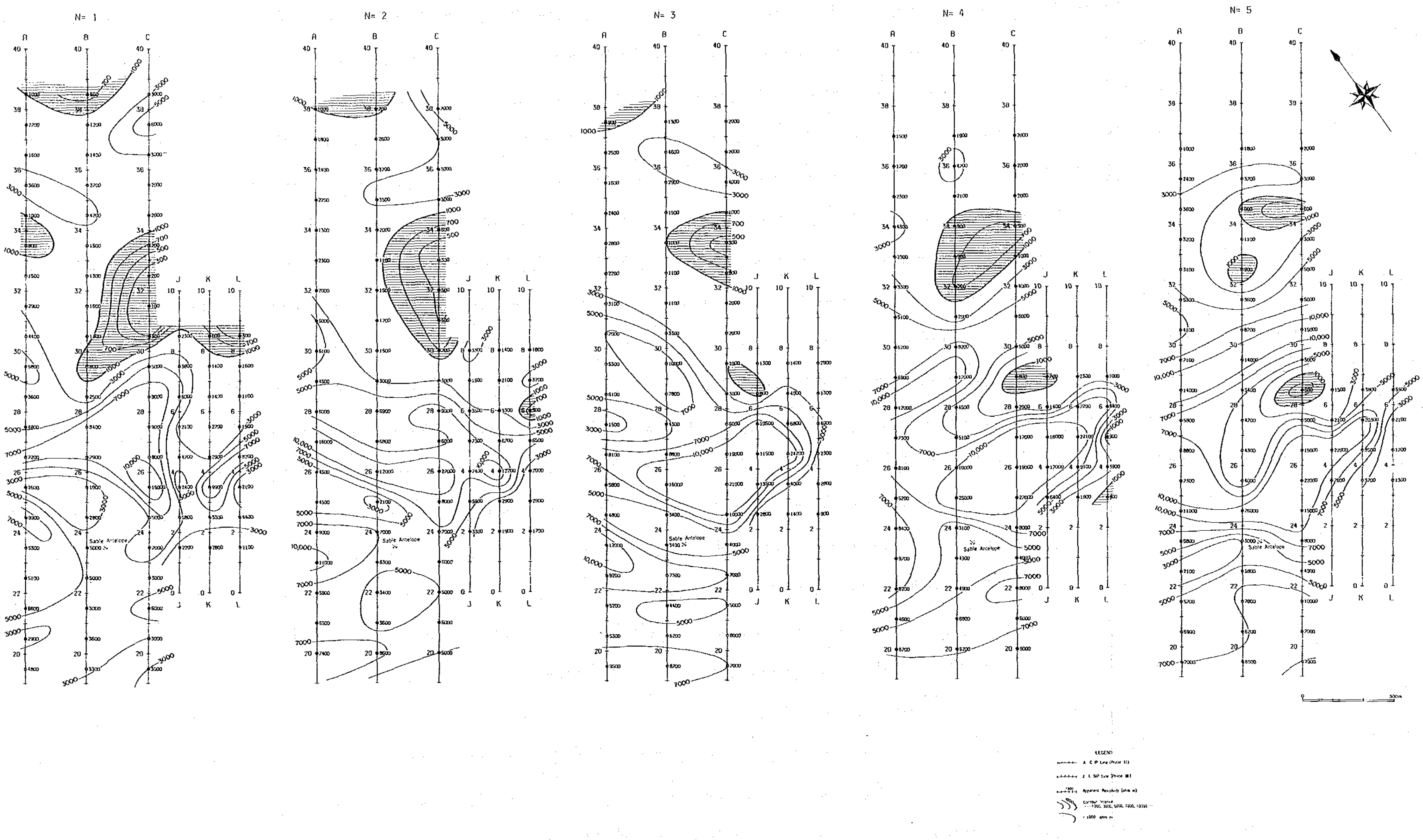


Fig. 7 Plan Map of AR(0.125Hz) (n=1~5)

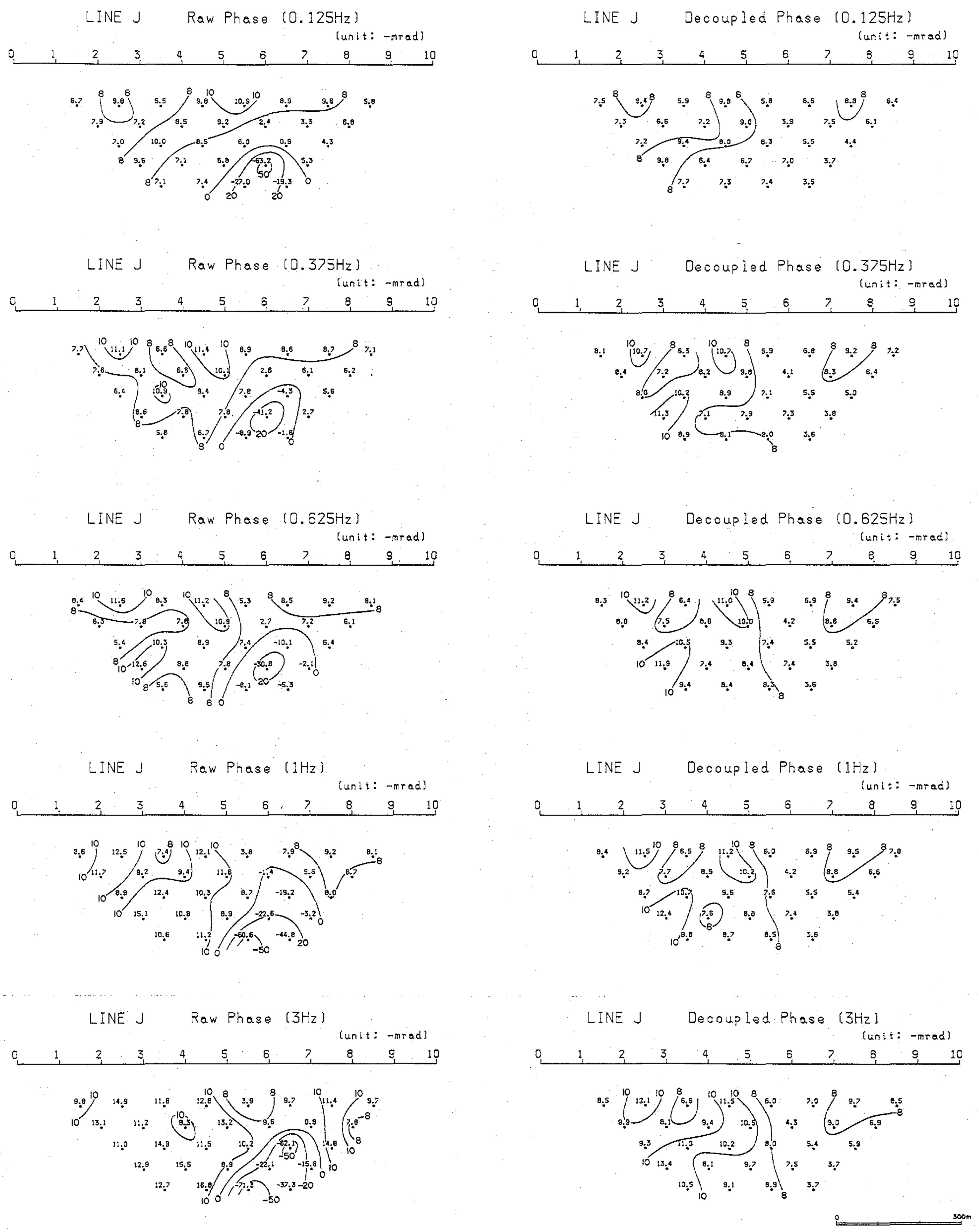


Fig. 8 Phase at Five Frequencies Line J

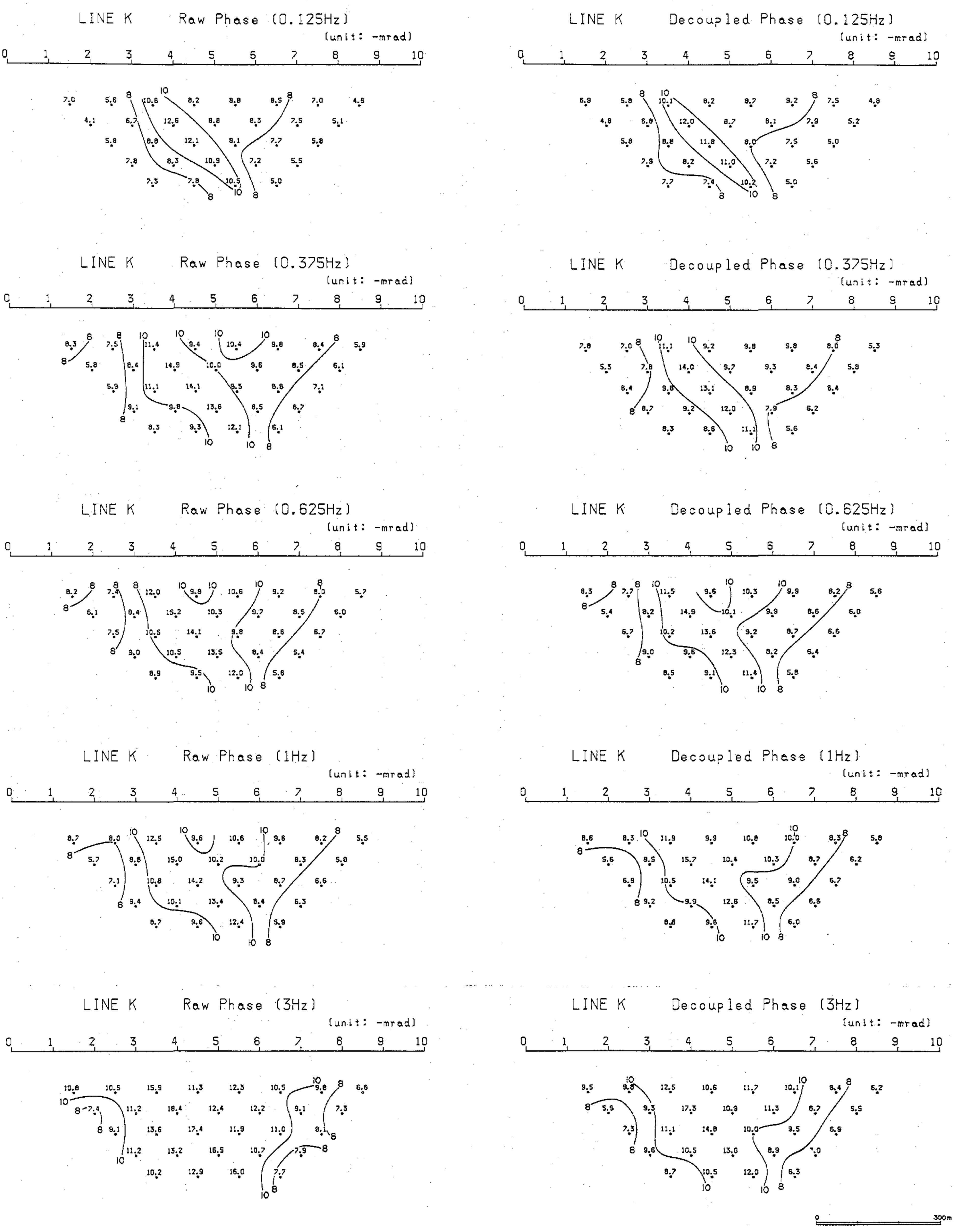


Fig. 9 Phase at Five Frequencies Lihe K

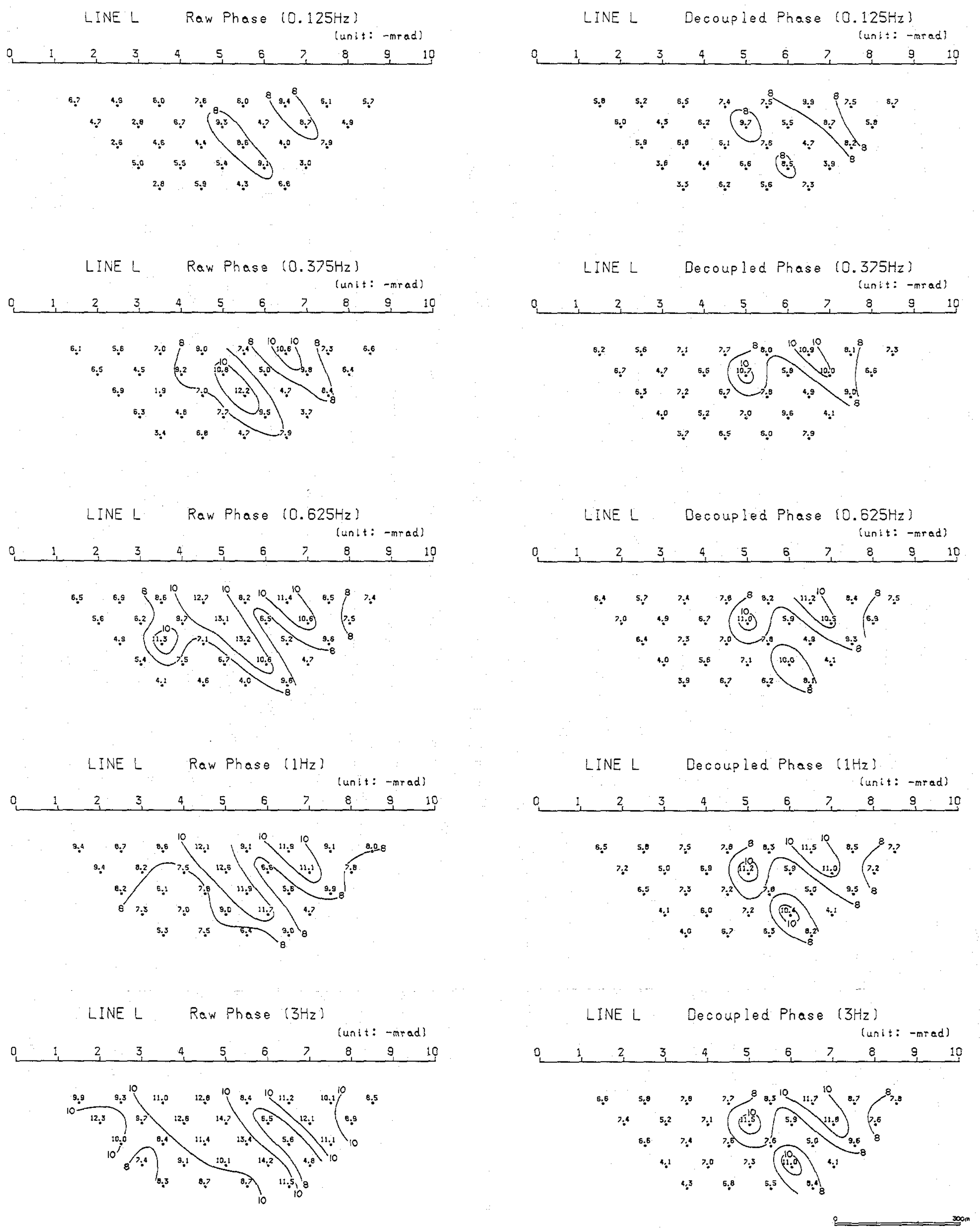


Fig. 10 Phase st Five Frequencies Line L

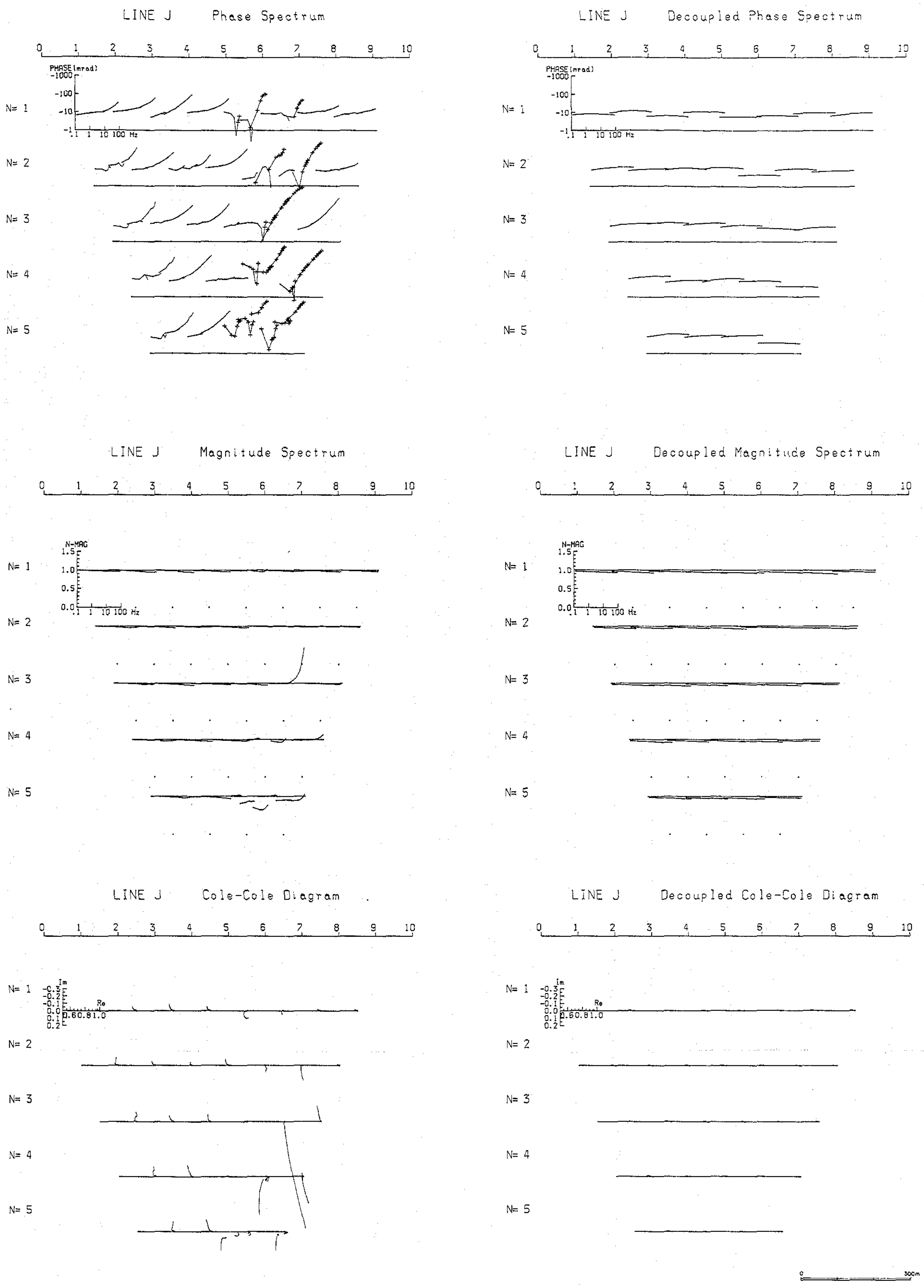


Fig. 11 Phase,Magnitude & Cole-Cole Spectrum Line J

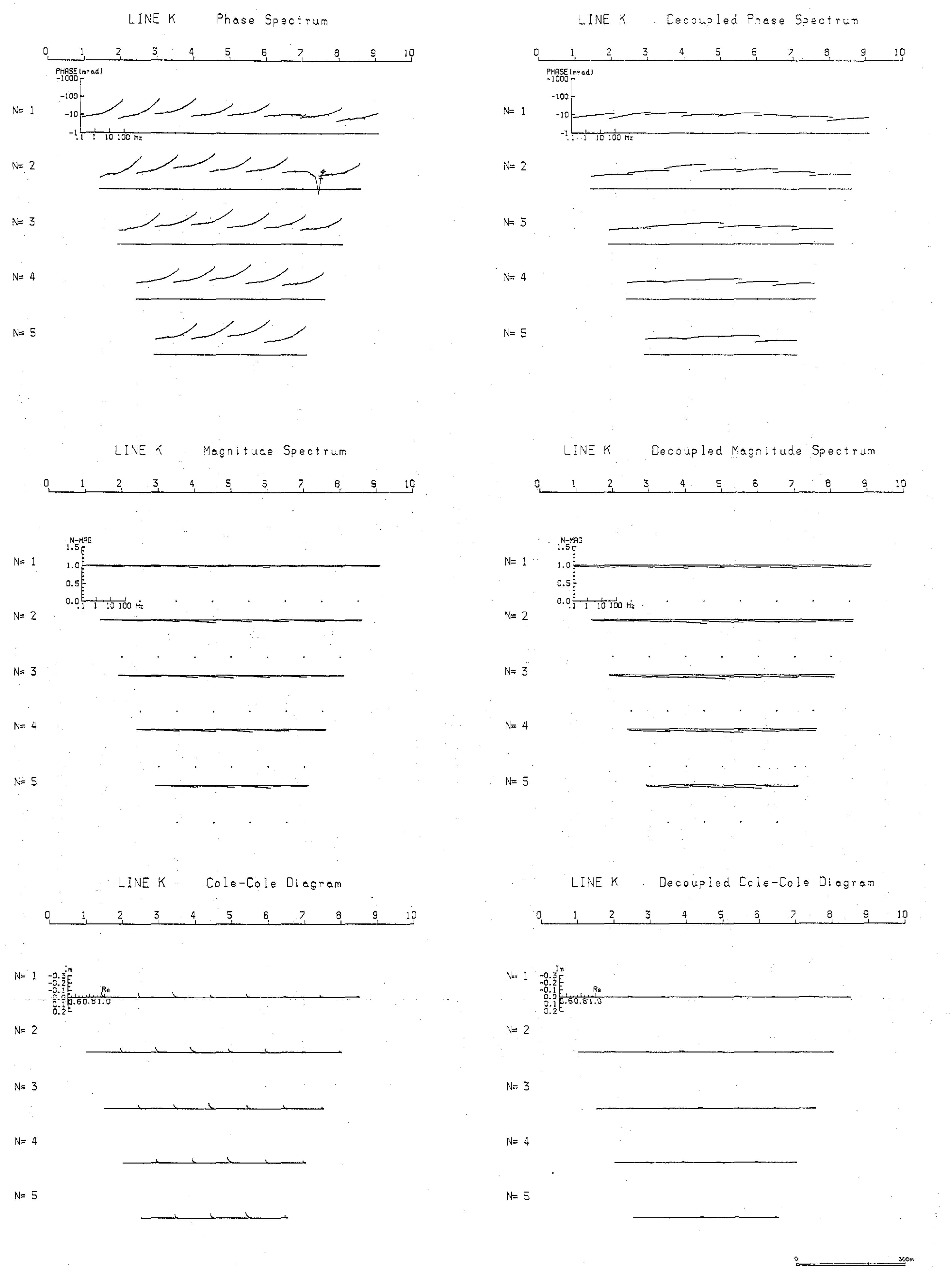


Fig. 12 Phase,Magnitude & Cole-Cole Spectrum Line K

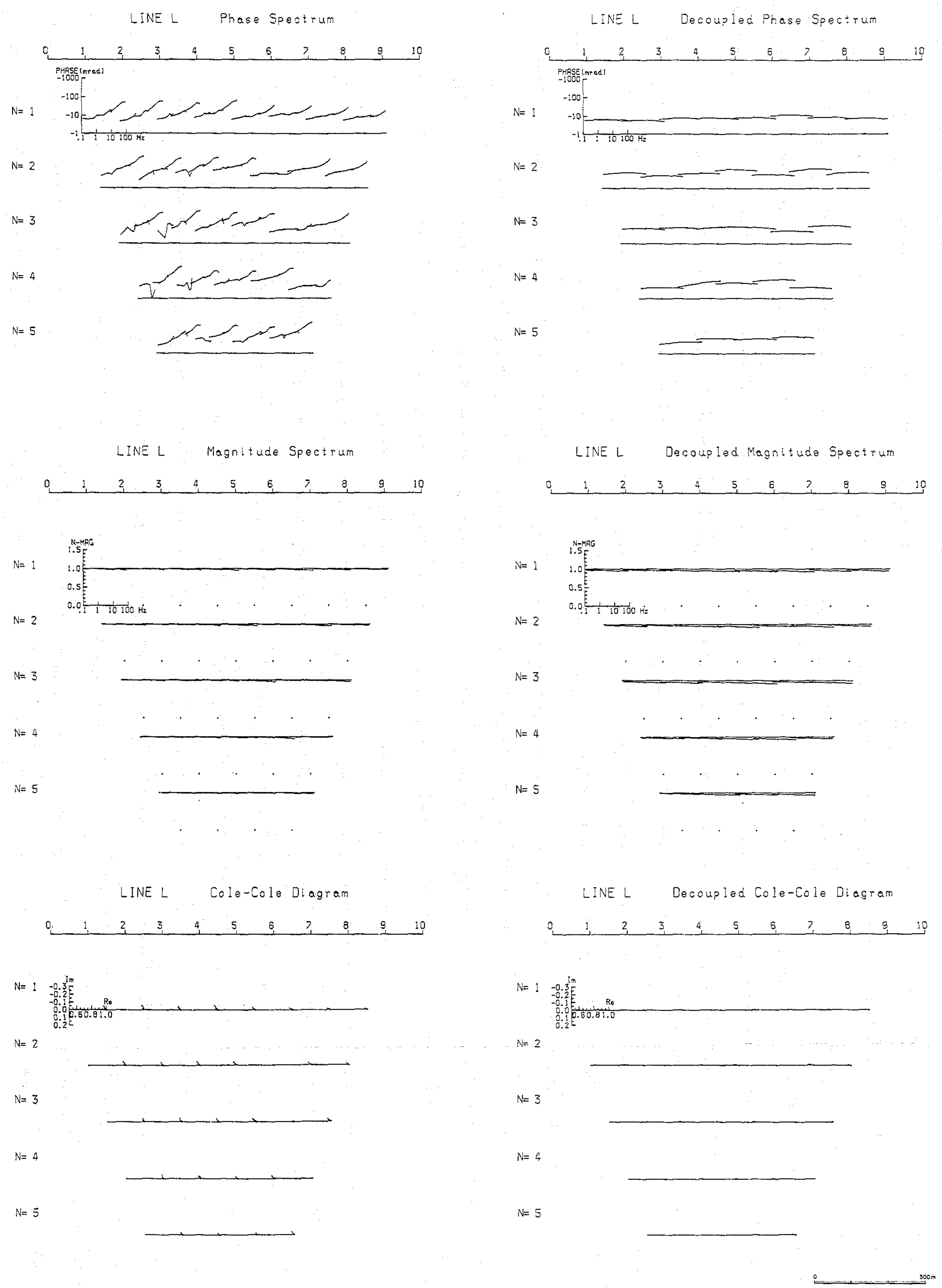


Fig. 13 Phase,Magnitude & Cole.Cole Spectrum Line L

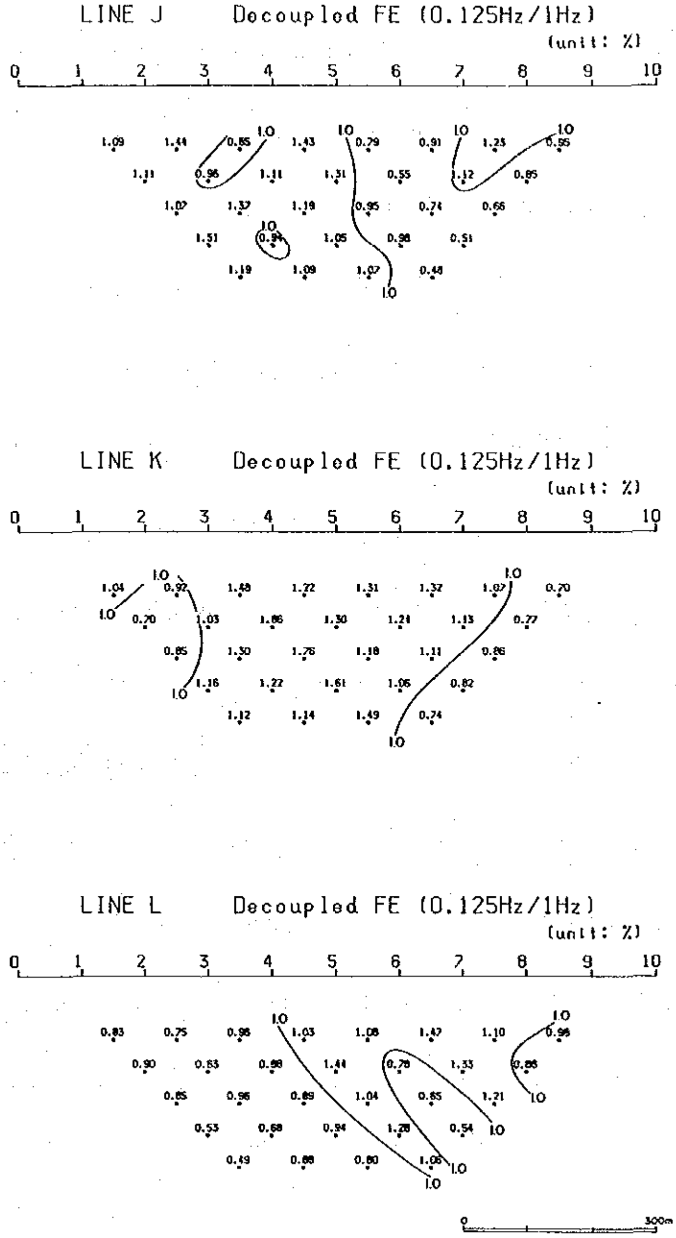


Fig. 14 Decoupled PFE Line J, K, L

MODEL NO. C-11

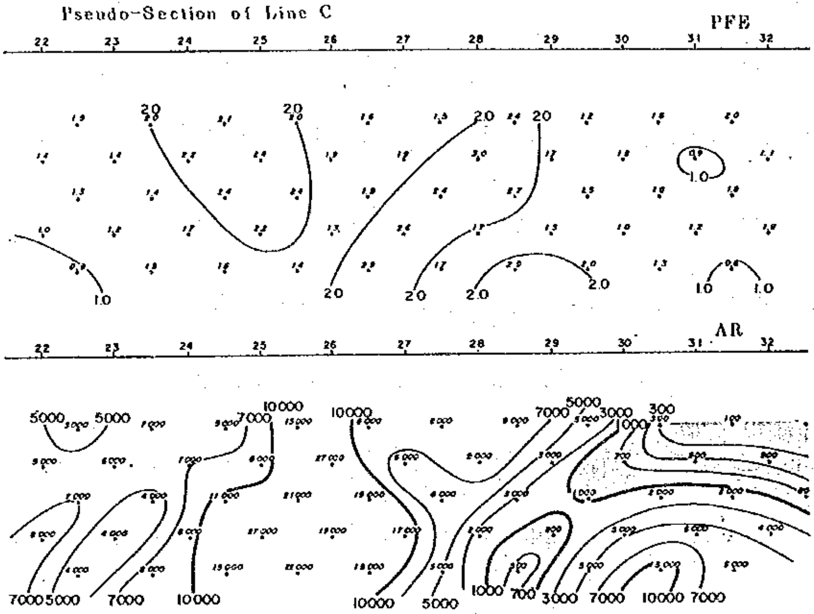
CODE	RESISTIVITY OHM M	F. E. %
1	200.	1. 5
2	6000.	1. 5
3	30000.	1. 5
4	6000.	2. 5
5	0.	. 0
6	0.	. 0
7	0.	. 0
8	0.	. 0
9	0.	. 0

Simulation Model

22 23 24 25 26 27 28 29 30 31 32

	1	222	222	222	222	222	222	222	222	111	111
	2	222	444	444	333	333	334	444	422	111	112
-100m	3	222	444	444	333	333	334	444	422	111	112
	4	222	444	444	333	333	334	444	422	111	112
	5	222	444	444	333	333	334	444	422	222	222
	6	222	222	222	333	333	332	222	222	222	222
-200m	7	222	222	222	333	333	332	222	222	222	222
	8	222	222	222	333	333	332	222	222	222	222
	9	222	222	222	333	333	332	222	222	222	222
-300m	10	222	222	222	333	333	333	222	222	222	222
	11	222	222	222	333	333	333	222	222	222	222
	12	222	222	222	333	333	333	222	222	222	222

Pseudo-Section of Line C



Calculated Anomaly

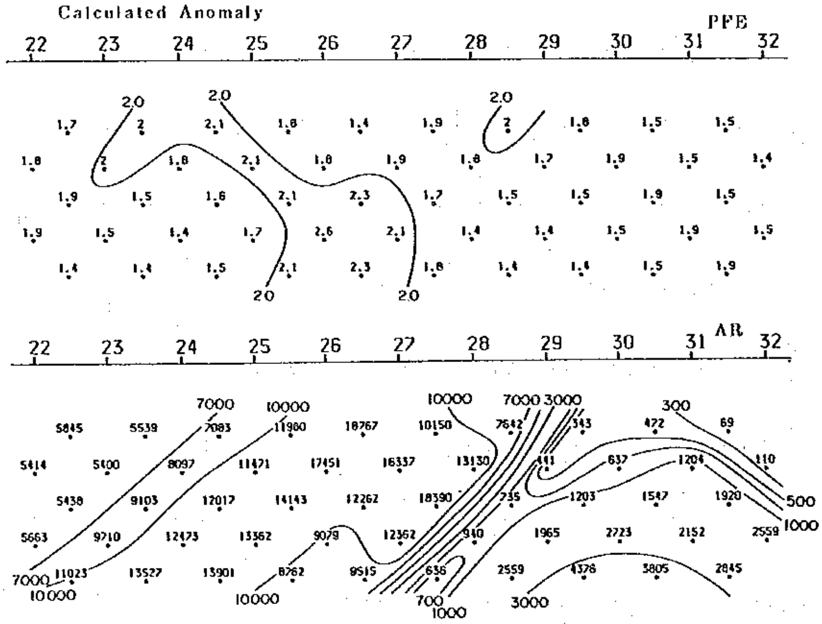


Fig. 15 Result of Model Simulation Line C

2-1-2 Surface geology

The condition of the exposed area is poor in some parts, so it is difficult to fully understand the details of the geology. A geological survey on the surface was conducted nonetheless for comparison with the surface geology studied during the investigation of the core by drilling.

This area, which consists mainly of massive dolomite up to dolomitic limestone as well as massive stratified limestone which belong to carbonate rocks, contains in the upper part of the southwestern portion massive stratified dolomitized arenaceous rock which belongs to the arenaceous-argillaceous rocks (Fig.16).

(1) Vicinity of the Blue Jacket mineralized zone

Along the southwestern portion of this area are distributed gray stratified limestone, shale and dolomite arenaceous rock.

The shale in layer is decolored near the surface and shows grayish brown colors. The layer thickness is small in the west and large in the east ranging from 100m to 150m. The dolomitized arenaceous rock is divided into two kinds, one of which has a remarkably developed stratified structure and the other is massive.

The geological structure features a WNW-ESE direction and a monocline with 80° to 90°S dip. It should also be noted that in the arenaceous rock layer there exists a remarkable interlayer fold - an abnormal fold zone. Mineralization is occurring locally across these layers.

The mineralization observed in and around the Blue Jacket mineralized zone is developing mainly in the dolomitized arenaceous rock and, rarely, in the shale. The mineralized zone occur discontinuously in a lenticular shape with stockworks disseminated mainly by chalcopyrite and partly of bornite and tennantite. In the mineralized zone, dolomite veinlet, siderite veinlets and sideritic calcite veinlets occur generally.

(2) Vicinity of the Sable Antelope deposit

The central to northeastern part of this area consists of an upper layer of gray stratified limestone and a lower zone of pinkish gray limestone with a relatively high impurity content. The former contains a remarkably expanding compact arenaceous rock layer which is thick and massive in the west.

The geological structure is not clear but is assumed to be in a WNW-ESE direction with a monocline at an dip of 60°S.

In the upper layer of limestone, brecciated and fractured zone is observed, which is particularly widespread in the east. A strong dolomitization is observed in this brecciated and fractured zone, with a weak tendency in the west.

The Sable Antelope deposit is located in the vicinity of the border of the above brecciated and fractured zone. The main mineralized zone is presumed to be located in the surface, about 100m length, and 2 to 10m width, strike in with N60°W strike, and 80° to 90°S dip. Mineralization is strong in the cementation zone of the brecciated dolomite. This zone is strongly silicified. There are minor mineralized zone and barren silicified, brecciated dolomite in another portion. There are siderite and ankerite formed widely in this portion.