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REPORT

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JAPAN [illegible]

REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE VERAGUAS・PROGRESO AREA,
THE REPUBLIC OF CHILE

PHASE II

MARCH, 1995

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

PREFACE

In response to the request of the Government of the Republic of Chile, the Japanese Government decided to conduct a Mineral Exploration in the Veraguàs-Progreso Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to Chile a survey team headed by Mr. Yoshikatsu Ichige from 24 October, 1994 to 14 Juarnuary, 1995. The team exchanged views with the officials concerned of the Government of Chile and conducted a field survey in the Veraguas and Progreso areas. After the returned to Japan, further studies were made and the present report has been prepared.

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

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

February 1995

Kimio FUJITA
President
Japan International Cooperation Agency

Takashi ISHIKAWA
President
Metal Mining Agency of Japan

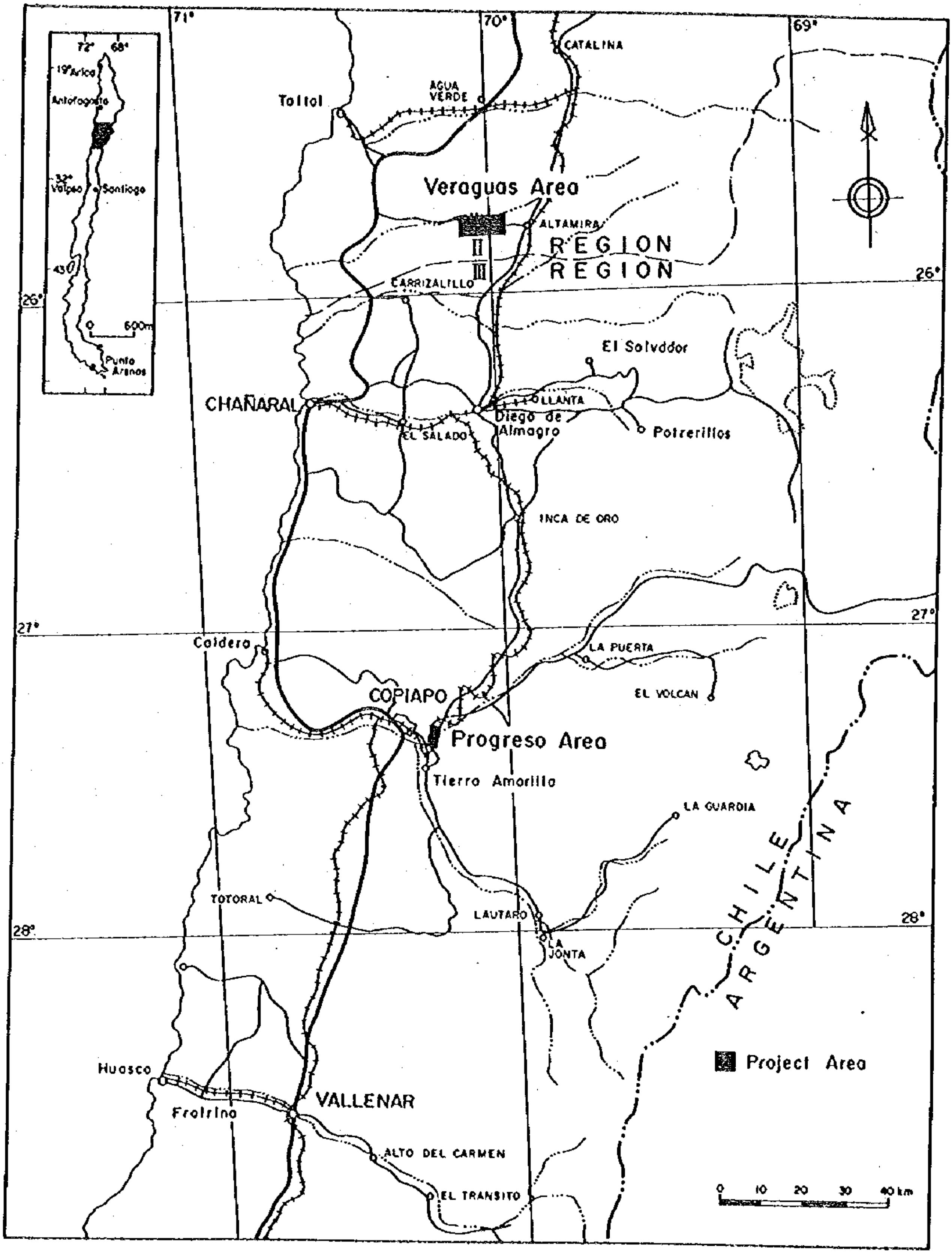

Fig. 1 Location of the project area

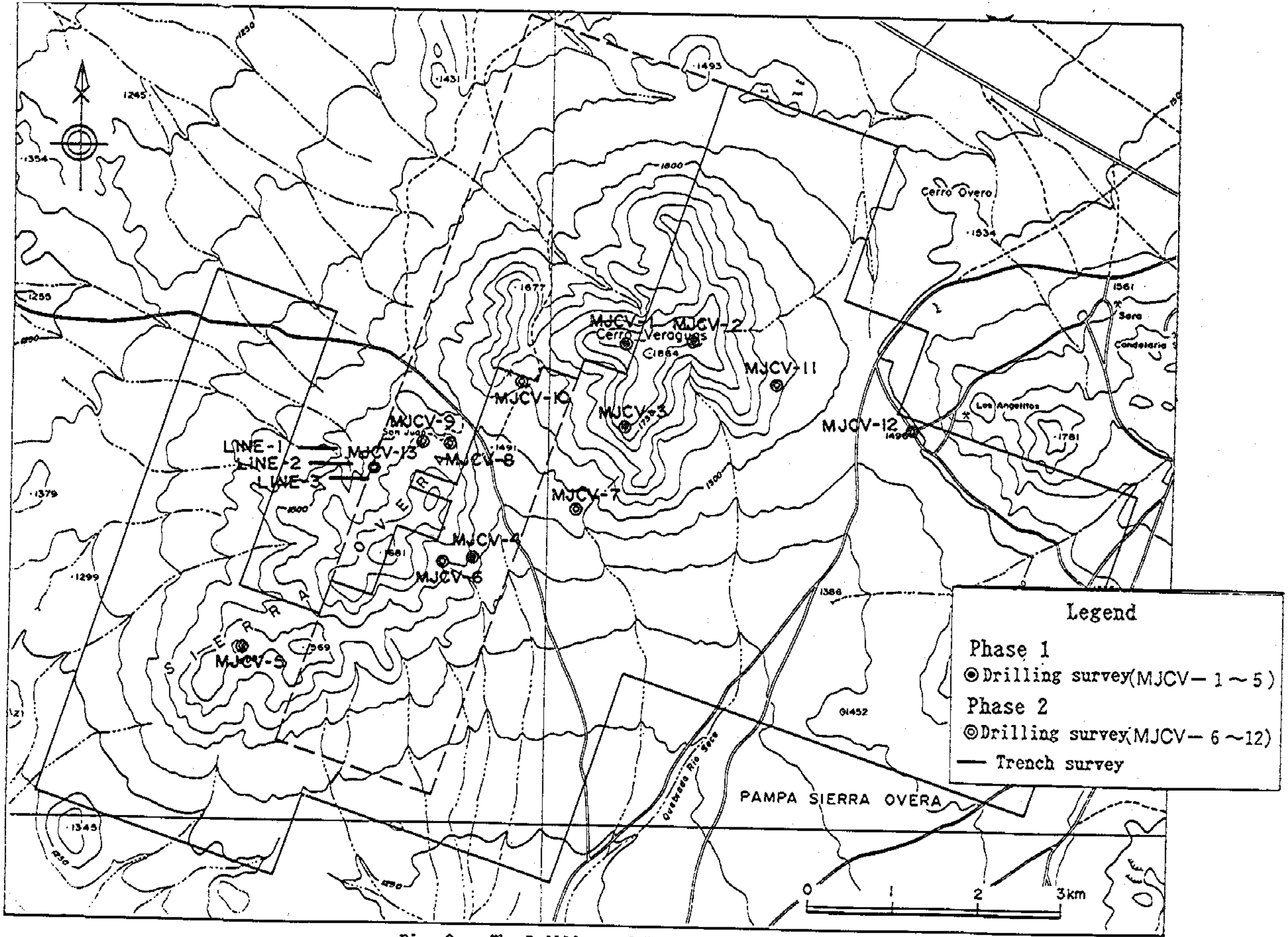

Fig. 2 The Drilling and Trench Surveys of the Veraguas area

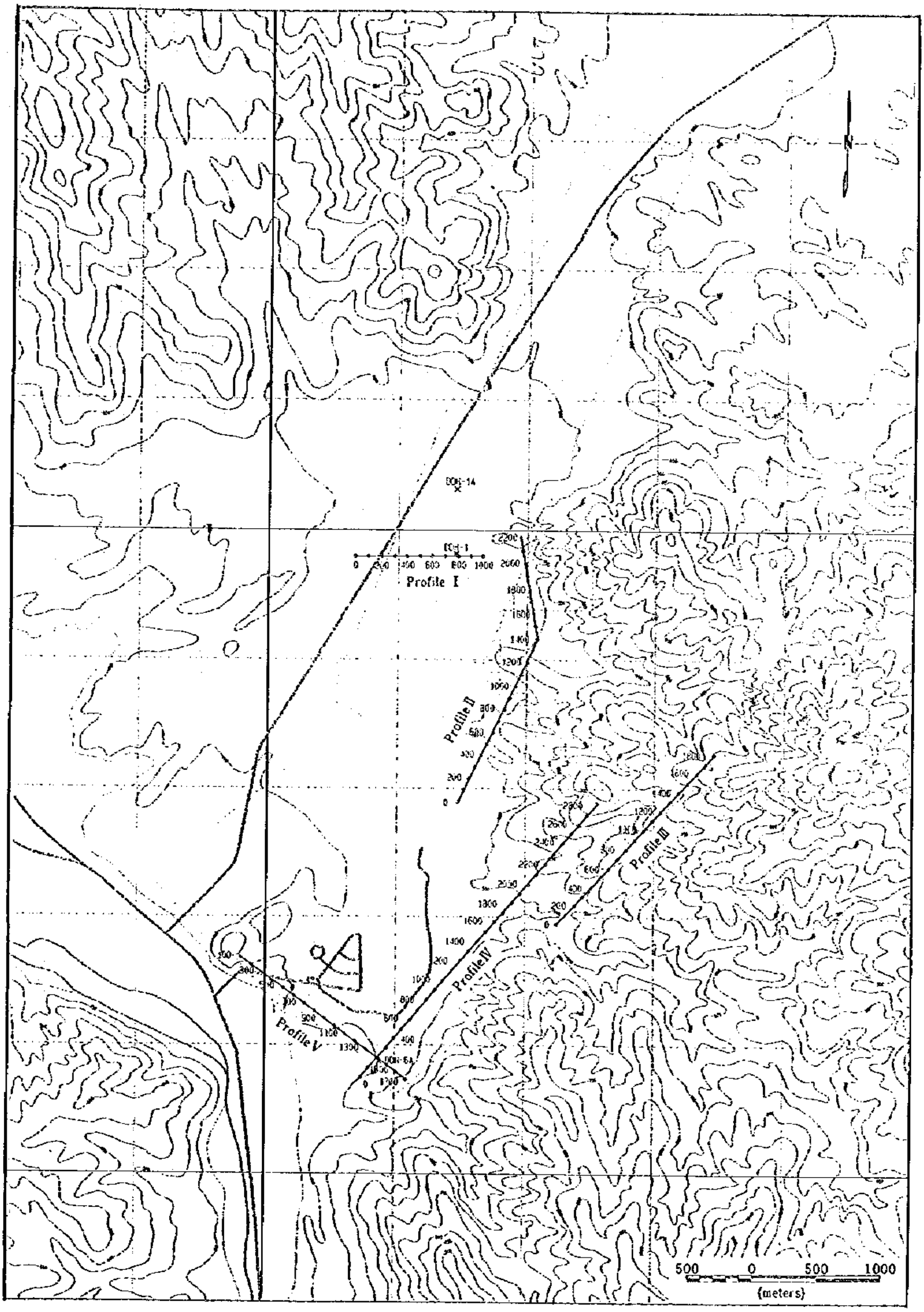

Fig. 3 The Geophysical Survey of the Progreso area

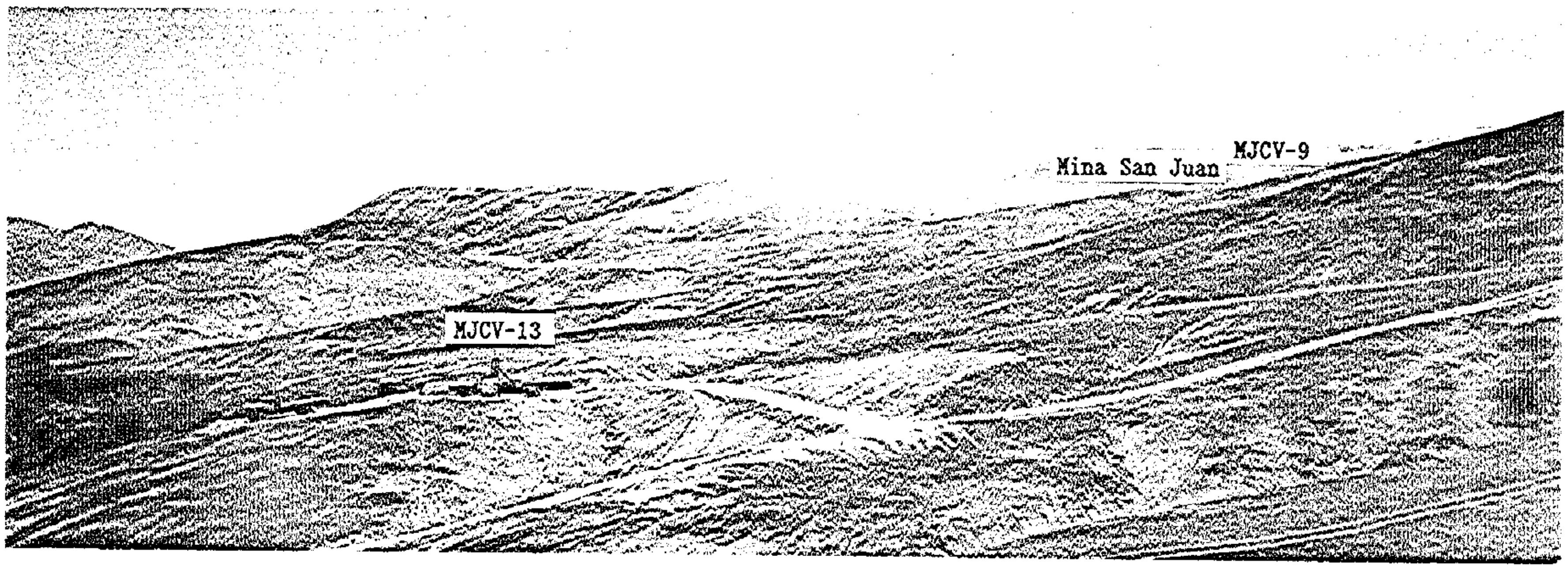

Photo 1 A view of northwestern hillside of the Sierra Overa (Veraguas Area)

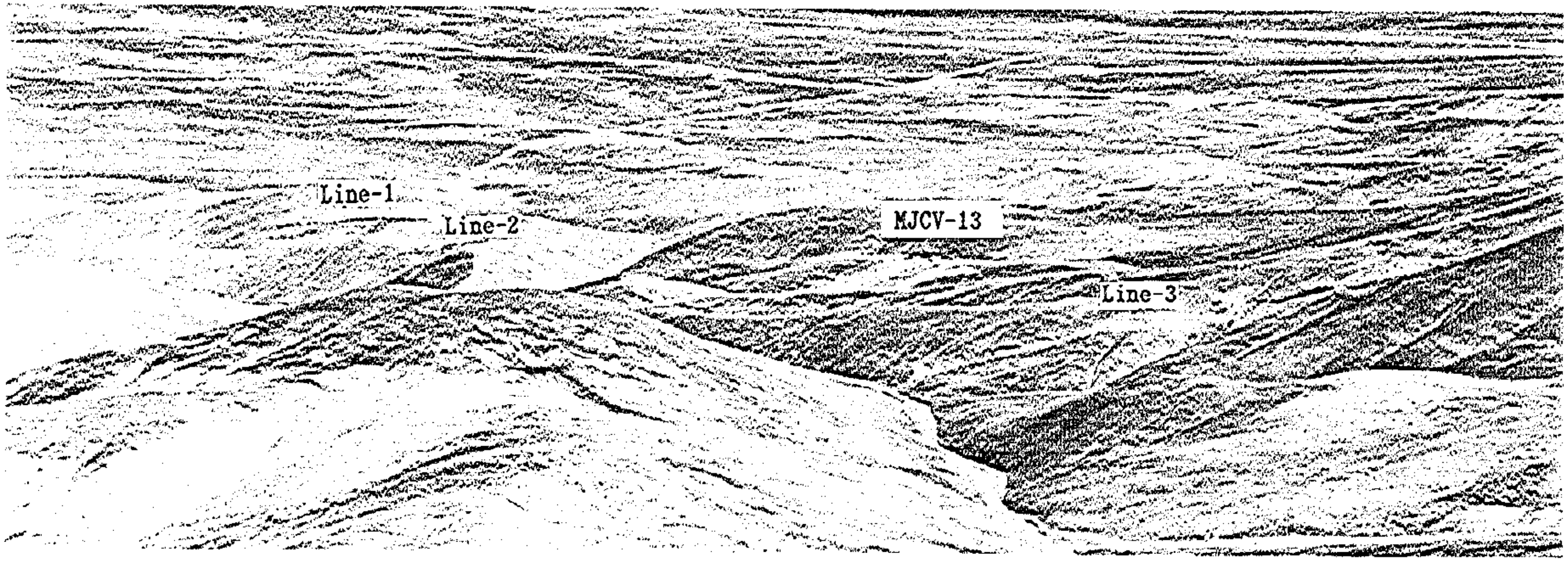

Photo 2 A view of northwestern hillside of the Sierra Overa from the peak (Veraguas Area)

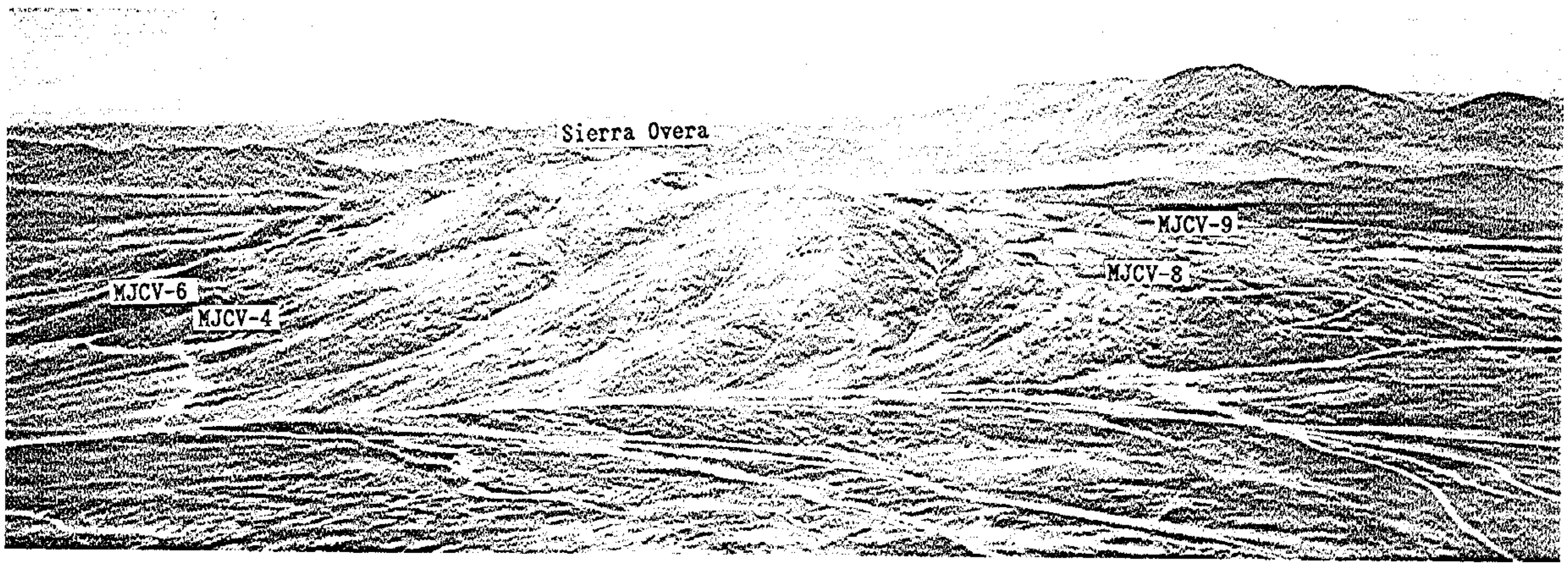

Photo 3 A view of east side of the Sierra Overa from the Cerro Veraguas (Veraguas Area)

Abstract

The present survey is Phase II of a cooperative mineral exploration of the Veraguas and Progreso areas of the Republic of Chile. In the Veraguas area drilling and trench surveys were carried out, and in the Progreso area geophysical survey was conducted. The purpose of the surveys is to elucidate the geological structure of these two areas and to ascertain the existence of new mineral deposits.

The results of the surveys led to the following conclusions.

1. Veraguas Area

The Cerro Veraguas and Sierra Overa which are located in the centre of the area are composed of andesite volcanics of the Lower Cretaceous Period with intrusive diorite-andesite porphyry, both rocks having undergone intense hydrothermal alteration. Fractures with N-S, NW-SE and NE-SW directions are developed and it is thought that these acted as a channel for the porphyry intrusion.

The hydrothermal alteration is divided into a leached zone, a siliceous argillized zone and a chloritized zone. The chloritized zone is further divided, from the top down, into the four zones listed below, corresponding to the phillic and potassic zones of alteration classification of porphyry copper deposits according to Lowell and Guilbert (1970).

Siliceous argillized-chloritized zone	: phillic zone
Chloritied zone	: phillic zone
Silicified-chlorite zone	: phillic zone
Silicified-chloritized-potassium felspare	: potassic zone

In the trench survey carried out in the northwestern hillside of the Sierra Overa, copper oxide mineralization was found accompanying the aphanitic andesite and diorite porphyry below the leached zone.

And some mineralized zones comprising copper oxide, native copper,chalcopyrite and small amounts of coveline, chalcocite and bornite in the diorite porphyry were also found in drill hole MJCV-13.

The relationship between the mineralization and alteration are as follows.

[MJCV-13]

Depth	Cu mineral	Cu ave.	max.	Auppm	Alteration
0- 17m	atacamite/brochanthite	0.55%	1.24%	0.20	siliceous argillized-chloritized
17- 70m	atacamite/brochanthite	0.24	1.12	0.14	chloritized
70- 78m	atacamite/brochanthite	0.34	0.40	0.21	chloritized
78-149m	Cu'·atacamite·azurite	0.23	0.66	0.13	chloritized
149-180m	Cu'·atacamite·azurite	0.18	0.52	0.13	silicified-chloiritized-potash feldspar
180-198m	atacamite·azurite	0.14	0.27	0.09	silicified-chloiritized-potash feldspar
198-250m	chalcopyrite	0.11	0.26	<0.04	silicified-chloiritized-potash feldspar
250-300m	chalcopyrite	0.10	0.55	<0.04	silicified-chloiritized-potash feldspar

In the phillic zone between 0-149m there was a T.Cu grade of >0.2% and a Au grade of >0.1ppm, but in the potassic zone below 149m there was a tendency for the mineralization of both copper and gold to weaken. In addition chalcopyrite dissemination accompanying the potassic zone deep down on the eastern side of the Sierra Overa was found in drilling hole MJCV-6, and copper oxide dissemination was found accompanying the leached zone in drilling hole MJCV-9, on the northern edge of the Sierra Overa, where the San Juan mine is located; and the existence of porphyry copper deposits may be expected below the the leached zone that forms the Sierra Overa.

It is hoped that further drilling and trench surveys will be carried out in the Sierra Overa district.

2. Progreso Area

In order to elucidate the state of distribution of the Punta del Cobre formation, a horizontal for ore deposit, and extract more zones of mineralization, AMT and IP survey was carried out along 5 profiles (9,4km), cores were measured their resistivity and polarizability in a laboratory, and PEM survey was carried out at the DDH-1A hole.

The results of the survey did not reveal the areas of anomaly showing low resistivity-high chargeability corresponded to Mant-type deposite anomaly that had initially been forecast. Moreover no anomalies indicating mineral prospects were observed from the results of PEM measurements in DDH-1A.

Both the resistivity values for the Punta del Cobre formation and the resistivity values for the Abundancia formation were high, and it is considered difficult to separate them using resistivity values. However, as the resistivity values of the alluvials are low and the difference is clear, it is possible to clarify the geologic structure of the survey area by tracing the structure of the high resistivity values.

In the laboratory measurements on boring cores it was found that the samples from this area showing a high chargeability tended on the whole to display a high resistivity. In particular, looking at the correspondence between the chargeability of core samples and copper analysis values, the high chargeability core samples in DDH-1A have the high copper analysis values.

Therefore it is possible to suppose that the high resistivity-high chargeability anomaly indicates a skarn mineral deposit, or indicates a structure in which the Punta del Cobre formation is distributed near the surface and is accompanied by the weak mineralization effect. When the anomalies where chargeability is over 50mV/V are laid over the a shallow region of a high resistivity zone , the region centering on profile II measurement point 1300 in the central eastern part of the area and the region centering on profile III measurement point 1000. In addition, a region with high chargeability centering on profile II measurement point 2000 in the northeast of the area was confirmed. While no rise in the zone of high resistivity is assumed, the region of high chargeability was observed; this is a region close to a high anomaly zone measured in the airborne magnetic survey, and it is hoped that these areas will be subjected to further surveys.

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Part I GENERAL REMARKS

CHAPTER 1 INTRODUCTION

1-1 Background and Objective

The region from the coastal mountain range to the Andes in the north of the Republic of Chile contains many gold, silver and copper ore deposits of the Manto type, disseminated type and porphyry-copper deposit type. As shown in Fig. 1, the Veraguas and Progreso areas are located within this region.

The present survey is being conducted in these areas based on the Scope of Work regarding the cooperative mineral exploration agreed in August 19th, 1993 between the government of Japan and the government of the Republic of Chile.

The survey covers $80km^2$ in the Veraguas area and $10km^2$ in the Progreso area, and is scheduled to take three years for completion. The present year represents the second phase of the survey, which was carried out by personnel dispatched by both Japan and the Republic of Chile.

In the first phase, the following surveys were carried out:

- An analysis of existing data on the Veraguas and Progreso areas.
- Drilling surveys and geochemical investigations in the Veraguas area.

The results of these surveys demonstrate the existence of promising mineralized zones in the district stretching from the southern side of the Cerro Veraguas to the eastern side of the Sierra Overa, and geochemical anomalous zone in the north-west district of the Sierra Overa.

Since it may be surmised that there is a strong possibility of the existence of porphyry-copper ore deposits in these promising districts, it was suggested that in the second phase a more detailed survey should be carried out with regard to these districts.

1-2 Conclusions and Recommendations of the First Phase Survey

1-2-1 Conclusions of the First Phase Survey

(1) Drilling Survey in the Veraguas Area

The survey was carried out 5 holes, with a total length of 2,053 m. The special features of copper mineralization understood as a result of the drilling survey are as follows.

Cerro Veraguas summit District (MJCV-1 & MJCV-2):

Copper mineralization is found in the porphyry of the lower part of the siliceous argillized zone and in the chloritized zone, particularly in the border area with the andesitic volcanics and along the fracture zone within the porphyry; but since the copper grade at T.Cu 500-1100ppm is low, and is accompanied as shown in the MJCV-2 hole by the mineralization effect of small amounts of lead and zinc, it is supposed that the region is some distance from the center of the mineralization.

Cerro Veraguas southern District (MJCV-3):

Copper mineralization is found in the porphyry of the chloritized zone below 300m at the MJCV-3 hole, in particular in and around the border area with the andesitic volcanics; and 10 points a total, 14m, had a T.Cu reading of 500-7000ppm. At these points the molybdenum grade is also high, with an average of 52.4ppm between 300-375 m and a maximum of 213ppm, indicating the special features of porphyry copper deposits.

Sierra Overa eastern District (MJCV-4):

Copper mineralization is found in the lower part of the siliceous argillized zone and in and around the border area between the porphyry and andesitic volcanics of the chloritized zone below 206m at the MJCV-4 hole and around the potassic zone below 400m; and 7 points a total, 13m, had a T.Cu reading of 500-3200ppm. Around the potassic zone below 490 m, gold mineralization (Au 0.6-4.8ppm) is also discovered. The discovery of copper and gold mineralization in the potassic zone shows the special features of porphyry copper deposits.

Sierra Overa southwest District (MJCV-5):

Between 280-292m at the MJCV-5 hole, where the porphyry and N-S fracture zone intersect, T.Cu measured 540ppm, and between 364-367m, the border area of the chloritized and siliceous argillized zones within the porphyry, 1,041ppm; from this it is surmised that the copper mineralization was controlled by changes in the alteration environment within the porphyry, and by the N-S fracture zone, a passage for hydrothermal water.

The results of the ore analysis showed the copper grade to be 7000ppm maximum, and did not lead directly to the discovery of deposits; but it was discovered that there was copper and molybdenum mineralization below 300m at the MJCV-3 hole in the Cerro Veraguas south district, and copper and gold mineralization below 400m at the MJCV-4 hole in the Sierra Overa eastern district. These instances of mineralization indicate the special features of porphyry copper deposits, and it may be expected that such deposits do exist nearby.

(2) Geochemical Survey

179 samples of caliche were collected in the Pampa and Northwest Districts where caliche is present in the alluvium/colluvium distribution areas. In addition, 49 samples of rock were collected from the hills in the Pampa South District where altered rocks are distributed. On these samples chemical analysis for 9 components was carried out and the geochemical anomalies obtained were examined.

With regard to the caliche, in the area around the Pampa Mine deposits, which are the only known mineral deposits in the area under investigation, results showing geochemical anomaly area of T.Cu and S.Cu were obtained. This is considered a clear reflection of the presence of mineral deposits below the alluvium/colluvium. Except the area around the Pampa Mine, a geochemical anomaly area of T.Cu and S.Cu was obtained at the east end of sampling line W in the Northwest District, and the presence of copper deposits below the alluvium/colluvium is expected here too. However, this zone of geochemical anomaly lies along the course of a dry river, and it is possible that the copper deposits exist upstream side.

While geochemical anomalies of S occur in around the Pampa Mine, on the eastern end of sampling line W geochemical anomaly area of FeO, Fe_2O_3 and SiO_2 occur, and it is possible that the copper deposits which may be expected to lie on the eastern end of sampling line W are of a different type to the Pampa Mine deposits.

With regard to the rock, geochemical anomaly of T.Cu is accordant with the existence of hematite, and since the hematite is considered to have been replaced from magnetite through the action of acidic hydrothermal activity, the geochemical anomaly of T.Cu is expected as being attributable to the presence of some amount of Cu in the igneous magnetite. In addition, from the fact that the acidic hydrothermal alteration in this district is different from the type of the potassium type alteration or phyllic type alteration that characterize the hydrothermal alteration of porphyry copper deposits, and neither pyrite nor its secondary mineral jarosite is present at all, the conclusion is reached that there was no mineralization accompanying the hydrothermal activity in this district.

1-2-2 Recommendations of the First Phase Survey

The present survey did not lead directly to the discovery of deposits, but it was discovered that there was copper and molybdenum mineralization below 300m at the MJCV-3 hole in the Cerro Veraguas southern district, and copper and gold mineralization below 400m at the MJCV-4 hole in the Sierra Overa eastern district. These instances of mineralization indicate the special features of porphyry copper deposits, and it may be expected that such deposits do exist nearby. On the northern side of the Sierra Overa, some 1,500 m northwest of the MJCV-4 hole, are the San Juan deposits.

It follows that in Phase II, it would be desirable for drilling survey to be carried out in the district reaching from southern hillside of the Cerro Veraguas to the east and north of the Sierra Overa.

With regard to the eastern end of sampling line W in the Northwest District where geochemical survey of the caliche showed geochemical anomaly area of Cu, it is advisable that a trench survey be carried out to ascertain the presence of the expected copper deposits beneath the alluvium/colluvium. However, since this geochemical anomaly lies along a dry river and the possibility exists that the copper deposits lie upstream side, it is desirable that the trench survey be carried out from the geochemical anomaly area toward its southeast part.

1-3 Outline of the Second Phase Survey

1-3-1 The Area Surveyed

The survey for the present year covers the Veraguas and Progreso areas. The location of the two survey areas is shown in Figs.2 and 3.

1-3-2 Purpose of the Survey

The purpose of the survey is to clarify the geological structure of the Veraguas-Progreso area of the Republic of Chile and to ascertain the existence of new ore deposits.

1-3-3 Method of Survey

In the Veraguas area a drilling survey and trench survey were carried out, and in the Progreso area a geophysical survey was conducted. Survey content and amounts are shown in Table 1-1-1.

The main themes for each survey were as follows.

(1) Drilling Survey

To elucidate the geological structure in the Veraguas area, and ascertain the existence of new porphyry-copper type ore deposits.

(2) Trench Survey

To ascertain the existence of mineralization corresponding to the Cu geochemical anomaly discovered by Phase I survey in the Veraguas area.

(3) Geophysical Survey

To ascertain the existence of sulfide ore deposits like Manto type in the Progreso area, by seizing the resistivity and polarizability of deep zone.

Table I-1-1 Amounts of field works and laboratory tests

1. Drilling Survey

Drill Hole	Direction	Inclination	Depth
MJCV- 6	--	-90°	400.0m
MJCV- 7	--	-90°	450.0m
MJCV- 8	--	-90°	450.0m
MJCV- 9	N 90°W	-75°	248.5m
MJCV-10	--	-90°	300.0m
MJCV-11	N 90°W	-60°	300.0m
MJCV-12	S 45°W	-75°	200.0m
MJCV-13	--	-90°	300.0m
Total	8 holes		2,648.5m

Laboratory tests		
①Polished thin section	44pcs	
②Polish section	16pcs	
③X-ray diffractin analysis	71pcs	
④Homogenization temperature measurement of fluid inclusion	15pcs	
⑤K-Ar dating	3pcs	
⑥Chemical analysis		
T.Cu,S.Cu,Au,Ag,Mo	2,616pcs	13,080elements
Pb,Zn	373pcs	746elements
T.Cu,S.Cu	180pcs	360elements
T.Cu	10pcs	10elements
⑦EPMA analysis	5pcs	
⑧Resistivity and Polarization measurement	59pcs	

2. Trench Survey

500m in length × 3 lines a total of 1,500m

Laboratory tests		
①Polished thin section	6pcs	
②X-ray diffractin analysis	16pcs	
③Chemical analysis		
T.Cu,S.Cu,Au,Ag,Mo	64pcs	320elements

3. Geophysical Survey

AMT	42 measuring points	9.4km total lines
IP	306 measuring points	9.4km total lines
PEM	1 hole 5 loops	

Laboratory tests
①Resistivity and polarization measurement 30pcs

1-3-4 Composition of the Survey Team

The following team members participated in this year's survey.

(1) Supervisor

Japanese side	Chilean side
Mr.Takashi Tsujimoto Metal Mining Agency of Japan	Mr.Jose Luis Mardones S. Empresa National de Mineria
Mr.Masayoshi Kameyama Metal Mining Agency of Japan	Mr.Mario Serrano Caviers Empresa National de Mineria
	Mr.Ivan Henriquez Sapunar Empresa National de Mineria
	Mr.Roberto Ponce Farias Empresa National de Mineria
	Mr.Guillermo Gonzales S. Empresa National de Mineria
	Mr.Pedro Ilabaca Ugarte Empresa National de Mineria

(2) On-site survey team

Japanese side	Chilean side
Drilling survey/Trench survey	
Mr.Yoshikatsu Ichige(Team leader) Nittetsu Mining Consultants Co.,LTD	Mr.Pedro Ilabaca Ugarte Empresa National de Mineria
Mr.Ken'etsu Sasaki Nittetsu Mining Consultants Co.,LTD	
Geophysical survey	
Mr.Koichi Matsuo Nittetsu Mining Consultants Co.,LTD	Mr.Osvaldo Cautin Moruna Empresa National de Mineria
Mr.Takeharu Takahashi Nittetsu Mining Consultants Co.,LTD	Mr.Benigno Zamora Contreras Empresa National de Mineria

1-3-5 Period of Survey

Phase 2 of the survey was carried out over the following periods.

On-site Survey (Departure from Japan to Return)

Drilling Survey/Trench Survey	:24th October 1994 to 14th January 1995
Geophysical Survey	:24th October 1994 to 23rd December 1994
Analysis and drawing up of report	:24th December 1994 to 28th February 1995

CHAPTER 2 GEOGRAPHICAL FEATURES OF THE SURVEY AREA

2-1 Veraguas Area

2-1-1 Location and Access

The Veraguas area is located approximately 850 km north of Santiago, the capital of Chile, some 80 km east of the Pacific coast, in the southern part of the II Region. The range covers a total land area of 80 Km^2 in ENAMI's Virgo 1-1213 mining field and the Chatal 3001-3400 mining field of Taltal Chanaral S. A., a local private company with which ENAMI has a prospecting contract. The site is 350 km by road from either Antofagasta, capital of the II Region, or Copiapo, capital of the III Region; a 4-hour journey by car.

2-1-2 Topography and Water System

The topography of the II Region in which the Veraguas area is located reflects the geology and structure of the region, and may be divided into three belts running north-south, from the west:

Coastal Cordillera
Central Depression
Domeyko Cordillera

The Veraguas area is located in the eastern edge of the coastal cordillera, bordering on the central depression. In the central part of the area, the peaks Cerro Veraguas (1,864 m) and Sierra Overa (1,681 m) have a relative height of 200 to 300 m and form a mountainous area stretching roughly 10 km NE to SW, with an average width of 3 km. To the SW of the saddle between the two peaks lies the San Juan Mine. In the south-east part of the area are low mountains (1,597 m) with a relative height of about 100 m, running NE to SW. These mountains display steep geographical features above 1,450 m, while the base of the mountains forms an area of gently-sloping hills 1,200-1,450 m above sea-level.

With regard to the water system, dry river beds can be seen running NW and SE along the edge of the NE-SW mountains, turning west in the lower reaches to empty into the Pacific Ocean. However, this water system was formed in the historical past when there was rainfall, and it is extremely rarely that any water actually flows here.

2-1-3 Climate and Vegetation

The Veraguas has a typical desert climate, with hardly any rainfall and continual clear skies. Temperatures are between 25°C-30°C during the day, dropping drastically at night to 10°C-15°C in the summer(December to February), 5°C-10°C in the winter (June to August). Mist often forms in the coastal areas, but very rarely penetrates into the Veraguas area. Thus vegetation is extremely limited; only cacti are to be found.

2-2 Progreso Area

2-2-1 Location and Access

The Progreso area is located approximately 660 km directly north of Santiago, 70 km east of the Pacific coast, in the center of the III Region. The range covers a land area of approximately 10km^2 of ENAMI's Progreso 1-211 mining field, including the grounds of the Paipote Smeltery. The area is 10 km by road from Copiapo and can be reached in 10 minutes by car.

2-1-2 Topography and Water System

The central part of the III Region in which the Progreso area is located shifts gradually from the coastal cordillera to the Domeyko cordillera. The Progreso area is located roughly in the center of the coastal cordillera, at the point where the Copiapo River, running SE-NE, joins the Paipote River, which runs NE-SW; the two rivers form a transverse valley. Both sides of the transverse valley are formed by mountain ranges 800-1,000 m above sea level, with a relative height of about 400 m.

2-1-3 Climate and Vegetation

The Progreso area has a dry, temperate climate in winter (June to August) and a dry, subtropical climate in summer (December to February), with a mean annual rainfall of less than 25 mm. Mean temperatures are 13°C in winter, 23°C in summer, with daily fluctuations from a minimum of -2°C to a maximum of 32°C. From May to October thick mists called camanchaca are generated at night along the valley of the Copiapo River.The land along side the Copiapo River is used for the cultivation of vines, tomatoes, onions, etc; however elsewhere nothing but low-growing grasses can withstand the dryness.

CHAPTER 3 REGIONAL GEOLOGY OF THE SURVEY AREA

3-1 Veraguas Area

Mercade, M.W. (1978), Naranjo, J.A and Puig, A (1984), Ulriksen, C.G (1990), Boric, P.R, Diaz, F.F and Maksaev, J.V (1990), etc., have reported on the regional geology of northern Chile, in which the Veraguas district is located. In addition, the International Mineral Resource Development Cooperation Association (JMEC, 1993) has on the basis of these data carried out satellite-image analysis of the region centered on this area, synthesizing the regional geological map, comprehensive geological columnar section and ore deposit & mineral-alteration zone distribution map shown in Fig. I-3-1, -2 & -3.

According to this information, the regional geology around the Veraguas area is clearly related to the topography, and the area may be divided into three zones: from the west, the Coastal Cordillera, Central Depression and Domeyko Cordillera. The Coastal Cordillera has a distribution on the west of rocks of the Paleozoic group and Triassic-Jurassic System, and on the east, underlying Cretaceous System. On the border between the two runs the Atacama Fault, which is a normal fault belt on a N-S axis, which suggests that the western land mass has risen in relation to the rest. The Central Depression has underlying Cretaceous System, while in the Domeyko Cordillera Jurassic to Cretaceous System is overlained by Tertiary and Quaternary Systems. In addition in the Domeyko Cordillera, the West Fault (Falla Oeste) and Domeyko Fault (Falla de Domeyko) on a N-S axis, are clearly developed.

The area covered by the present survey is located on the border of the Coastal Cordillera and the Central Depression, and in the western part of this area porphyritic and aphanitic andesite lava and pyroclastics of the Aeropueruto formation dominate. In the eastern part the Aeropueruto formation is in many places covered by andesitic lava and pyroclastics of the Palaeogene Chile-Alemania formation and Neogene Atacama conglomerate.

These volcanic rocks are penetrated by batholith so called "the Cerro de Pingo Group" composed of diorite, tonalite and granite and small rock bodies of dioritic or andesitic porphyry, thought to have been active from the later Cretaceous Period to the Paleogene Period.

The Veraguas area is composed of the Aeropuerto formations of the Cretaceous period and intrusive rocks. These rocks had been altered in the Tertiary period, forming the Cerro Veraguas and the Sierra Overa. The flat or gently sloping areas surrounding the hills are covered in alluvium, colluvium and river deposits of the Pliocene to the Quaternary periods.

The Aeropuerto formations are composed mainly of dacitic or andesitic volcanic rock and are accompanied with subordinate sedimentary rocks. The intrusive rocks are composed of quartz diorite, tonalite, quartz andesite and porphyry. The type of alteration is seemed to be derived from lava or pyroclastics. According to ENAMI (1987), the alteration is classified into intensely silicified zone, quartz-sericitized zone, siliceous-argillized zone and propylitized zone. In the intensely silicified and quartz-sericitized zones, there are strong concentrations of sulfide cercilla relics, limonite, hematite, jarosite, etc., controlled by the fracture zone.

Within the area are located the Pampa Copper Mine (small-scale, at present unworked, irregular form, chrysocolla, hematite, specularite, calcite) 3 km east of the peak of the Cerro Veraguas, and the San Juan Copper Mine (small-scale, at present unworked, veined, chrysocolla, hematite) 2.5 km to the south-west. In addition, 8 km to the east, outside the area are distributed the Sierra Overa group of copper and gold mines, at present unworked or worked on a small scale. Thus it may be considered that the potential for copper and gold deposits in this area is high.

3-2 Progreso Area

In the environs of the Progreso area many manto-type mines have been developed and are being worked, such as the Punta de Cobre Mine and the La Canderaria Mine.

The geology of Copiapo, which includes the Progreso area, has been investigated by Segerstrom and Parker (1959), K. Segerstrom (1962), Francisco Ortiz (1966) and others, and since the area contains a stratum of Punta de Cobre which is the country rock of manto-type deposits, ENAMI has, since 1992, conducted the geological, geochemical and physical surveys.

The geology of the area and its environs is comprised of lowerCretaceous volcanic and sedimentary rocks, intrusive rocks thought to have been active from the mid-Cretaceous to early Tertiary Periods, and unconsolidated sediment of the Pleistocene and Holocene Periods. The volcanic rocks and sedimentary rocks of the lower Cretaceous period are classified, from the bottom, into the Punta del Cobre, Abundancia, Nantoco and Bandurrias formation. Of these, distributed within the survey area are the Punta del Cobre and Abundancia formation.

The Punta del Cobre formation is distributed in the foothills on both the east and west sides of the Copiapo River, along an anticlinal axis in a NE-SW direction. The formation may be divided into a lower (kpcli) and an upper (kpcls) formation. The lower stratum is made up of mainly andesitic lava, and the nether limit of the stratum is unascertained. The upper stratum has a depth of 60-120 m, and is made up of andesitic lava, andesitic tuff breccia, lapilli tuff and tuff volcanic rocks, intercalated with sedimentary rocks, such as slate, sandstone, calcareous sandstone, limestone, etc. Within the area, the andesite of the upper formation and albitized meta-andesitic lava are exposed in parts, but mostly they are covered by a Quaternary stratum.

The Abundancia formation covers the Punta del Cobre formation, and is distributed in its east, south and southwest parts. The formation is divided into three layers, from the bottom, kad, kau and kam. The kad layer is a stratified limestone-prominent stratum, the kau layer a weakly-stratified to massive limestone stratum sandwiched with trackitic tuff, and the kam layer is made up of skarn accompanying mineralization. These formations are in conformity, showing a strike in a NNE to NE direction and forming an anticlinorium with an axis in the same direction. The area is located on the western wing of the anticlinorium, and with the trackitic tuff of the kau layer as the key stratum it is possible to suppose the location of the upper layer of the Punta del Cobre formation.

The intrusive rocks are made up of granites of the Andes batholith distributed widely on the western side of the Copiapo River, and acidic to basic dykes penetrating them.

The above-mentioned rocks are controlled by a folding structure with a NE-SW axis and a NW-SE, N-S fracture structure. On the west side of the Copiapo River, this tendency is strong, and the NW-SE, N-S linearment is prominent. On the east side of the Copiapo River each stratum has a gentle easterly incline, but in the NE part where the survey area is located the folding structure and thrust fault accompanying it, are developed.

The ore deposits in the area and its environs are classified into three as shown below, and are generated controlled by the folding structure in the NE-SW direction and the NW-SE, N-S fracture structure.

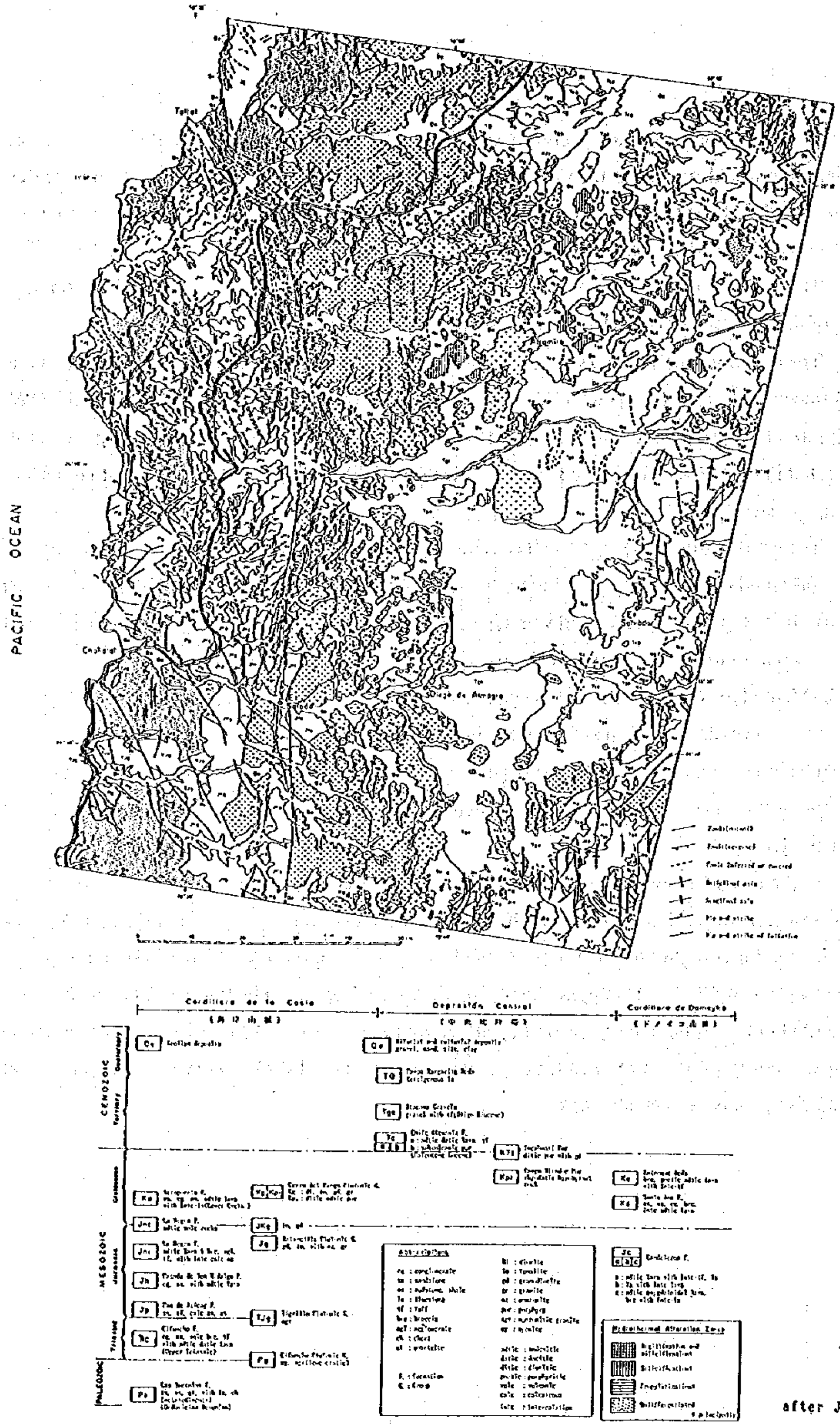
a) Manto type, breccia type and vein type ore deposits with the Punta del Cobre formation as the country rock. Made up of chalcopyrite - pyrite - magnetite - hematite ores.

b) Manto type ore deposits with the garnet skarn and Hornfels of the Abundancia formation as the country rock. Made up of gold-bearing oxidized copper - chalcopyrite ores.

c) Gold-bearing iron ore vein-type deposits within the Andes batholith as the country rock.

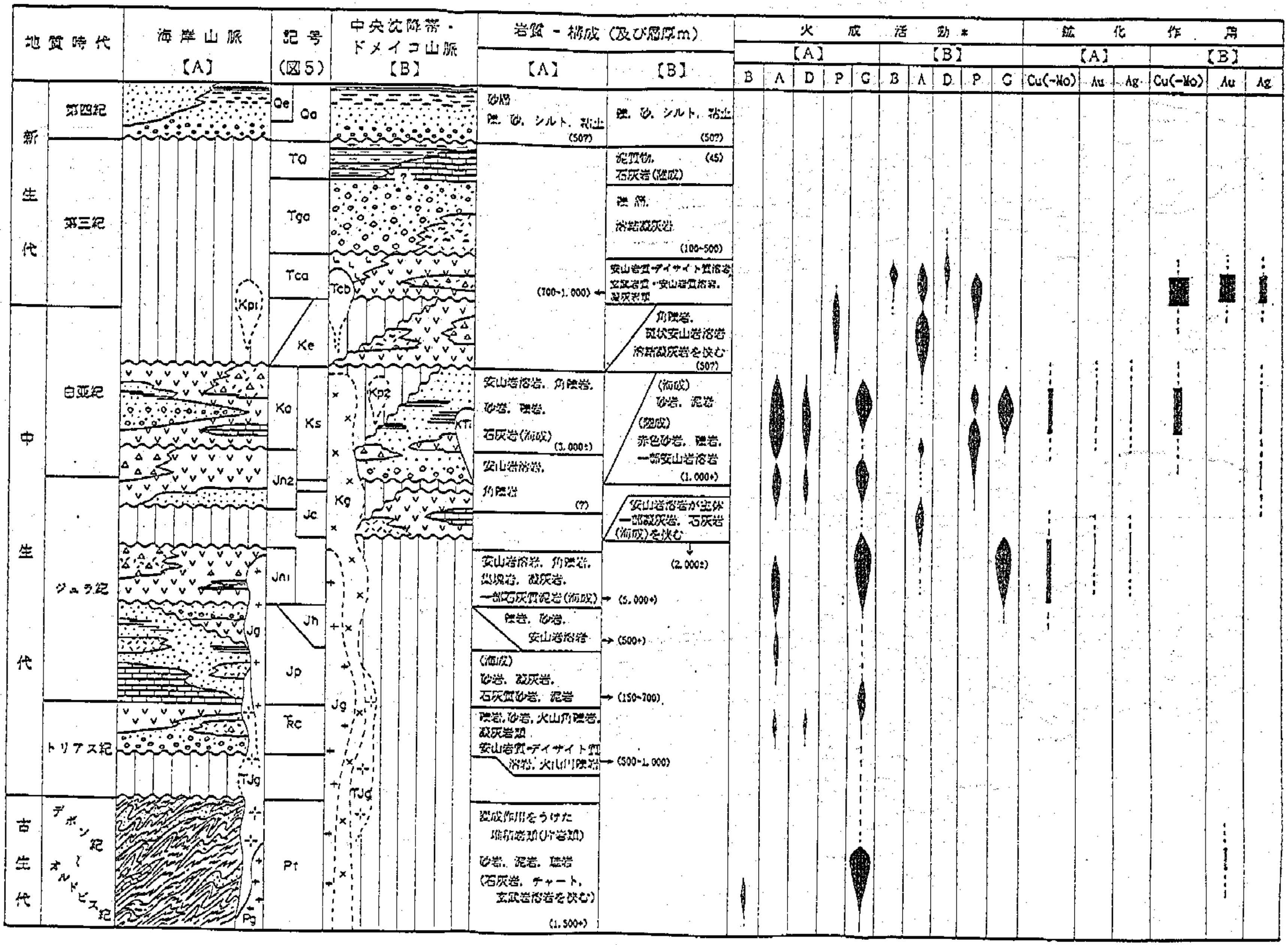
Of these, a) is of economic value, and there are mines in operation on both east and west sides of the copiapo river.

In the Progreso area, the southeast and northern parts are selected as fields for exploration. The southeast part conceals the Punta del Cobre stratum, which is a horizon for manto-type ore deposits, and a geochemical investigation of the rocks in the kau layer, the upper layer distributed on the surface, produced values of Cu:205-1660ppm, Au:<50ppm, Ag:6.3-20ppm. The Punta del Cobre stratum is also concealed in the northern part, covered by alluvium; in the skarn in the upper kam layer, mineral indications of mainly pyrite have been found, and in a geochemical rock survey of the outcrops values of Cu:35-585 ppm have been obtained.



after JMEC(1993)

Fig. I−3−1 Regional geology of the Veraguas area



＊ B : basalt, A : andesite, D : dacite, P : porphyry, G : granitoids

after JMEC(1993)

Fig. I-3-2 Synthetic geologic colum

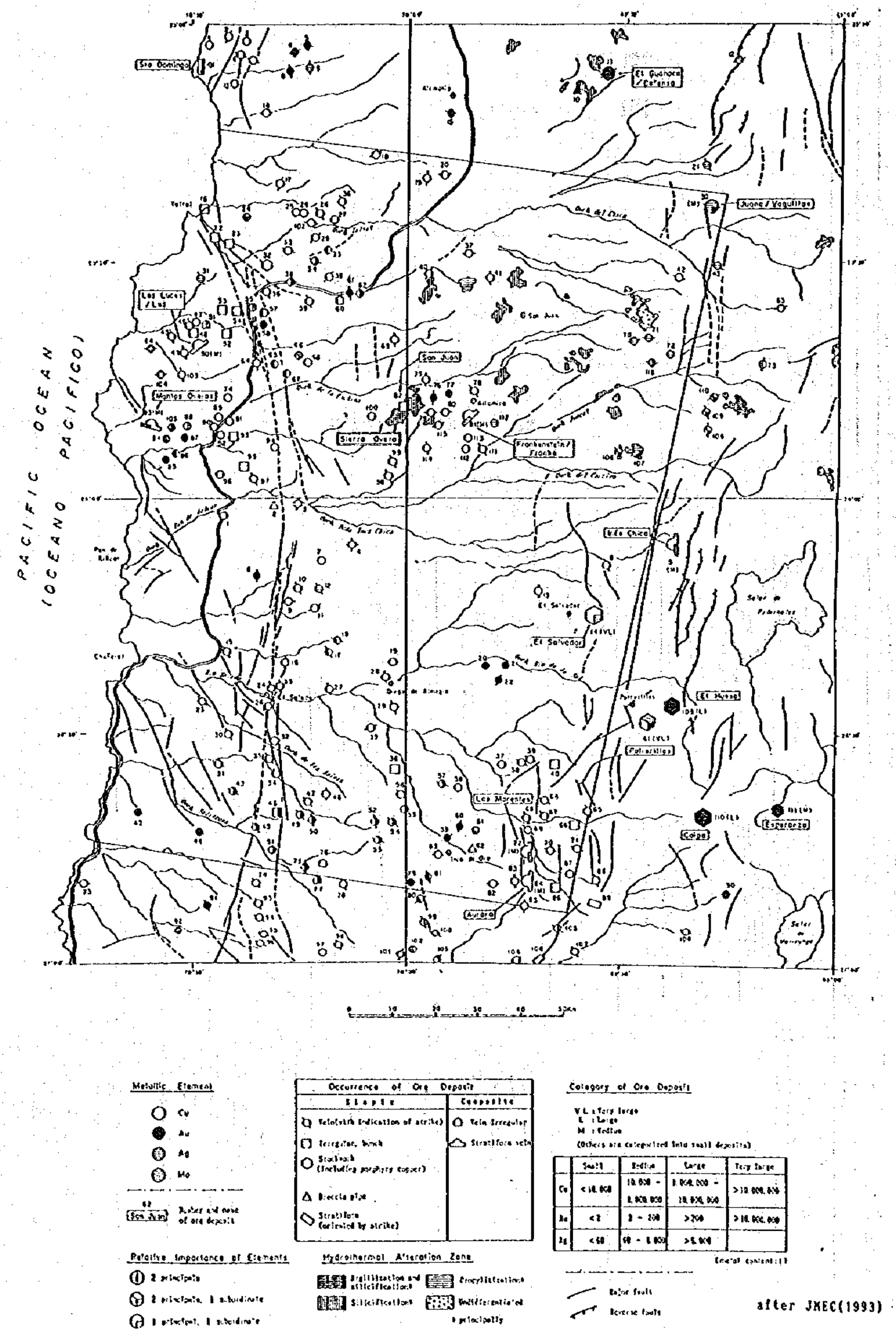


Fig. I–3–3　Distribution of ore deposits and hydrothermal zones

CHAPTER 4 DISCUSSION OF THE SURVEY RESULTS

4-1 Characteristics of the Mineralizing Alteration in the Veraguas Area

An examination of the characteristics and structural control of the mineralizing alteration was made for each district in the Veraguas area, on the basis of the results of the drilling and trench surveys carried out in Phase 2.

1. Sierra Overa District

The district is made up of andesite volcanics of the Lower Cretaceous Aeropuerto formation, with intrusive diorite-andesite porphyry, both rocks having undergone strong hydrothermal alteration. The district has fractures running in a N-S and NW-SE directions, and it may be considered that these fractures acted as channels for the porphyry intrusion. In particular, the porphyry stock striking NW-SE and ranging in width 100 to 200m is exposed in the northwestern hillside of the Sierra Overa. In this district, the surface stratum and along the above-mentioned fractures forms a leached zone 10 to 200 m thick made up of a intensely silicified zone, a quartz-sericitized zone and a siliceous argillized zone with strong concentrations of jarosite and reddish hematite.

Below the leached zone, the alteration is divided into a siliceous argillized zone and a chloritized zone. The chloritized zone is further divided, from the top down into the four zones listed below, and corresponds to the phillic and potassic zones of alteration classification of the porphyry copper deposit by Lowell and Guilbert (1970).

siliceous argillized-chloritized zone	: phillic
chloritized zone	: phillic zone
silicified-chloritized zone	: phillic zone
silicified-chloritized-potash feldspar zone	: potassic zone

The trench survey of the northwestern hillside of the Sierra Overa revealed copper oxide mineralization in the aphanitic andesite and diorite porphyry below the leached zone. Further, MJCV-13 revealed a mineralized zone containing copper oxides, native copper, chalcopyrite and small amounts of covelline, chalcocite and bornite in the diorite porphyry. The relationships between the mineralization and alteration are as shown below.

[MJCV-13]

Depth	Cu mineral	Cu ave.	max.	Auppm	Alteration
0- 17m	atacamite/brochanthite	0.55%	1.24%	0.20	siliceous argillized-chloritized
17- 70m	atacamite/brochanthite	0.24	1.12	0.14	chloritized
70- 78m	atacamite/brochanthite	0.34	0.40	0.21	chloritized
78-149m	Cu'·atacamite·azurite	0.23	0.66	0.13	chloritized
149-180m	Cu'·atacamite·azurite	0.18	0.52	0.13	silicified-chloiritized-potash feldspar
180-198m	atacamite·azurite	0.14	0.27	0.09	silicified-chloiritized-potash feldspar
198-250m	chalcopyrite	0.11	0.26	<0.04	silicified-chloiritized-potash feldspar
250-300m	chalcopyrite	0.10	0.55	<0.04	silicified-chloiritized-potash feldspar

In the phillic zone between 0-149m, the T.Cu grade is >0.2% and the Au grade >0.1ppm, but in potassic zone below 149m, the mineralization of copper and gold tends to weaken.

Native copper occurs in disseminate and film form between 78-180.0m, and microscopic observation reveals small amounts of chalcopyrite and bornite associated with native copper. In addition to the above-mentioned copper minerals, hematite and magnetite also occur universally. In places where native copper occurs the hematite has not completely replaced the magnetite, and both associate together. In places where copper oxides are abundant, the replacement of magnetite by hematite is more advanced.

As shown in Fig.I-4-1, from MJCV-6 chalcopyrite dissemination was been found accompanying the potassic zone deep under the eastern side of the Sierra Overa, and from MJCV-9 copper oxide dissemination was found accompanying the leached zone of the north of the Sierra Overa, where the San Juan mine is located. Thus it may be expected that porphyry copper deposits would be embedded under the leached zone that forms the Sierra Overa, and there is a need to continue further prospecting.

2. Cerro Veraguas District

Like the Sierra Overa district, this district is made up of andesite volcanics with intrusive diorite-andesite porphyry, both of which have undergone strong hydrothermal alteration. The district has fractures running in NE-SW and NW-SE directions, and it may be considered that these fractures acted as channels for the porphyry intrusion. The surface stratum and along the fractures forms a leached zone 50 to 300m thick made up of a intensely silicified zone, a quartz-sericite zone and a siliceous argillized zone with strong concentrations of jarosite and reddish hematite. The aleration pattern is the same as the Sierra Overa district.

In the eastern part of the Cerro Veraguast,MJCV-11 found a mineralization of approximately 2m wide with a T.Cu grade of 0.76% , made up of covelline and chalcocite, accompanying a porphyry assumed to have intruded controlled by the NW-SE structure. Thus in the east of the Cerro Veraguas, the existence of porphyry copper deposits controlled by the NW-SE structure may be expected, albeit on a small scale. However, in the district from the center to the western part of the Cerro Veraguas, although drilling in the first year and this year revealed local copper mineral prospects in the range of 0.2% to 0.7%, the poor continuity suggests that widespread mineralization is not to be expected.

3. The plain south of the Cerro Veraguas

The plain south of the Cerro Veraguas is covered by the Paleogene Chile-Alemania formation. Below this lies a basement of andesite volcanics of the Aeropuerto formation which has undergone silicification and chloritization and hematite dissemination, but shows little if any signs of sulphides such as pyrite, not to mention copper minerals.

4. Pampa District: the plain east of the Cerro Veraguas

Quartz diorite stock, which NW-SE liniation is developed, is distributed over a range 2 x 2km. The one or two kilometres between the district and the Cerro Veraguas are covered by aluviums and colluviums and the border between the stock and the andesite volcanics of the Aeropuerto formation is not clear.

The MJCV-12 revealed a stockwork type mineralization comprising copper oxide and chalcopyrite accompanying hematite dissemination in quartz-diorite that has undergone chloritization and epidotization.

Between 0-131.0m and 178-182m the copper oxides such as chalcanthite and brochanthite are yielded in film form along fructures, in addition to which small amounts of chalcocite and covelline may be observed. Between 13-19m in particular, the average T.Cu grade is 0.6% and copper oxides are associate with calcite network and/or hematite film. Between 125-131m the average T.Cu grade is 1.02% and copper oxides are associated with hematite film and dissemination. Between 131-178m chalcopyrite dissemination accompanies pyrite and hematite and the average T.Cu grade is 0.31% between 131-148m, 0.1% between 148-178m.

It is thought that this mineralization zone exists controlled by the NW-SE structure.

It is hoped that in a further survey the border between the quartz diorite stock and the andesite volcanics of the Aeropuerto formation will be clarified. and that the relationship between the stock work mineralization of the district and the porphyry copper type mineralization of the Sierra Overa, will be elucidated.

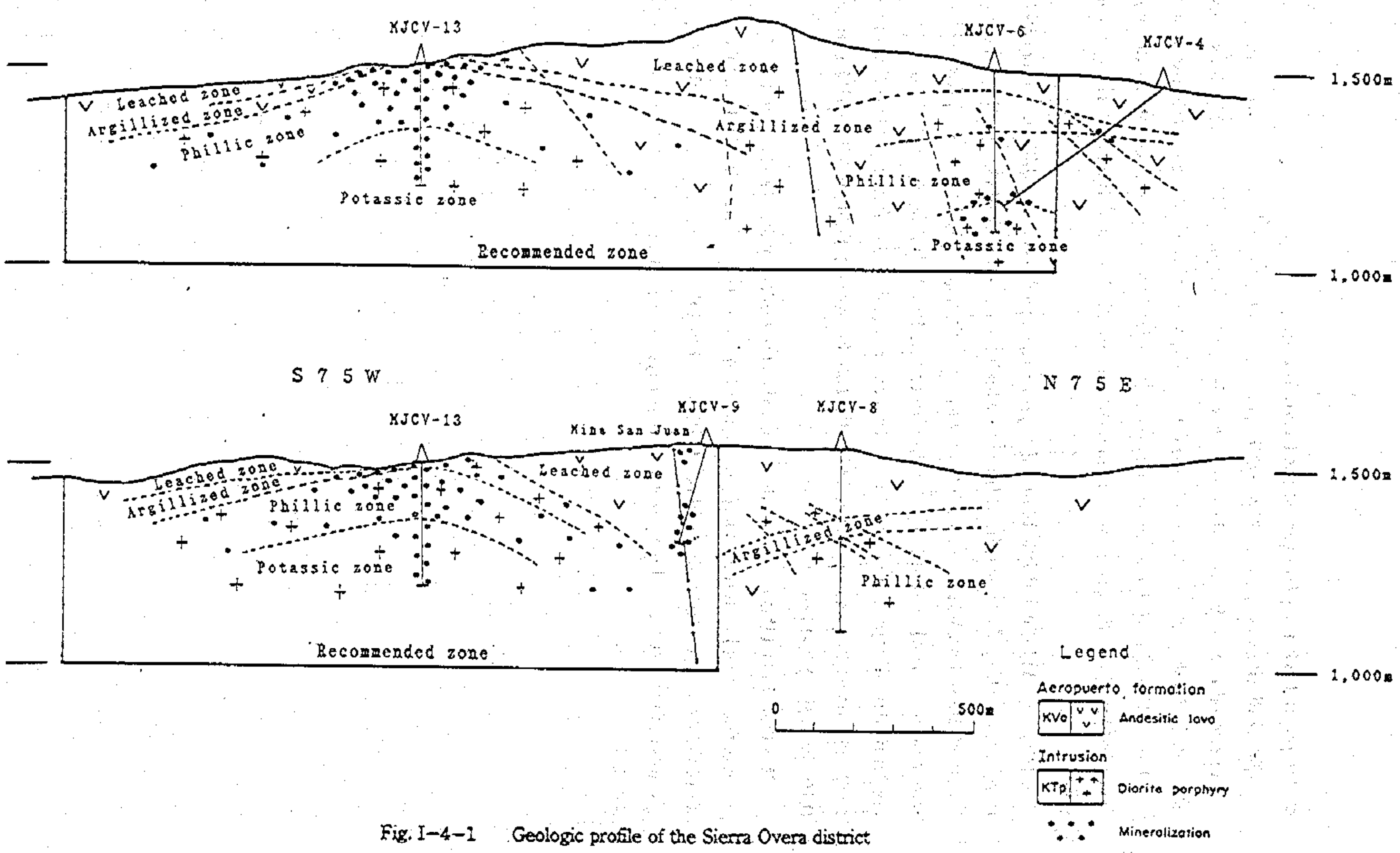


Fig. I-4-1 Geologic profile of the Sierra Overa district

4-2 Relationship of geophysical anomaly and geological structure of the Progreso Area

The results of the survey did not reveal the areas of anomaly showing low resistivity-high chargeability that had initially been forecast. In the laboratory measurements on boring cores it was found that the samples from this area showing a high chargeability tended on the whole to display a high resistivity. Values measured in samples taken from DDH-1A and DDH-6A, where the Punta del Cobre formation, a horizontal ore deposit, has been verified, displayed high resistivity values of 800Ωm(average resistivity 10,635Ωm). Like the resistivity values for the Punta del Cobre formation, resistivity values for the Abundancia formation, which were verified in DDH-6A, were high, 1,000Ωm or above (average resistivity value 3,510.2Ωm), and it is considered difficult to separate the Punta del Cobre formation from the Abundacia formation using resistivity values. However, as the resistivity values of the alluvials are low and the difference is clear, it is possible to clarify the geologic structure of the survey area by tracing the structure of the high resistivity values.

Taking an overall view of the resistivity structure of this area, the results of the two-dimensional joint inversion analysis show that in the resistivity structure of the whole area there is a tendency for the zone of high resistivity to be shallow on the east side, and deep on the west side. In the north, taking profile II measurement point 1400 as the boundary, the high resistivity zone becomes rapidly deeper on the north side and the existence of a fault is assumed. In the east, the high resistivity zone juts out from profile III measurement point 800 towards profile IV measurement point 2200, and the existence of intrusive rocks is assumed from this structure. In the south, the high resistivity zone becomes shallow on the south side linking profile V measurement point 500 and profile IV measurement point 800, and then becomes deep again on the south side linking profile V measurement point 1100 and profile IV measurement point 400. From the range of the present measurements it is impossible to ascertain whether this tendency extends over the entire south side of the survey area or is a local drop. The high resistivity zone on the west side from profile V measurement point 200 is shallow. This is an area in which geologically also the Abundacia formation is distributed on the surface, so that both results agree.

Looking at the correspondence between the chargeability of core samples and copper analysis values, the high chargeability core samples in DDH-1A have the high copper analysis values.

While the lack of boring data actually striking deposits in this area makes it difficult to be certain, it is thought probable that actual Manto-type deposits do have a low resistivity-high chargeability, and it was not possible from the results of this survey to extract any such marked anomaly. However, the high resistivity-high chargeability anomaly either arises from a garnet skarn of the Abundancia formation accompanying mineralization, or the resistivity of the andesite which is the country rock of the Punta del Cobre formation is extremely high and the influence of this was observed in the surface measurements as high resistivity-high chargeability. If this is the case, we cannot expect to find large scale deposits of minerals, but the question can be considered a survey index.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5-1 Conclusions

The conclusions reached from the second phase of the Cooperative Mineral Exploration in the Veraguas-Progreso areas of the Republic of Chile, are asfollows.

5-1-1 Drilling Survey in the Veraguas Area

1. Sierra Overa District

The district is made up of andesite volcanics with intrusive diorite/andesite porphyry, both rocks having undergone strong hydrothermal alteration. The district has fractures running in N-S and NW-SE directions, and it may be considered that these fractures acted as channels for the porphyry intrusion. In articular, the porphyry stock striking NW-SE and ranging in width 100-200m is exposed in the north-western hillside of the Sierra Overa. In the district, the surface stratum and along the above-mentioned fractures forms a leached zone 10 to 200m thick made up of a strongly silicified zone, a quartz-sericitized zone and a siliceous argillized zone with strong concentrations of jarosite and reddish hematite.

Below the leached zone, the alteration is divided into a siliceous argillized zone and a chloritized zone. The chloritized zone has marked pyrite dissemination and is further divided, from the top down, into four zones; siliceous argillized-chloritized zone, chloritized zone ,silicified-chloritized zone and silicified-chloritized-potash feldspar zone. From this mineral association, it may be considered that the first three zones correspond to the phillic zone, and the fourth zone to the potassic zone of the alteration classification of porphyry copper deposits by Lowell and Guilbert (1970).

In the northwestern hillside of the Sierra Overa, MJCV-13 revealed a mineralized zone containing copper oxides, native copper, chalcopyrite and small amounts of covelline, chalcocite and bornite in the diorite porphyry. The mineralization and alteration show the following correspondence.

[MJCV-13]

Depth	Cu mineral	Cu ave.	max.	Auppm	Alteration
0- 11m	atacamite/brochanthite	0.55%	1.24%	0.20	siliceous argillized-chloritized
11- 70m	atacamite/brochanthite	0.24	1.12	0.14	chloritized
70- 78m	atacamite/brochanthite	0.34	0.40	0.21	chloritized
78-149m	Cu°·atacamite·azurite	0.23	0.66	0.13	chloritized
149-180m	Cu°·atacamite·azurite	0.18	0.52	0.13	silicified-chloiritized-potash feldspar
180-198m	atacamite·azurite	0.14	0.21	0.09	silicified-chloiritized-potash feldspar
198-250m	chalcopyrite	0.11	0.26	<0.04	silicified-chloiritized-potash feldspar
250-300m	chalcopyrite	0.10	0.55	<0.04	silicified-chloiritized-potash feldspar

In the phillic zone between 0-149m, the T.Cu grade is >0.2% and the Au grade >0.1ppm, but in potassic zone below 149m , the mineralization of copper and gold tends to weaken.

Native copper occurs in disseminate and film form between 78-180m, and observation under the microscope reveals small amounts of chalcopyrite and bornite with native copper. In addition to the above-mentioned copper minerals, hematite and magnetite also occur universally. In places where natvive copper occurs the hematite has not completely replaced the magnetite,

and both associate together. In places where copper oxides are abundant, the replacement of magnetite by hematite is more advanced.

In addition, from MJCV-6 chalcopyrite dissemination was found accompaning the potassic zone deep under the eastern side of the Sierra Overa, and from MJCV-9 copper oxide dissemination was found accompanying the leached zone of the north of the Sierra Overa, where the San Juan mine is located.

Thus it may be expected that porphyry copper deposits would be embedded under the leached zone that forms the Sierra Overa, and there is a need to continue further prospecting.

2. Cerro Veraguas District

This area is made up of andesite volcanics with intrusive diorite-andesite porphyry, both of which, like the Sierra Overa area, have undergone strong hydrothermal alteration. The district has fractures running in NE-SW and NW-SE directions, and it may be considered that these fractures acted as channels for the porphyry intrusion. In the eastern part of the Cerro Veraguas, MJCV-11 found a mineralization approximately 2m wide with a T.Cu grade of 0.76%, made up of covelline and chalcocite accompaning a pophyry assumed to have intruded regulated by the NW-SE fracture. Thus it may be expected that in the eastern part of the Cerro Veraguas district the porphyry copper deposits would be embedded controlled by the NW-SE structure, albeit on a small scale.

However, in the area from the center to the western part of the Cerro Veraguas, although drilling in the first year and this year revealed localized copper mineralization in the range of 0.2% to 0.7%, the poor continuity suggests that widespread mineralization is not to be expected.

Also the plain to the south of the Cerro Veraguas is covered to a depth of approximately 200m with andesite volcanics and volcanic sandstone of the Paleogene Chile-Alemania formation that has not undergone alteration, so the existence of mineralization is not expected.

3. Pampa District: the Plain east of the Cerro Veraguas

Quartz diorite stock, which NW-SE liniation is developed, is distributed over a range 2 x 2km. The rock yields copper oxide and chalcopyrite in film and disseminate form, accompanied by hematite, chlorite, epidote, quartz and calcite. This mineralized zone is thought to be stockwork deposits, controlled by the NW-SE structure. The one or two kilometres between the district and the Cerro Veraguas are covered by alluviums and colluviums and the borders between the quartz diorite stock and the andesite volcanics of the Aeropuerto formation is not distinct. And the genetic relationship between the mineralization and the porphyry copper type mineralization is not apparent. These points should be further surveyed.

4. K-Ar Dating

K-Ar dating was carried out on the dioritic porphyry of the Sierra Overa area and on the quartz diorite of the Pampa area which had undergone mineralized alteration. The results are as follow;

The results are as follows;

Diorite porphyry(Sierra Overa east district)	: 104.0±+2.0Ma
Diorite porphyry(Sierra Overa northwest district)	: 115.0±+4.0Ma
Quartz diorite(Pampa District)	: 93.8±+2.1Ma

1. K-Ar ages indicate them to be Cretaceous in age. The diorite porphyry of the Sierra Overa district has undergone either phillic and potassic alteration, which displays the alteration pattern of porphyry copper deposits, while the quartz diorite of the Pampa district is characterized by chlorite, epidote and calcite, which displays the typical alteration of vein and stockwork type deposits found widely in the coastal cordillera ; but there is little difference in the period in which both underwent mineralizing alteration.

2. Since the K-Ar ages of the Grupo Plutonico Cerro del Pingo,which have a wide distribution over the coastal cordillera, indicate 109-121Ma (Naronjo et. al., 1984), the period of the mineralizing alteration corresponds roughly to that of the activity of the granitic magma.

3. The K-Ar ages of the porphyry copper deposits embedding along the Domeyko Cordillera in northern Chile indicate 30-40Ma(Olson,1989), as shown in Fig.II-1-7.

Although the alteration pattern in the Sierra Overa district is similar to that of the porphyry copper deposits, the period in which the alteration has been formed differs from that of the porphyry copper deposits of the Domeyko Cordillera.

5-1-2 Trench Survey in the Veraguas District

The Sierra Overa northwest district is made up of aphanitic andesite of the Cretaceous Aeropuerto formation and intrusive diorite porphyry that have undergone hydrothermal alteration, and intrusive dioritic porphyry. The porphyry is distributed over a width of 100-200m in a NW-SE direction, and is thought to be spread in stock form in the deeper part. The alteration is divided, from the top down, into the following zones.

Silicified & siliceous argillized zone: The eastern part of Line 3, on the ridge of the Sierra Overa.

Leached zone with strong concentrations of pulverized reddish hematite, jarosite and natrojarosite, accompanying siliceous clay: The central part of Line 3 and Lines 1 & 2 on the foot of the Sierra Overa.

Chloritized zone : The western part of Line 3 and the eastern part of Line 2, to the north of that.

Cu oxides disseminates and film in the aphanitic andesite and diorite porphyry, belonging to the chloritized zone. Cupper mimerals are chalcanthite, atacamite and small amount of chalcopyrite, bornite accompaning magnetite, hematite and goethite.

Principal component analysis was carried out using the chemical analysis data of the 64 samples. The results were as follows.

(1)First principal component: T.Cu, S.Cu, I.Cu, Au display identical behaviour.

(2)Second principal component: Mo shows independent behaviour.

(3)Third principal component: Au and I.Cu interact.

From the occurrence and the behaviour of the components described above, it is thought that the copper oxides have been formed as secondary mineral from oxidized primary copper sulphides, and that this was accompanied by concentrations of gold.

It is therefore necessary to continue prospecting, in order to ascertain the existence of the secondary enrichment and primary deposits in the deeper part of the Sierra Overa.

5-1-3 Geophysical Survey in the Progreso Area

The results of the survey did not reveal the areas of anomaly showing low resistivity-high chargeability that had initially been forecast. In the laboratory measurements on boring cores it was found that the samples from this area showing a high chargeability tended on the whole to display a high resistivity. Values measured in samples taken from DDH-1A and DDH-6A, where the Punta del Cobre formation, a horizontal ore deposit, has been verified, displayed high resistivity values of 800 Ωm(average resistivity 10,635 Ωm). While the lack of boring data actually striking deposits in this area makes it difficult to be certain, it is thought probable that actual Manto-type deposits do have a low resistivity-high chargeability, and it was not possible from the results of this survey to extract any such marked anomaly. However, the high resistivity-high chargeability anomaly either arises from a garnet skarn of the Abundancia formation accompanying mineralization, or the resistivity of the andesite which is the country rock of the Punta del Cobre formation is extremely high and the influence of this was observed in the surface measurements as high resistivity-high chargeability. If this is the case, we cannot expect to find large scale deposits of minerals, but the question can be considered a survey index.

Like the resistivity values for the Punta del Cobre formation, the resistivity values for the Abundancia formation, which were verified in DDH-6A, were high, 1,000 Ωm or above (average resistivity value 3,510.2 Ωm), and it is considered difficult to separate the Punta del Cobre formation from the Abundacia formation using resistivity values. However, as the resistivity values of the alluvials are low and the difference is clear, it is possible to clarify the geologic structure of the survey area by tracing the structure of the high resistivity values. Moreover, looking at the correspondence between the chargeability of core samples and copper analysis values, the high chargeability core samples have the high copper analysis values.

Taking an overall view of the resistivity structure of this area, the results of the two-dimensional joint inversion analysis show that in the resistivity structure of the whole area there is a tendency for the zone of high resistivity to be shallow on the east side, and deep on the west side. In the north, taking profile II measurement point 1400 as the boundary, the high resistivity zone becomes rapidly deeper on the north side and the existence of a fault is assumed. In the east, the high resistivity zone juts out from profile III measurement point 800 towards profile IV measurement point 2200, and the existence of intrusive rocks is assumed from this structure. In the south, the high resistivity zone becomes shallow on the south side linking profile V measurement point 500 and profile IV measurement point 800, and then becomes deep again on the south side linking profile V measurement point 1100 and profile IV measurement point 400. From the range of the present measurements it is impossible to ascertain whether this tendency extends over the entire south side of the survey area or is a local drop. The high resistivity zone on the west side from profile V measurement point 200 is shallow. This is an area in which geologically also the Abundacia formation is distributed on the surface, so that both results agree.

As described above, anomalies indicating marked mineral prospects with a low resistivity-high chargeability were not found in this area. However, assuming that the high resistivity-high chargeability anomaly indicates a skarn mineral deposit, or indicates a structure in which the Punta del Cobre formation is distributed near the surface and is accompanied by the mineralization effect, the chargeability is over 50mV/V are laid over the a shallow region of a high resistivity zone is thought to be an effective indicator of mineral prospects in the survey area. Those regions can be extracted, the region centering on profile II measurement point 1300 in the central eastern part of the area and the region centering on profile III measurement point 1000. In addition, a region with high chargeability centering on profile II measurement point 2000 in the northeast of the area was confirmed. While no rise in the zone of high resistivity is assumed, a region of high chargeability was observed; this is a region close to a high anomaly zone measured in the airborne magnetic survey, and it is hoped that these areas will be subjected to further surveys.

5-2 Recommendations for Phase III

On the basis of the results of the Phase I surveys, the following recommendations are made for Phase III.

5-2-1 Veraguas Area

From this phase of the survey it may be expected that mineral deposits originating in the Cretaceous granitic magma activity and contolled by the NW-SE structure do exist in the Sierra Overa district and the district from the eastern side of the Cerro Veraguas to the Pampa plain, where copper mineralizations were found. In particular it may be expected that porphyry copper type deposits would be embedded under the leached zone that forms the Sierra Overa.

Thus it would be desirable for drilling and trench surveys to be continued over from this year into Phase 3, in the Sierra Overa area indicated on Fig.I-5-1.

5-2-2 Progreso Area

Anomalies indicating marked mineral prospects with a low resistivity-high chargeability were not found in this area. However, assuming that the high resistivity-high chargeability anomaly indicates a skarn mineral deposit, or indicates a structure in which the Punta del Cobre formation is distributed near the surface and is accompanied by the mineralization effect, a search brings to the fore the region centering on profile II measurement point 1300 in the central eastern part of the area and the region centering on profile III measurement point 1000. In addition, a region with high chargeability centering on profile II measurement point 2000 in the northeast of the area was confirmed. While no rise in the zone of high resistivity is assumed, a region of high chargeability was observed; this is a region close to a high anomaly zone measured in the airborne magnetic survey, and it is hoped that these areas will be subjected to further surveys. Thus it is desirable in Phase 3 for a drilling survey to be carried out in the central-eastern and northeastern parts of the Progreso area indicated on Fig.I-5-2.

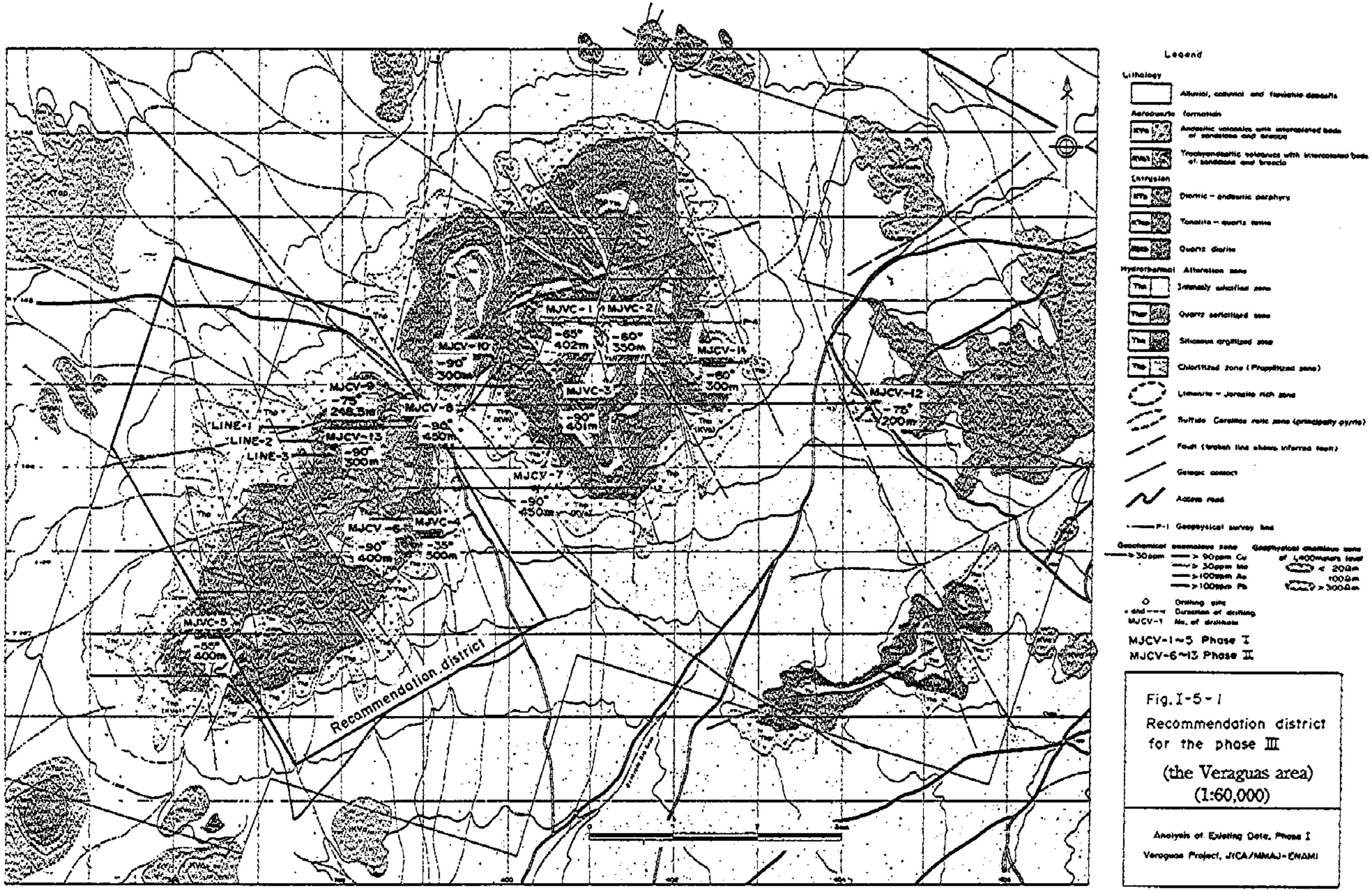


Fig. I-5-1
Recommendation district for the phase III
(the Veraguas area)
(1:60,000)

Analysis of Existing Data, Phase I
Veraguas Project, JICA/MMAJ-ENAMI

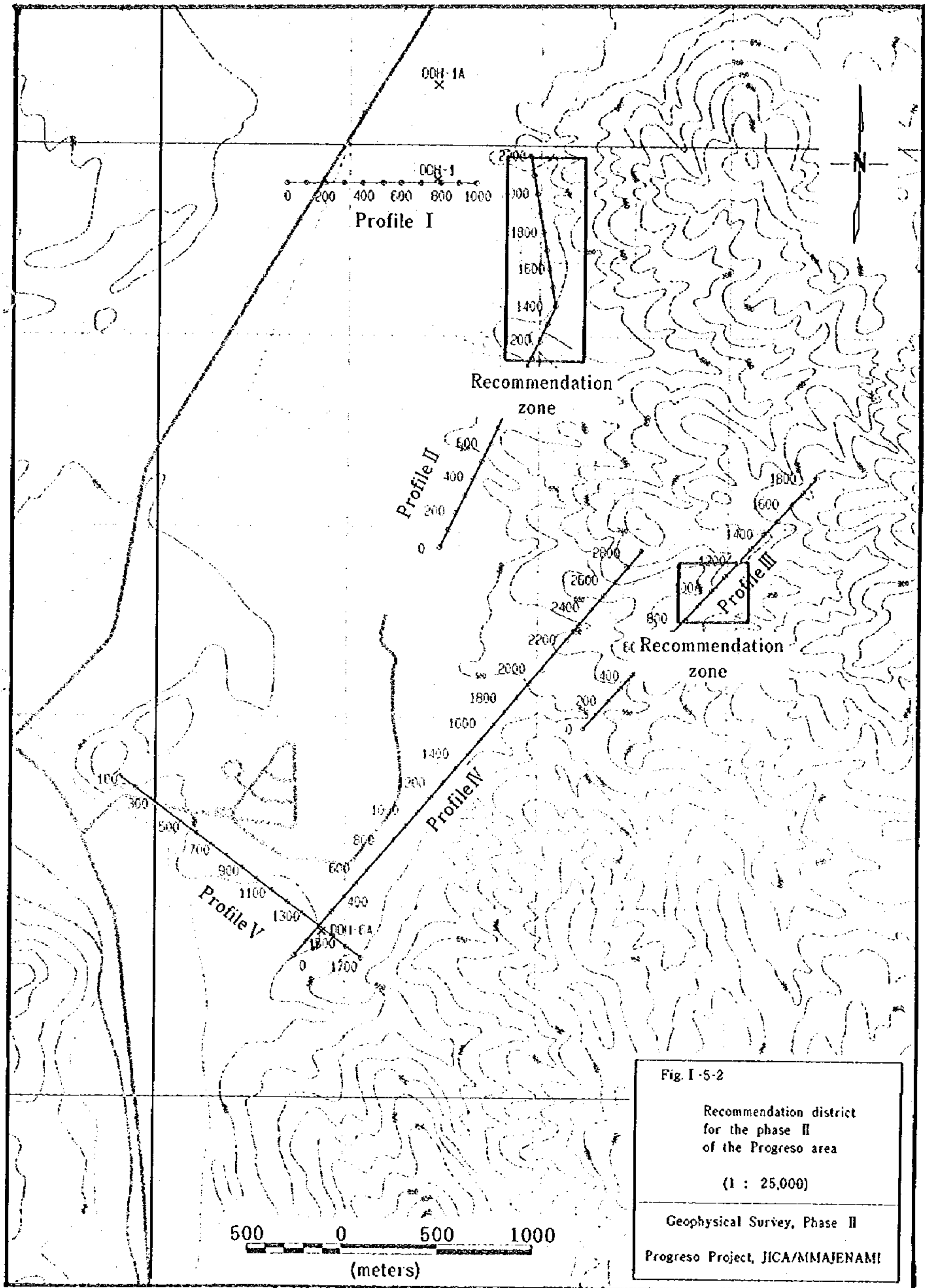


Fig. I-5-2

Recommendation district for the phase II of the Progreso area

(1 : 25,000)

Geophysical Survey, Phase II

Progreso Project, JICA/MMAJENAMI

PART II DETAIL DESCRIPTION

PART II DETAILS OF THE SURVEYS

CHAPTER 1 DRILLING SURVEY IN THE VERAGUAS AREA

1-1 Purpose of survey

The purpose of this survey was to elucidate the geological structure and to ascertain the existence of pophyry copper type ore deposits in the district stretching from the southern base of the Cerro Veraguas to the eastern base of the Sierra Overa where the drill holes MJCV-3 and MJCV-4, from which mineralization was obtained in Phase 1 survey, are located.

The position coordinates, direction, inclination and depth of each drill hole are shown in Fig.II-1-1 and Table II-1-1.

Table II-1-1 Contents of Drilling

Drill Hole	N	E	H(m)	Dir.	Incli.	Depth
MJCV- 6	7,143,100.00	398,750.00	1,500.00	---	-90°	400.0m
MJCV- 7	7,143,750.00	400,300.00	1,480.00	---	-90°	450.0m
MJCV- 8	7,144,500.00	398,900.00	1,550.00	---	-90°	450.0m
MJCV- 9	7,144,500.00	398,550.00	1,560.00	N90° W	-75°	248.5m
MJCV-10	7,145,300.00	399,700.00	1,550.00	---	-90°	300.0m
MJCV-11	7,145,250.00	402,700.00	1,560.00	N90° W	-60°	300.0m
MJCV-12	7,144,697.00	404,325.00	1,486.00	S45° W	-75	200.0m
MJCV-13	7,144.250.00	397,870.00	1,512.00	---	-90°	300.0m
Total	8 holes					2,648.5m

Fig. II-1-1

Location map of the drilling survey area

(1 : 60,000)

Analysis of Existing Data, Phase I
Veraguas Project, JICA/MMAJ-ENAMI

1-2 Operating conditions

The on-site investigation period for the drilling survey was from 24th October 1994 to 14th January 1995. Of that time drilling work was conducted over the period from 1st November 1994 to 5th January 1995. The drilling equipment and consumption goods used in the drilling work are shown in Table II-1-2 and Table II-1-3 respectively; drilling progress charts and drilling work charts for each hole are shown in Table II-2-4 and Table II-2-5 respectively.

As shown in the drilling work charts, drilling was carried out with hole diameters of HX,NX, BX; and its average core recovery rate of 89.45 excepting surface soil and talus was achieved. Drilling efficiency varied greatly depending on the geological conditions; due in particular to the crumbling of holes in clay areas, and inundation in and around the fracture zone. Average drilling efficiency for individual holes ranged 9.94 - 37.50m/working day, the overall average being 19.19m/working day.

1-3 Results of survey

As stated above, the drilling core recovery rate was good. Color photographs were taken of the cores collected, and visual appraisal of the cores was made; samples were also taken for ore analysis.

The cores remaining after samples had been taken were placed in 4 m lengths in lidded wooden boxes and stored in a local warehouse. Appendix A shows the columnar boring section drawn up on a scale of 1:200 from the visual appraisal of the cores. For the ore analysis, each core was split in half using a diamond cutter, and samples for analysis taken every metre. The results of the chemical analysis are listed in Appendix B. For observation of the boring cores, samples of ore and rock deemed necessary were taken and subjected to microscope observation and X-ray diffraction, and these were used for reference in the analysis of the columnar boring section and the boring profile. The results of the microscope observation are shown in Table II-1-6 & 7, and the results of the X-ray diffraction analysis are shown in Table II-1-7.

The geology, mineralization and alteration of each drill hole are shown in the boring profiles Fig.II-1-2(1)-(7) and in the synthetic columns Fig.II-1-3(1)-(8).

Table II-1-2 Equipment of drilling

Item	Spec.	Total	1st	2nd	3rd	Remarks
Drilling machine		3	HH-20	LY-44	LY-38	set
Drilling pump	Royal bean 434	3	1	1	1	set
Drilling rods	HXWL	235	85	85	65	3.05m/rod
	NXWL	460	170	170	120	3.05m/rod
	BXWL	290		170	120	3.05m/rod
Inner tube assembly	HXWL	9	3	3	3	set
	NXWL	9	3	3	3	set
	BXWL	9	3	3	3	set
Core barrel assembly	HXWL	9	3	3	3	set
	NXWL	9	3	3	3	set
	BXWL	9	3	3	3	set
Casing	HXCP	210	70	70	70	3.05m/rod
	NXCP	300	100	100	100	3.05m/rod
	BXCP	0				3.05m/rod
Drilling depth	MJCV- 6	400.0	400.0			m
	MJCV- 7	450.0	450.0			m
	MJCV- 8	450.0		450.0		m
	MJCV- 9	248.5		248.5		m
	MJCV-10	300.0			300.0	m
	MJCV-11	300.0	300.0			m
	MJCV-12	200.0			200.0	m
	MJCV-13	300.0	300.0			m
	Total	2,648.5	1,450.0	698.5	500.0	m

Table II-1-3 Articles of consumption

ITEM	SPEC.	TOTAL	MJCV-6	MJCV-7	MJCV-8	MJCV-9	MJCV-10	MJCV-11	MJCV-12	MJCV-13
TRICON BIT		2	0	0		1	1			
DIAMOND	HX	21	1	2	4	5	3	3	2	1
BIT	NX	19	2	2	7	2		2	1	3
	BX	1				1				
REAMING	HX	8	1	1	1	1	1	1	1	1
SHELL	NX	7	1	1	1	1		1	1	1
	BX	1				1				
CASING	HX	3	1			1		1		
SHOE	NX	3	1		1	1				
	BX	0								
CEMENT	bag	15		2	2		2	4		5
BENTONITE	bag	479	46	18	132	147	25	55	4	52
CLEAR MUD	kg	680	20	100	160	80	120	80	60	60
C.M.C.	kg	499	91		136	91	23	114		45
RAYBAN	kg	114	23		23	23	23	23		
CAUST.SODA	kg	60				60				
GYPSUM	bag	9				2	4	1		2
GASOLINE	l	28,926	3,264	2,720	6,256	6,256	3,264	2,814	1,632	2,720
CORE BOX	box	855	130	133	143	80	117	92	68	92

Table II-1-4 Program of drilling

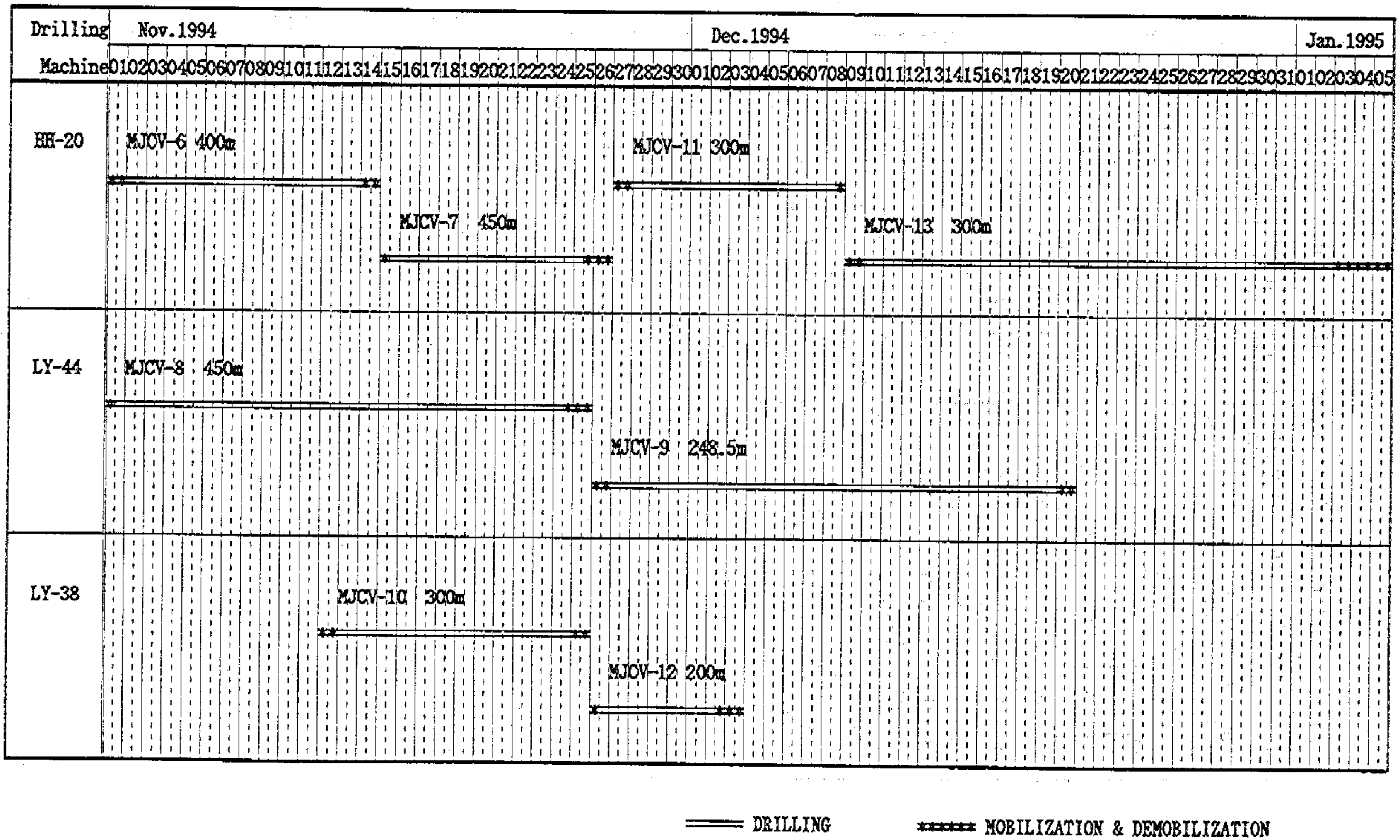


Table II-1-5 Summary of drilling activity (1)

MJCV-6	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/01	2	2	0	8	1.0
DRILLING	11/02-13	24	24	0	96	12.0
DEMOBILIZATION	11/14	2	2	0	8	1.0
TOTAL	11/01-14	28	28	0	112	14.0

DEPTH PLANNED	400.00 (m)	DRILLING	33.33	(m/drilling day)
DEPTH DRILLED	400.00 (m)	SPEED	28.57	(m/total working day)
TRICON(NON CORE)	0.00 (m)	CASING	4.80	HWCP(m)
CORE LENGTH	390.46 (m)		163.30	NXCP(m)
CORE RECOVERRY	97.61 (%)			

MJCV-7	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/15	1	1	0	4	0.5
DRILLING	11/15-25	20	20	0	80	10.0
DEMOBILIZATION	11/25-26	3	3	0	12	1.5
TOTAL	11/15-26	24	24	0	96	12.0

DEPTH PLANNED	450.00 (m)	DRILLING	45.00	(m/drilling day)
DEPTH DRILLED	450.00 (m)	SPEED	37.50	(m/total working day)
TRICON(NON CORE)	1.10 (m)	CASING	0.00	HWCP(m)
CORE LENGTH	445.80 (m)		72.00	NXCP(m)
CORE RECOVERRY	99.31 (%)			

MJCV-8	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/01	1	1	0	4	0.5
DRILLING	11/01-24	46	46	0	184	23.0
DEMOBILIZATION	11/24-25	3	3	0	12	1.5
TOTAL	11/01-25	50	50	0	200	25.0

DEPTH PLANNED	450.00 (m)	DRILLING	19.57	(m/drilling day)
DEPTH DRILLED	450.00 (m)	SPEED	18.00	(m/total working day)
TRICON(NON CORE)	0.00 (m)	CASING	3.00	HWCP(m)
CORE LENGTH	350.07 (m)		190.30	NXCP(m)
CORE RECOVERRY	77.79 (%)			

MJCV-9	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/26	2	2	0	8	1.0
DRILLING	11/27-12/19	46	46	0	184	23.0
DEMOBILIZATION	12/20	2	2	0	8	1.0
TOTAL	11/26-12/21	50	50	0	200	25.0

DEPTH PLANNED	248.00 (m)	DRILLING	10.80	(m/drilling day)
DEPTH DRILLED	248.50 (m)	SPEED	9.94	(m/total working day)
TRICON(NON CORE)	19.50 (m)	CASING	19.50	HWCP(m)
CORE LENGTH	203.50 (m)		142.50	NXCP(m)
CORE RECOVERRY	88.86 (%)			

Table II-1-5 Summary of drilling activity (2)

MJCV-10	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/12	2	2	0	8	1.0
DRILLING	11/13-24	24	24	0	96	12.0
DEMOBILIZATION	11/25	2	2	0	8	1.0
TOTAL	11/12-25	28	28	0	112	14.0
DEPTH PLANNED	300.00 (m)		DRILLING	25.00 (m/drilling day)		
DEPTH DRILLED	300.00 (m)		SPEED	21.43 (m/total working day)		
TRICON(NON CORE)	3.00 (m)		CASING	3.00 HWCP(m)		
CORE LENGTH	290.85 (m)			0.00 NXCP(m)		
CORE RECOVERRY	97.93 (%)					

MJCV-11	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/27	2	2	0	8	1.0
DRILLING	11/28-12/08	21	21	0	84	10.5
DEMOBILIZATION	12/08	1	1	0	4	0.5
TOTAL	11/27-12/08	24	24	0	96	12.0
DEPTH PLANNED	300.00 (m)		DRILLING	28.57 (m/drilling day)		
DEPTH DRILLED	300.00 (m)		SPEED	25.00 (m/total working day)		
TRICON(NON CORE)	2.05 (m)		CASING	3.00 HWCP(m)		
CORE LENGTH	292.80 (m)			62.80 NXCP(m)		
CORE RECOVERRY	98.27 (%)					

MJCV-12	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/26	1	1	0	4	0.5
DRILLING	11/26-12/02	12	12	0	48	6.0
DEMOBILIZATION	12/02-03	3	3	0	12	1.5
TOTAL	11/26-12/03	16	16	0	64	8.0
DEPTH PLANNED	200.00 (m)		DRILLING	33.33 (m/drilling day)		
DEPTH DRILLED	200.00 (m)		SPEED	25.00 (m/total working day)		
TRICON(NON CORE)	3.00 (m)		CASING	3.00 HWCP(m)		
CORE LENGTH	194.00 (m)			101.40 NXCP(m)		
CORE RECOVERRY	98.48 (%)					

MJCV-13	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	12/09-	2	2	0	8	1.0
DRILLING	12/10- 1/02	48	20	28	80	24.0
DEMOBILIZATION	1/03-05	6	6	0	24	3.0
TOTAL	12/09- 1/05	56	28	28	112	28.0
DEPTH PLANNED	300.00 (m)		DRILLING	30.00 (m/drilling day)		
DEPTH DRILLED	300.00 (m)		SPEED	13.64 (m/total working day)		
TRICON(NON CORE)	1.00 (m)		CASING	0.00 HWCP(m)		
CORE LENGTH	290.85 (m)			79.60 NXCP(m)		
CORE RECOVERRY	97.27 (%)					

Table II-1-5 Summary of drilling activity (3)

Total	PERIOD	TOTAL TURNS	WORKING TURNS	DAY OFF TURNS	TURN *WORKER	DAYS
MOBILIZATION	11/01-	13	13	0	52	6.5
DRILLING	11/02- 1/02	241	213	28	852	120.5
DEMOBILIZATION	1/03- 1/05	22	22	0	88	11.0
TOTAL	11/01- 1/05	276	248	28	992	138.0

DEPTH PLANNED	2,648.00 (m)	DRILLING SPEED	21.98 (m/drilling day)
DEPTH DRILLED	2,648.50 (m)		19.19 (m/total working day)
TRICON(NON CORE)	29.65 (m)	CASING	36.30 HWCP(m)
CORE LENGTH	2,458.33 (m)		811.90 NXCP(m)
CORE RECOVERRY	93.87 (%)		

1-3-1 MJCV-6

1. Outline

(1) Reasons for drilling

This hole is located on the eastern foot of the Sierra Overa, within the Cu geochemical anomalous zone by ENAMI (1993). The purpose is to establish the continuity of the copper mineralization (206-209m 0.2%T.Cu) and gold mineralization (492-493m 4.8g/t Au) discovered by MJCV-4 drilled in PhaseI.

(2) Summary of results

The hole is made up of andesite and diorite-andesite porphyry that have undergone hydrothermal alteration divided into siliceous argillized zone and chloritized zone. Chalcocite disseminates with a grade of T.Cu 0.2-1.38% between 149-169 m, in which lies the border between the two types of rock.

Chalcopyrite disseminates with a T.Cu grade of 0.1% in the chloritized zone which accompanies the silicification and potassium addition below 318m.

The position coordinates and drilling details of the hole are as given below.

Coordinates : 7,143,100.00N 398,750.00E 1,500.0m above sea level

Drilling details: Direction -- Inclination -90° Depth 400.0m

2. Geology

(1) Litho-Units

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00~ 49.00m	unknown	siliceous argillized	jarosite,hematite rich	leached zone
49.00~101.80m	andesite	siliceous argillized	hematite diss.	
101.80~149.25m	andesite	siliceous argillized	hematite diss.	
149.25~168.20m	andesite	siliceous argillizes-chloritized	hematite,pyrite,chalcocite diss.	
168.20~242.90m	porphyry	siliceous argillized-chloritized	pyrite diss.	phillic zone
242.90~270.00m	porphyry	siliceous argillized-chloritized	pyrite diss.	phillic zone
270.00~318.00m	porphyry	silicified-chloiritized	pyrite diss.	phillic zone
318.00~339.00m	porphyry	silicified-chloiritized	pyrite,chalcopyrite diss.	phillic zone
339.00~400.00m	porphyry	silicified-chloiritized-potash feldspar	pyrite,chalcopyrite diss.	phillic zone

(2) Alteration

A siliceous argillized zone, comprising mainly kaolinite, quartz and sericite, extends from the surface to a depth of 149.25 m. Near the surface, to a depth of 49.00m, is a leached zone with strong concentrations of pulverized reddish hematite, jarosite and natrojarosite. Between 49.00m and 149.25m a large quantity of hematite are disseminated. Between 149.25m and 242.90m is characterized by siliceous argillization and chloritization with pyritization. Below 242.9m dominate chloritization, silicification, sericitization,albitization and pyritization, and below 339.0m added to potash feldspar. From this association of alteration it may be considered that the area between 149.25m and 339.0m corresponds to the phillic zone, and the area between 339.0m and 400.0m to the potassic zone of the alteration classification of porphyry copper deposits according to Lowell and Guilbert (1970).

(3) Mineralization

Chalcocite disseminates with a grade of T.Cu 0.2-1.38% between 149 m and 169 m, in which lies the border between andesite and porphyry. Chalcopyrite disseminates with a T.Cu grade of 0.1% in the chloritized zone which accompanies the silicification and potassium addition below 318m.

3. Results of ore analysis

Depth m- m	range m	T.Cu %	S.Cu %	Au ppm	Ag ppm	Mo ppm	Original rock	Alteration zone
149-150	1	1.38	0.38	<0.04	3.8	19	andesite	siliceous argillizes-chloritized
150-151	1	0.73	0.27	<0.04	1.5	19	andesite	siliceous argillized-chloritized
165-169	4	0.27	0.07	<0.04	<0.4	14	and./porp.	siliceous argillized-chloritized
322-323	1	0.10	0.00	0.06	1.7	38	pophyry	silicified-chloiritized
341-344	3	0.14	0.00	<0.04	1.1	17	pophyry	silicified-chloiritized-potash feldspar
392-395	3	0.12	0.00	<0.04	<0.4	70	pophyry	silicified-chloiritized-potash feldspar
398-400	2	0.13	0.00	<0.04	<0.4	82	pophyry	silicified-chloiritized-potash feldspar

1-3-2 MJCV-7

1. Outline

(1) Reasons for drilling

This hole is located on the southern foot of the Cerro Veraguas. The purpose is to establish the continuity of the copper mineralization (368-369m T.Cu 0.7%) discovered by MJCV-3, drilled in Phase I on the southern ridge of the Cerro Veraguas.

(2) Summary of results

This hole is divided into two parts: from the surface to 286.25m, composed of volcanic sandstone, andesite pyroclastics and coarse grained vesicular andesite; and from 286.25 m to 450.0m, composed of silicified dacitic andesite and fine grained andesite. From the fact that the former is slightly altered and covers from the foot of the Cerro Veraguas to the plain, it may be considered to correspond to the Palaeogene Chile-Alemania formation. The latter may be considered to be equivalent to the andesitic lava of the Aeropuerto formation that forms the Cerro Veraguas.

It is clarified that the location where it was forecast there would be mineralization, has been covered with the ChileAlemania formation unrelated to the mineralization.

The position coordinates of the hole and drilling details are as given below:

Coordinates : 7,143,750.00N 400,300.00E 1,480.0m above sea level

Drilling details: Direction -- Inclination -90° Depth 450.0 m

2. Geology

(1) Litho-Units

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00~ 37.40m	volcanic sandstone		hematite diss.	chile-alemania formation
37.40~ 46.65m	andesite pyroclastics		hematite diss.	chile-alemania formation
46.65~ 92.65m	vesicular andesite	chloritized	hematite diss.	chile-alemania formation
92.65~207.55m	andesite pyroclastics		hematite diss.	chile-alemania formation
207.55~286.25m	vesicular andesite	chloritized	hematite diss.	chile-alemania formation
286.25~362.20m	dacitic andesite	intensely silicified		aeropuerto formation
362.20~450.00m	andesite	chloritized	hematite diss.	aeropuerto formation

(2) Alteration

Hematite disseminates in volcanic sandstone, andesitic pyroclastics and coarse grained vesicular andesite of the Chile-Alemania Formation. The vesicles are filled with chlorite between 46.65-92.65m, and with chlorite, quartz and calcite between 207.55-286.25m. In addition the coarse phenocrysts of plagioclase have altered to albite.

The Aeropuerto formation consists of dacitic andesite and fine andesite. The dacitic andesite has undergone intense silicification composed of secondary quartz, kaolinite, deckite and gypsum. Hematite disseminates in fine grained andesite.

(3) Mineralization

Hematite disseminates universally throughout this hole, but there is hardly any discernible trace of pyrite or other sulfide minerals.

3. Results of ore analysis

Apart from 400-1000ppm of T.Cu at 117-121m, the grade is less than 100ppm, and copper mineralization is not observable throughout this hole.

1-3-3 MJCV-8

1. Outline

(1) Reasons for drilling

This hole is located on the northern edge of the Sierra Overa, 400m east of the San Juan mine, and in the low resistivity zone of CSAMT by ENAMI (1993). The purpose is to establish the continuity of the San Juan deposits.

(2) Summary of results

The hole is made up of andesite and porphyry that have undergone hydrothermal alteration. The andesite exists to a depth of 167.8m from the surface, and forms leached zone with strong concentrations of pulverized reddish hematite,jarosite and natrojarosite. The porphyry exists below 167.8m, has undergone kaolinization, chloritization and silicification, and is disseminated throughout with pyrite. Copper mineralization is not observable throughout this hole. The low resistivity zone corresponds more or less to the leached zone,and is not considered to correspond to any mineralization.

The position coordinates of the hole and drilling details are as given below:

Coordinates : 7,144,500.00N 398,900.00E 1,500.0m above sea level

Drilling details: Direction -- Inclination -90° Depth 450.0m

2. Geology

(1) Litho-Units

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00～167.80m	andesite	siliceous argillized	jarosite,hematite rich	leached zone
167.80～180.50m	porphyry	siliceous argillizes-chloritized	pyrite,hematite diss.	phillic zone
180.50～219.25m	porphyry	siliceous argillized-chloritized	pyrite diss.	phillic zone
219.25～230.90m	andesite	siliceous argillized-chloritized	pyrite diss.	phillic zone
230.90～280.00m	porphyry	chloritized	pyrite diss.	phillic zone
280.00～450.00m	porphyry	chloritized	pyrite diss.	phillic zone

(2) Alteration

From the surface to a depth of 168.0m is a siliceous argillized zone composed mainly of kaolin and quartz, forming leached zone with strong concentrations of pulverized reddish hematite, jarosite and natrojarosite. As the kaolinization weakens between 168.0-230.9m, chloritization and pyritization become apparent. Below 230.9m dominate chloritization,silicification,sericitization albitization and pyritization, accompanied by gypsum film.

(3) Mineralization

Pyrite disseminates in andesite and porphyry below 160.8m that have undergone to chloritization, but copper mineralization is not observable throughout this hole.

3. Results of ore analysis

Apart from 1100ppm of T.Cu at 32-33m, the grade is less than 600ppm.

1-3-4 MJCV-9

1. Outline

(1) Reasons for drilling

The hole is located within the San Juan deposits. The purpose is to establish the continuity of the deposits in the deeper levels.

(2) Summary of results

The hole shows marked siliceous argillization, and comprises a leached zone with strong concentrations of pulverized reddish hematite,jarosite and natrojarosite. Initially drilling was planned to a depth of 400m, but the work has been stopped at 248.5m due to jamming because of the fracture zone arising in the N-S fault.

The position coordinates of the hole and drilling details are as given below:

Coordinates : 7,144,500.00N 398,550.00E 1,560.0m above sea level

Drilling details: Direction N90°W Inclination -70° Depth 248.5m

2. Geology

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00~ 69.35m	unknwn	siliceous argillized	jarosite,hematite rich	leached zone
69.35~156.00m	unknwn	siliceous argillized	jarosite,hematite rich	leached zone
156.00~248.50m	andesite	siliceous argillized	jarosite,hematite rich, cu oxide diss.	leached zone

(2) Alteration

The hole shows marked siliceous argillization, and comprises a leached zone with strong concentrations of pulverized reddish hematite,jarosite and natrojarosite. In addition, below 200m the change to fault clay is particularly marked, and it is thought that the N-S fault at the surface continues down to a deep level.

(3)Mineralization

Between 30 and 31m atacamite disseminates with a T.Cu grade of 3.2%. Below 156m T.Cu grade is more or less 0.1%, accompanying slightly dissemination of copper oxides such as chalcanthite. In addition,between 156-196m Mo grade is more 100ppm.

3 Results of ore analysis

The places where a T.Cu grade of >0.1% continues for 2m or more are as follows.

Depth m- m	range m	T.Cu %	S.Cu %	Au ppm	Ag ppm	Mo ppm	Original	Alteration zone
29- 30	1	0.18	0.15	<0.04	<0.4	34	andesite	siliceous argillized (leached zone)
30- 31	1	3.20	0.24	<0.04	4.6	36	andesite	siliceous argillized (leached zone)
156-178	22	0.17	0.11	<0.04	0.4	154	andesite	siliceous argillized (leached zone)
182-196	14	0.13	0.09	<0.04	0.8	123	andesite	siliceous argillized (leached zone)
199-204	5	0.12	0.08	<0.04	<0.4	55	andesite	siliceous argillized (leached zone)
226-248	22	0.12	0.08	0.15	<0.4	69	andesite	siliceous argillized (leached zone)

1-3-5 MJCV-10

1. Outline

(1) Reasons for drilling

The hole is located on the southwestern foot of the Cerro Veraguas, within the Cu and Mo geochemical anomalous zone by ENAMI (1993). The purpose is to search for the existence of mineralization connected with the geochemical anomalies.

(2) Summary of results

The hole is composed of andesite and porphyry that have undergone hydrothermal alteration. From the surface to a depth of 222m porphyry occurs in the form of dykes in the andesite. Porphyry continues below 222m. In the porphyry dykes between 59.0-90.2m, copper mineralization with a T.Cu grade of >0.2%, and molybdenum mineralization with a maximum of 780ppm have been encountered.

The position coordinates of the hole and drilling details are as given below:

Coordinates : 7,145,300.00N 399,700.00E 1,550.0m above sea level

Drilling details: Direction -- Inclination -90° Depth 300.0 m

2. Geology

(1) Litho-Units

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00~ 65.00m	andesite	siliceous argillized	jarosite,hematite diss.	leached zone
65.00~ 90.20m	porphyry	siliceous argillized-chloritized	pyrite diss.	phillic zone
90.20~121.50m	andesite	siliceous argillized-chloritized	pyrite diss.	phillic zone
121.50~130.30m	porphyry	chloritized	pyrite diss.	phillic zone
130.30~142.00m	andesite	chloritized	pyrite diss.	phillic zone
142.00~169.00m	porphyry	siliceous argillized-chloritized	pyrite diss.	phillic zone
169.00~222.00m	andesite	chloritized	pyrite diss.	phillic zone
222.00~300.00m	porphyry	silicified-chloiritized	pyrite diss.	phillic zone

(2) Alteration

From the surface to a depth of 65.0m is a siliceous argillized zone comprised mainly of kaolin, quartz and sericite, accompanied by jarosite and reddish hematite. Between 65.0-169.0m as the kaolinization becomes weaker, chloritization,albitization and pyritization are apparent. The fracture zone between 150.0-169.0m shows marked kaolinization. Below 169.0m chloritization, silicification, serification, albitization and pyritization are marked.

(3) Mineralization

Pyrite dissemination with chlorite is observable throughout the andesite and porphyry below 59.0m. In and around the porphyry dykes between 65.0-90.2m copper mineralization is observable, and in the three places detailed below the T.Cu grade is >0.2%. In addition, the Mo grade in the vicinity is high, with a maximum of 780ppm.

3 Results of ore analysis

Depth m- m	Range m	T.Cu %	S.Cu %	Mo ppm	Au ppm	Ag ppm	Original rock	Alteration zone
59- 61	2	0.28	0.14	61	<0.04	<0.4	andesite	siliceous argillized
68- 70	2	0.20	0.12	45	<0.04	<0.4	porphyry	siliceous argillized-chloritized
82- 86	4	0.23	0.12	60	<0.04	0.5	porphyry	siliceous argillized-chloritized
86- 87	1	0.04	0.01	780	<0.04	0.6	porphyry	siliceous argillized-chloritized
93- 97	4	0.02	0.00	274	<0.04	0.9	andesie	siliceous argillized-chloritized
106-111	5	0.05	0.00	301	0.07	0.5	andesite	siliceous argillized-chloritized

1-3-6 MJCV-11

1. Outline

(1) Reasons for drilling

The hole is located on the eastern foot of the Cerro Veraguas, within the Cu geochemical anomalous zone by ENAMI (1993), where shifts from the low resistivity zone to the high resistivity. The purpose is to search for the existence of mineralization connected with these geochemical and geophysical anomalies.

(2) Summary of results

The hole is composed of andesite and porphyry that have undergone hydrothermal alteration. Chalcocite and covelline disseminate with a T.Cu grade of 0.76% in the porphyry between 265.2-266.85m.

The position coordinates of the hole and drilling details are as given below:

Coordinates :7,145,250.00N 402,700.00E 1,560.0m above sea level

Drilling details: Direction N90°W Inclination -60° Depth 300.0m

2. Geology

(1) Litho-Units

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00~ 23.80m	unknwn	siliceous argillized	jarosite,hematite rich	leached zone
23.80~108.40m	andesite	siliceous argillized		
108.40~165.90m	andesite	siliceous argillized	jarosite,hematite rich	leached zone
165.90~199.10m	andesite	siliceous argillized	hematite rich	leached zone
199.10~221.70m	andesite	siliceous argillized-chloritized	hematite rich	leached zone
221.70~235.90m	andesite	chloritized	hematie,pyrite diss.	phillic zone
235.90~300.00m	porphyry	silicified-chloiritized	pyrite diss.	phillic zone

(2) Alteration

From the surface to a depth of 221.70m is a siliceous argillized zone composed mainly of kaolin, quartz and sericite. Near the surface, to a depth 23.8m, and the fault fracture zone between 108.4 and 221.70m form leached zones with strong concentrations of pulverized reddish hematite,jarosite and natro-jarosite. Between 221.7-235.9m dominates chloritization with gypsum veins developed, and pyrite, hematite and goethite disseminate. Below 235.9m chloritization, silicification, sericitization, albitization and pyritization are dominates and gypsum vein is developed. The CSAMT low resistivity zone corresponds to the upper siliceous argillized zone, and the high resistivity zone corresponds to the distribution of massive and compact porphyry that has undergone silicification and chloritization below 235.9m.

(3) Mineralization

Pyrite disseminates in the andesite and porphyry that have undergone chloritization below 221.7m, and scarce amounts of chalcopyrite can be found at 232m and 300m. In the porphyry between 265.2-266.85m, chalcocite and covelline disseminate accompaning quartz and calcite in patches.

3. Results of ore analysis

Depth m- m	Range m	T.Cu %	S.Cu %	Mo ppm	Au ppm	Ag ppm	Original rock	Alteration zone
265-267	2	0.76	0.00	26	<0.04	6.3	porphyry	silicified-chloiritized

1-3-7 MJCV-12

1. Outline

(1) Reasons for drilling

The hole is located in the Pampa District, south-east of the Cerro Veraguas and in the Cu geochemical anomalous zone discovered by the geochemical survey of Phase 1. Around the platform several abandoned small mines are found. The purpose is to establish the continuity of surface copper mineralization.

(2) Summary of results

The hole is composed of quartz diorite that has been altered by chlorite and epidote. Specularitic hematite disseminates and films with them. Copper oxides and chalcopyrite are accompanied by the hematite. The copper grades in the places of copper dissemination are as follows:

between 13- 19m; the average T.Cu grade 0.6 % Cu oxide dissemination
between 125-131m; the average T.Cu grade 1.02% Cu oxide dissemination
between 131-148m; the average T.Cu grade 0.31%. Chalcopyrite dissemination

The position coordinates of the hole and drilling details are as given below:

Coordinates :7,144,697.00N 404,325.00E 1,486.00m above sea level

Drilling details:Direction S45°W Inclination -75° Depth 200.0m

2. Geology

(1) Litho-Units

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00~ 53.90m	quartz diorite	chlorite·epidote·calcite	cu oxide·hematite diss.	
53.90~131.00m	quartz diorite	chlorite·epidote·calcite	cu oxide·hematite diss.	
131.00~178.40m	quartz diorite	chlorite·epidote	chalcopyrite·pyrite·hematite diss.	
178.40~182.00m	quartz diorite	chlorite·epidote	cu oxide·hematite diss.	
182.00~200.00m	quartz diorite	chlorite·epidote	hematite diss.	

(2) Alteration

The hole is composed of fine to medium grained quartz diorite that has undergone marked chloritization and epidotization. Between 0-53.9m chlorite and epidote are accompanied by secondary quartz, kaolinite, calcite, albite, sericite and biotite. Between 53.9-182.0m chlorite and epidote are particularly dominant with small amounts of secondary quartz and calcite, and potassium feldspar. Between 182.0-200.0m chlorite and actinolite are dominant but epidote is scarce.

(3) Mineralization

Supecularitic hematite disseminates and films accompanied by chlorite and epidote. In the part near the surface, to a depth of 53.9m, the hematite has altered to jarosite. With hematite, chalcanthite, brochanthite and other copper oxides film along the fractures between 0-131.0m, and infinitesimal amounts of chalcocite and covelline are observable. Between 13-19m copper oxides occur with calcite network and hematite film, and the average T.Cu grade is 0.6%. Between 125-131m copper oxides occur with hematite in film and disseminate form, and the average T.Cu grade is 1.02%. Between 131-178m chalcopyrite disseminates with hematite and the average T.Cu grade is 0.31% between 131-148m and 0.10% between 148-178m.

3. Results of ore analysis

Depth m- m	Range m	T.Cu ppm	S.Cu ppm	Mo ppm	Au ppm	Ag ppm	Original rock	Altered mineral	/Cu mineral
13- 19	6	0.60	0.44	15	0.04	<0.4	quartz diorite	chlorite·epidote·calcite	/cu oxide·hematite diss.
125-131	6	1.02	0.80	48	<0.04	<0.4	quartz diorite	chlorite·epidote·calcite	/cu oxide·hematite diss.
131-148	17	0.31	0.02	39	<0.04	<0.4	quartz diorite	chlorite·epidote	/chalcopyrite·pyrite·hematite diss.
148-178	30	0.10	0.00	7	<0.04	<0.4	quartz diorite	chlorite·epidote	/chalcopyrite·pyrite·hematite diss.
178-182	4	0.33	0.25	12	<0.04	<0.4	quartz diorite	chlorite·epidote	/ cu oxide

1-3-8 MJCV-13

1. Outline

(1) Reasons for drilling

The hole is located on the northwestern hillside of the Sierra Overa. The trench survey carried out this year (detailed later) have shown the existence of the copper oxides dissemination in the diorite porphyry and aphanitic andesite that have undergone chloritization below the leached zone. The purpose is to encounter the copper mineralization accompanying diorite porphyry and aphanitic andesite.

(2) Summary of results

The hole is made up of diorite porphyry, and copper oxides, native copper, chalcopyrite disseminate in the following associations.

0.0- 78.0m copper oxides
78.0-180.0m native copper & copper oxides
180.0-198.5m copper oxides
198.5-300.0m chalcopyrite, pyrite

The position coordinates of the hole and drilling details are as given below:

Coordinates : 7,144,250.00N 397,870.00E 1,512.0m above sea level
Drilling details: Direction -- Inclination -90° Depth 300.0 m

2. Geology

(1)Litho-Units

Depth	Original rock	Alteration zone	Mineralization	Remarks
0.00~ 16.90m	diorite porphyry	siliceous argillized-chloritized	cu oxide·jarosite·hematite	phillic zone
16.90~ 70.00m	diorite porphyry	chloritized	cu oxide·jarosite·hematite	phillic zone
70.00~ 78.00m	diorite porphyry	chloritized	cu oxide·jarosite·hematite	phillic zone
78.00~149.00m	diorite porphyry	chloritized	native copper·cu oxide·hematite	potassic zone
149.00~180.00m	diorite porphyry	silicified-chloiritized-potash feldspar	native copper·cu oxide·hematite	potassic zone
180.00~198.50m	diorite porphyry	silicified-chloiritized-potash feldspar	cu oxide·jarosite·hematite	potassic zone
198.50~300.00m	diorite porphyry	silicified-chloiritized-potash feldspar	chalcopyrite·pyrite·hematite	potassic zone

(2) Alteration

Between 0-16.9m is a siliceous argillized-chloritized zone comprised of kaolin, quartz, sericite and chlorite, and a gypsum vein with jarosite and reddish hematite is well developed. Between 16.9-70.0m the alteration is weak and the diorite porphyry texture remains distinct. The altered mineral is chlorite, secondary quartz, albite, potassium feldspar, sericite and biotite, in addition to which quartz, gypsum and jarosite develop in fine veins. Below 70.0m the alteration mentioned previously strengthens; between 78.0-149.0m the alteration to chlorite, and between 149.0-300m the alteration to chlorite, silicates and potassium feldspar is particularly marked. Also, between 70.0-180.0m fine films of gypsum and anhydrite develop in a network form. From these mineral associations it may be considered that 0-149.0m corresponds to the phillic zone, and 149.0-300.0m to the potassic zone, of alteration classification of porphyry copper deposits according to Lowell and Guilbert (1970).

(3) Mineralization

Hematite films and disseminates widely derived from the alteration of magnetite. And hematite have altered to jarosite and goethite in the upper part and along fractures.

Copper oxides, native copper, chalcopyrite disseminate in the following associations.

Between 0-16.9m, copper oxides such as atacamite and brockanthite occur in film and dissemination form along fractures and with gypsum films. Under microscopy very small amounts of native copper and chalcopyrite are observable. The average grade of T.Cu between 2-17m is 0.55%,with a maximum of 1.24%. Between 16.9-78.0m, copper oxides such as atacamite and brockanthite occur in film and dissemination form as described above, and the average T.Cu grade is 0.3% with a maximum of 1.12%.

Between 78.0-180.0m, native copper disseminates and films in particles measuring 0.005-0.3mm filling the spaces between crystals and accompanying gypsum film. Between 80.0-112.0m, 138.5-140.6m and 149.0-180.0m in addition to native copper, copper oxides such as atacamite and azurite occur in film and disseminate form. Under microscope chalcopyrite and bornite are observable in particles measuring 0.01mm or less in diameter.

In the places where native copper is observable, hematite has not completely replaced the magnetite, so that both are invariably found together. In the places rich in Cu oxides, the hematization of the magnetite have been further advanced.

Below 149.0m the amount of native copper decreases as the alteration to potassium feldspar increases, and below 180.0m it can be found scarcely. The T.Cu grade shows an average of 0.23%,

maximum 0.66% between 78.0-149.0m, and an average of 0.18%, maximum 0.52% between 149.0-180.0m. Below 198.5m in place of native copper, chalcopyrite and small amounts of chalcocite and covelline are observable accompanying pyrite. Between 198.0-300.0m the T.Cu grade is 0.11% on average, with a maximum of 0.55%. Between 0-180m the Au grade is an average of 0.1-0.2ppm and a maximum of 1.22ppm; but below 180.0m the Au grade is less than 0.10ppm, showing roughly the same behavior as the copper.

3. Results of ore analysis

Depth m - m	Range m	T.Cu ppm	S.Cu ppm	Mo ppm	Au ppm	Ag ppm	Alteration zone	Cu mineral
2- 17	15	0.55	0.41	10	0.24	<0.4	phillic zone	cu oxide·jarosite·hematite
17- 70	53	0.24	0.12	19	0.14	<0.4	phillic zone	cu oxide·jarosite·hematite
70- 78	8	0.33	0.20	19	0.21	<0.4	phillic zone	cu oxide·jarosite·hematite
78-149	71	0.23	0.10	56	0.13	<0.4	phillic zone	native copper·cu oxide·hematite
149-180	31	0.18	0.09	42	0.13	<0.4	potassic zone	native copper·cu oxide·hematite
180-198	18	0.14	0.07	37	0.09	<0.4	potassic zone	cu oxide·jarosite·hematite
198-250	52	0.11	0.03	34	<0.04	<0.4	potassic zone	chalcopyrite·pyrite·hematite
250-300	50	0.10	0.01	17	<0.04	<0.4	potassic zone	chalcopyrite·pyrite·hematite