AN INTERIM REPORT OF
MINERAL EXPLORATION IN
CERRO NEGRO
THE REPUBLIC OF CHILE

PHASE I

FEB. 1993

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

PREFACE

In response to the request the Government of The republic of Chile,the Japanese Government decided to conduct a Mineral Exploration in The Cerro Negro 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. Fumio Wada from 7 November, 1992 to 11 March, 1993.

The team exchanged views with the officials concerned of the Government of Chile and conducted a field survey in the Cerro Negro area.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.

March 1993

Kensuke Yanagiya

Kensuke YANAGIYA

President

Japan International Cooperation Agency

Takashi Ishikawa

Takashi Ishikawa

President

Metal Mining Agency of Japan

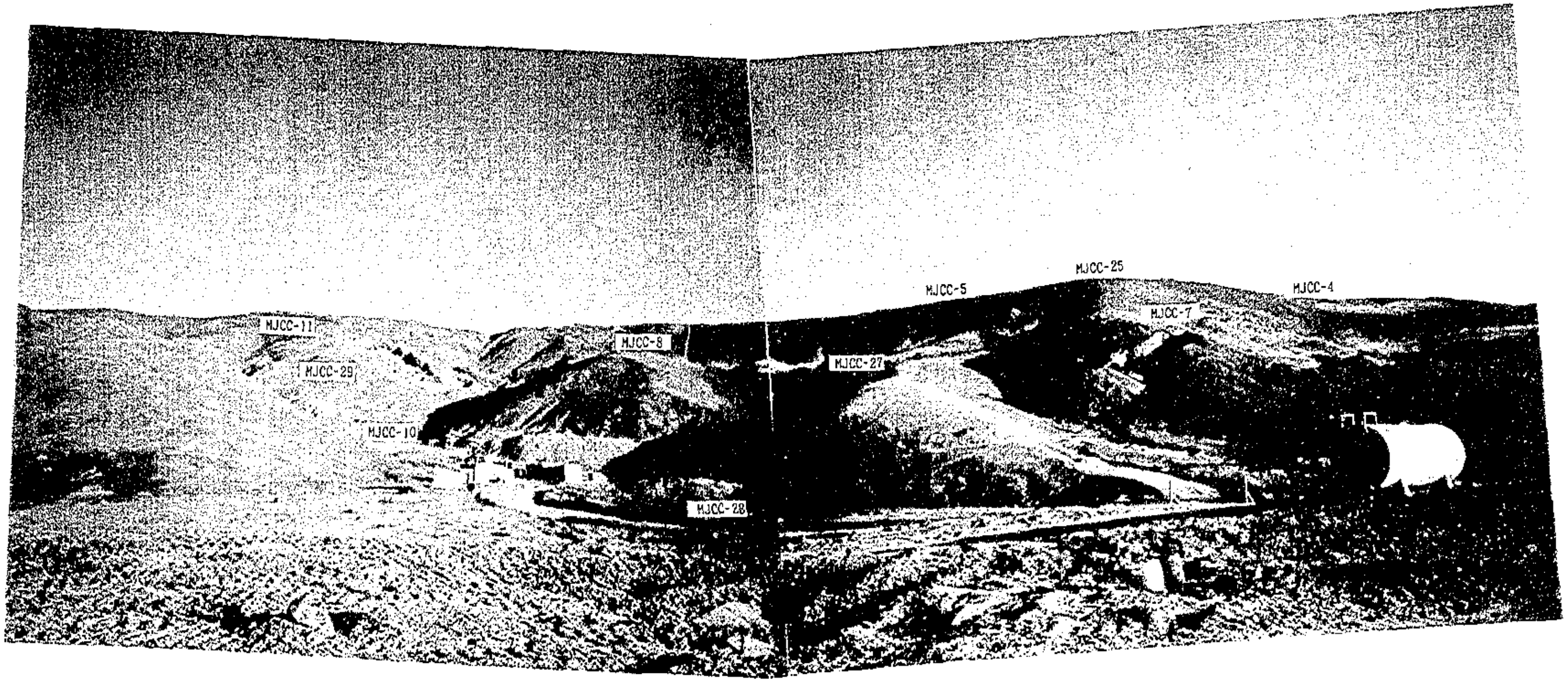


Photo 1 The Locality Map of Survey Area, Cerro Florida (Eastward Scene)

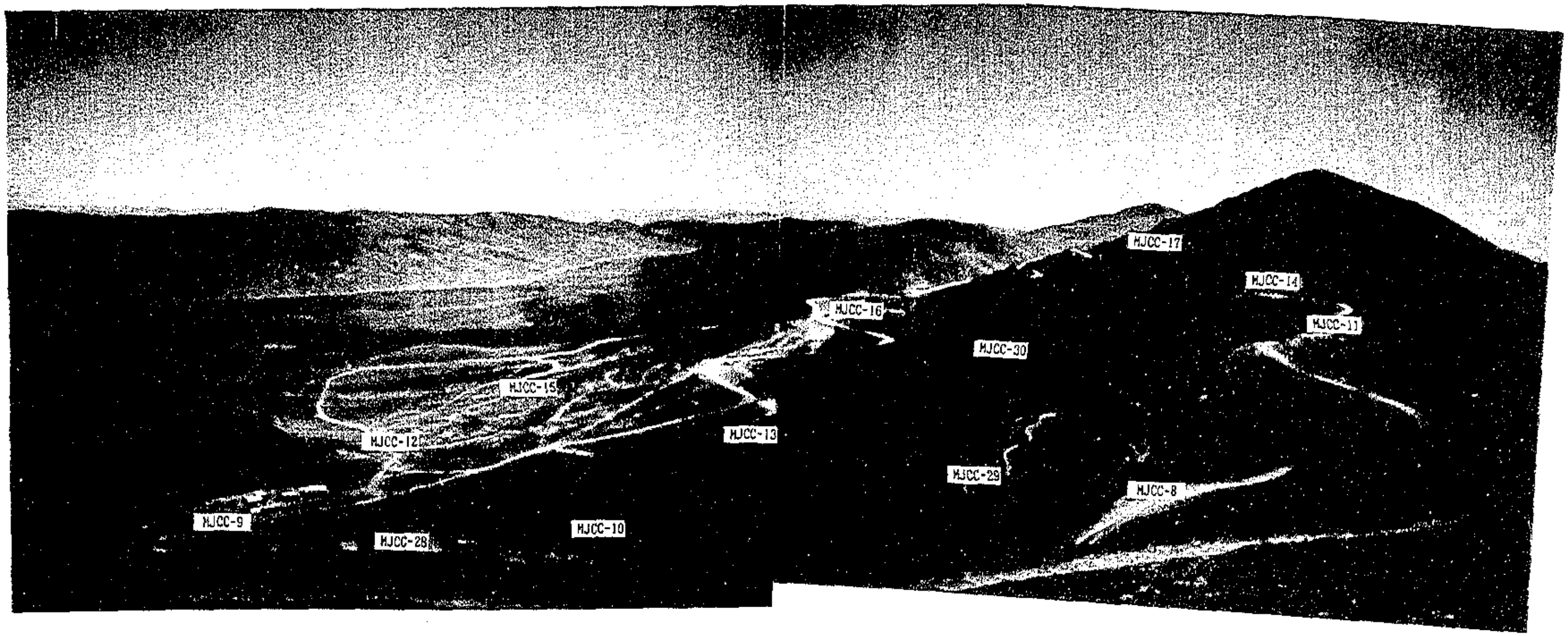


Photo 2　The Locality Map of Survey Area, Cerro Florida (Northward Scene)

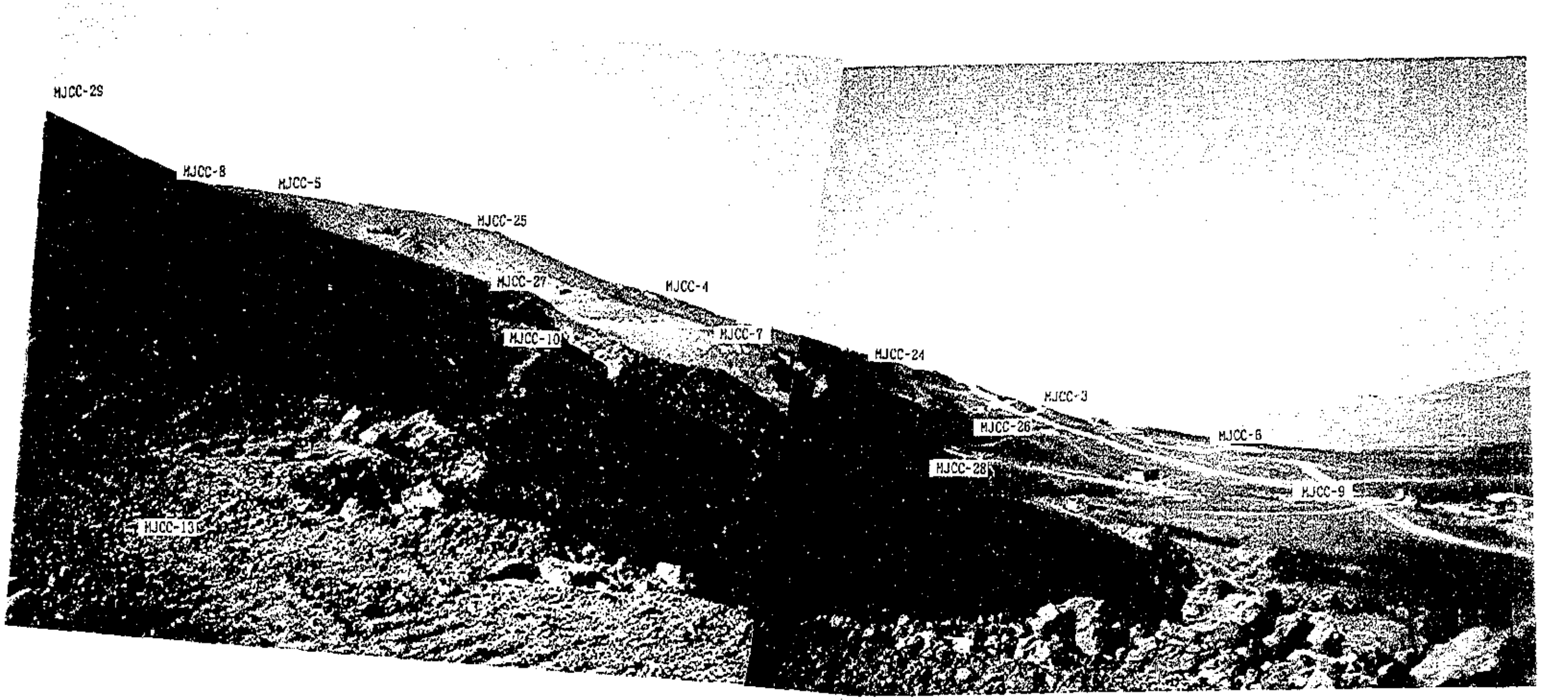
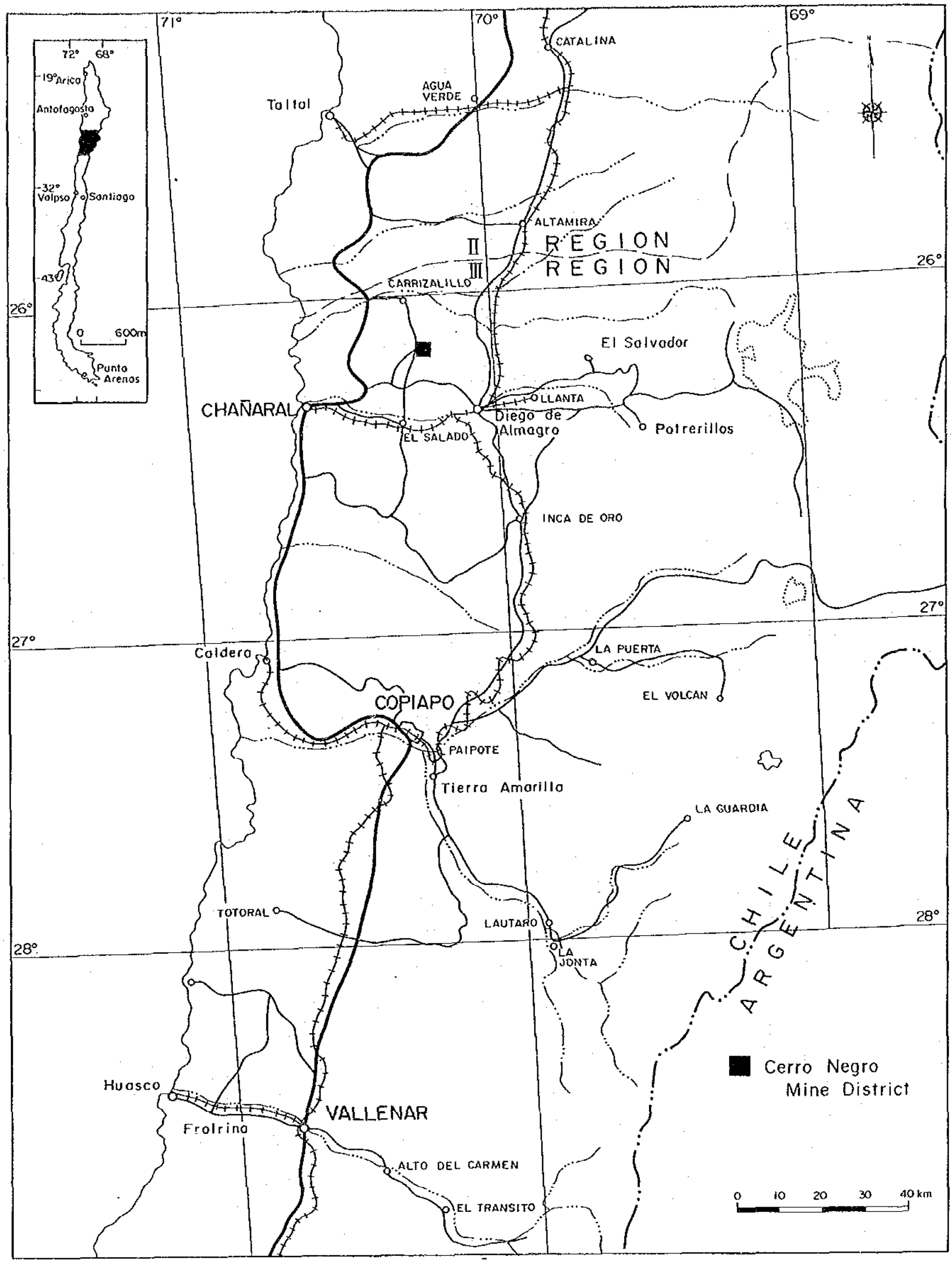
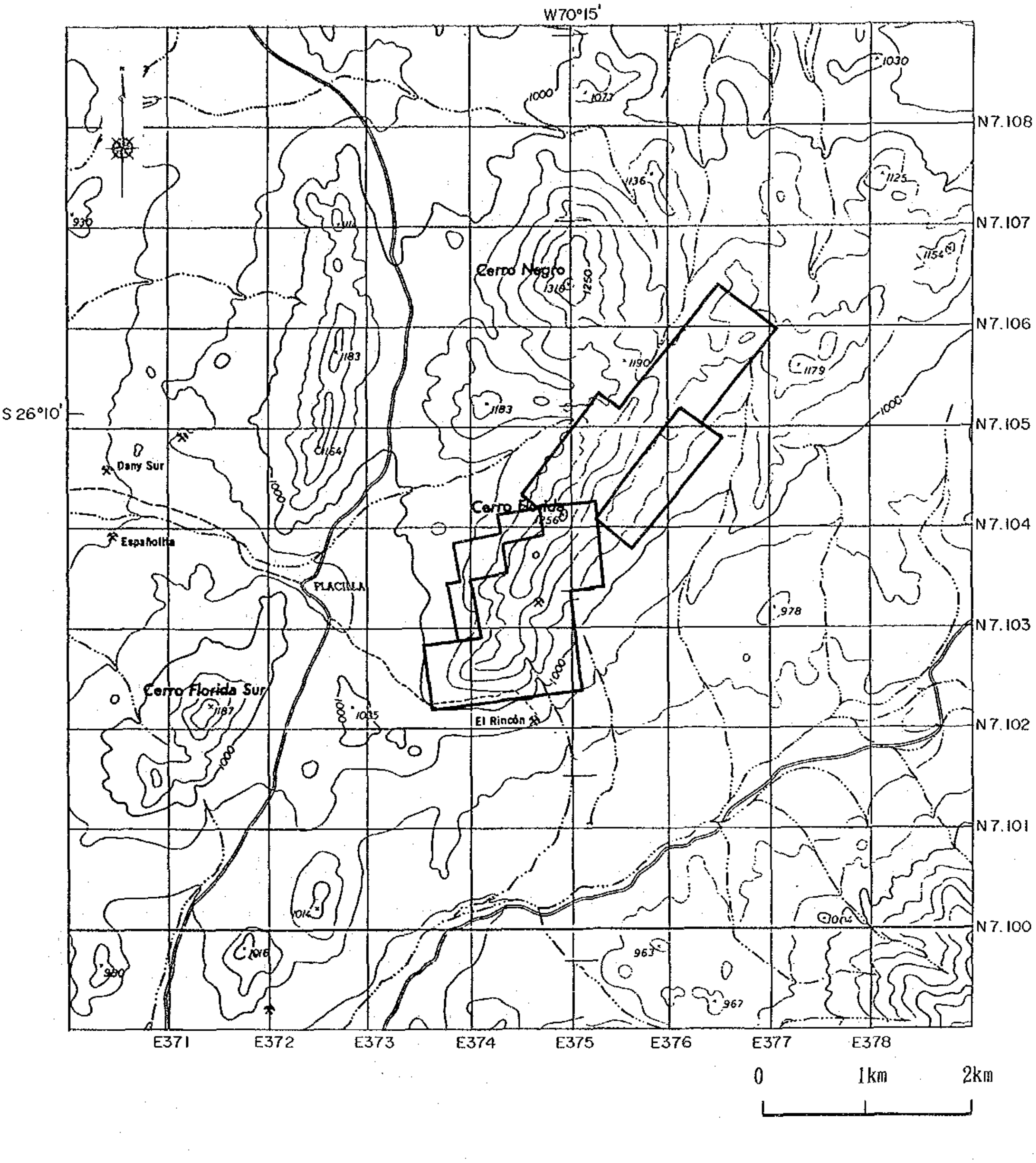


Photo 3 The Locality Map of Survey Area, Cerro Florida (Southward Scene)



The Locality Map of the Survey Area



The Locality Map of the Dolling Survey and Geophysical Exploration

ABSTRACT

The object of the survey is to confirm the existence of new mineral deposits in Cerro Negro region, the Republic of Chile and to evaluate them by elucidating its geology and the distribution of mineral deposits.

1.Main Theme

(1) Drilling Survey

The dimension and grades of copper oxide deposits and copper sulfide deposits should be confirmed.

(2) Analysis of Existing Data

Existing data on the dressing of copper sulfide ore and copper oxide ore should be collected and analyzed to use their analytical results for planning ore dressing tests expected to be made in the second year.

(3) Geophysical Survey

The physical properties of host rock and mineral deposits should be clarified by carrying out geophysical well-logging to formulate the principle of future ore prospecting.

2.Result of the Survey

(1) Drilling Survey

The important mineralization zones, which were recognized based on detailed data on the 12 drill holes, are mentioned below. As for the largest mineralization zones of the two kinds, the copper oxide ore zone has a thickness of 25m (average Cu grade of 1.023%) while the copper sulfide ore zone has a thickness of 29m (average Cu grade of 1.021%).

Drill Hole	Depth (renge)	TCu%	SCu%	ICu%	TFe%	Mineralization type
MJCC−7	0m- 15m (15m)	0.673	0.536	0.137	32.23	Oxidation zone
MJCC−7	15m- 40m (25m)	1.023	0.917	0.106	29.23	Oxidation zone
MJCC−7	46m- 54m (8m)	0.692	0.492	0.200	31.93	Oxidation zone
MJCC−7	125m- 154m (29m)	1.021	0.046	0.975	34.07	Sulfurization zone
MJCC−8	0m- 21m (21m)	0.458	0.208	0.250	27.12	Oxidation zone
MJCC−10	0m- 45m (45m)	0.750	0.532	0.218	30.01	Oxidation zone
MJCC−10	45m- 50m (5m)	0.748	0.218	0.530	38.06	Intermediate zone
MJCC−10	50m- 105m (55m)	0.689	0.037	0.652	36.13	Sulfurization zone
MJCC−11	30m- 32m (2m)	1.030	0.945	0.079	32.42	Oxidation zone
MJCC−11	38m- 39m (1m)	0.910	0.800	0.110	28.44	Sulfurization zone

Drill Hole	Depth (renge)	TCu%	SCu%	ICu%	TFe%	Mineralization type
MJCC−11	57m- 59m (2m)	0.740	0.580	0.160	51.21	Intermediate zone
MJCC−11	163m- 164m (1m)	1.750	0.150	1.600	24.63	Oxidation zone
MJCC−12	38m- 40m (2m)	0.875	0.810	0.065	7.70	Oxidation zone
MJCC−12	57m- 68m (11m)	0.409	0.294	0.115	7.43	Intermediate zone
MJCC−12	79m- 107m (28m)	0.409	0.065	0.344	6.43	Sulfurization zone
MJCC−12	115m- 148m (41m)	0.697	0.014	0.683	12.12	Sulfurization zone
MJCC−13	9m- 17m (8m)	1.089	0.848	0.241	23.68	Oxidation zone
MJCC−13	20m- 37m (17m)	0.744	0.335	0.408	24.13	Intermediate zone
MJCC−13	45m- 51m (6m)	1.168	0.312	0.857	38.10	Intermediate zone
MJCC−13	59m- 74m (15m)	0.472	0.014	0.458	28.78	Sulfurization zone
MJCC−16	50m- 93m (44m)	0.548	0.249	0.299	15.58	Intermediate zone
MJCC−16	93m- 111m (18m)	0.451	0.008	0.443	11.83	Sulfurization zone
MJCC−17	0m- 8m (8m)	0.464	0.201	0.263	13.69	Oxidation zone
MJCC−17	11m- 22m (11m)	0.531	0.253	0.278	20.53	Oxidation zone
MJCC−17	33m- 41m (8m)	0.464	0.258	0.206	20.21	Oxidation zone
MJCC−17	41m- 55m (14m)	0.911	0.573	0.338	22.81	Oxidation zone
MJCC−20	6m- 38m (32m)	0.454	0.208	0.246	21.63	Intermediate zone
MJCC−20	55m- 126m (71m)	0.407	0.127	0.281	30.35	Sulfurization zone

The host rock for all the copper mineralization zones contains a high percentage of iron oxide ore, and hydrothermal breccia is often equivalent to semi-iron ore. The relationship between such iron oxide ore and copper ore deposits should be studied in later.

(2) Calculation of Ore Reserves

1) Evaluation for drilling intervals, relationship between ore grade distribution and geological factors etc. remained to be a subject of further study.

2) No mine evaluation was carried out as no sufficient data are available for ore reserve calculation.

3) Judging from the variogram configuration, geostatistical ore reserve calculation requests a 50 m to 100 m drilling interval.

(3) Analysis of Existing Data (Ore Dressing)

CIMM's research facilities and talented personnel seems to be sufficient enough to carry out metallurgical test of Cerro Nergo ore except for no pilot plant for SX/EW.

Metallurgical tests should be conducted both in Japan and in Chile using same ore materials and the results must be compared for further study.

(4) Geophysical Prospecting

The results obtained by physical prospecting are as mentioned below.

<1> The results of simulation for high IP and low resistivity anomaly detected by land surface IP satisfactorily show the distribution of mineralization zones.

<2> According to the analysis of physical-property data, the sources of high IP and low resistivity anomaly detected by land surface IP simulation are imagined to be mineralization zones consisting of chalcopyrite and magnetite.

<3> The causes of high magnetic anomaly zones detected by magnetite prospecting are imagined to be magnetite mineralization zones.

<4> Fig. III–1–1 shows the distribution ranges of IP > 10%, magnetic susceptibility > 5,000 x 10^{-6}, mineral coefficients?? > 0.1 and insoluble copper grades > 0.15%, the range of simulation models for land surface IP anomaly, and the distribution range of high magnetic susceptibility zones imagined by land surface magnetic prospecting as a figure of integrated physical propriety measurements.

This figure can tell that most high anomaly values overlap the range of them around MJCC–10 to 13, and satisfactorily correspond to the results of land surface physical prospecting.

<5> Fig. II–4–32 shows the range of high IP and low resistivity zones detected by the re–analysis of land surface IP anomaly as well as the range of high magnetic susceptibility zones detected by the re–analysis of land surface magnetic anomaly. This figure indicates that the range of high IP and low resistivity zones is narrower in east–west width around MJCC–13 than the past analytical results while the range of high magnetic susceptibility zones is wider almost in a circle around MJCC–10 and 13.

3. Proposal for the Second Year's Investigation

(1) DRILLING SURVEY

A detailed drilling programme is recommended for PHASE U, especially around the area of MJCC-7 and MJCC-20 to clarify the mode of occurrence of Cerro Negro copper mineralization.

And the study on genetic relation between the Atacama fault and copper mineralization in "hydrothermal breccia" is also recommended.

(2) CALCULATION OF ORE RESERVES

Further 30 to 40 drills are required for ore reserve calculation from geostatistical point of view.

A modelling of grade distribution based on geological factors and anisotropy of mineralized bodies is also essential for confident ore reserve calculation.

(3) DRESSING TEST

Outline of metallurgical tests proposed for PHASE U is shown in below:

Key Points for the Design of Mineral Processing Tests (Proposal)

METHOD OF TEST	SAMPLE	TERMS (MONTH)								
		0	2	4	6	8	10	12	14	16
1. MINERALOGICAL STUDY		—								
2. FLOTATION (BENCH SCALE)	200～500kg	—	—							
3. LEACHING (COLUMN TEST)	2～6 ton	—	—							
4. FLOWSHEET DEVELOPMENT				—	—					
5. PRE-FEASIBILITY STUDY					—	—				

Tests start mineralogical study and complete pre-feasibility study.

These tests require at least 10 months.^Z

(4) Geophysical Prospecting

IP method and CASMT method are effective in investigating mineralization zones with high IP and low resistivity in this area. CSAMT method can be imagined to be used to investigate whether mineralization zones exist at deeper places.

CONTENTS

Part II Details of the Surveys

Pages

Part III Conclusion and Recommendation

LIST OF FIGURES

List of Tables

Appendix

P l a t e

Part I General Remarks

CHAPTER 1 INTRODUCTION

1-1 object of the investigation

The object of the survey is to confirm the existence of new mineral deposits in Cerro Negro region, the Republic of Chile and to evaluate them by elucidating its geology and the distribution of mineral deposits.

1-2 methods of the survey

(1) Drilling Survey

<1> Purpose

The dimension and grades of copper oxide deposits and copper sulfide deposits should be confirmed.

<2> Drilling Survey in Cerro Negro Region

1) Table 1-1-1 lists the contents of the drilling survey.

2) Drilling machines, which are capable of fully drilling the ground down to the planned depth, should be used to satisfactorily cope with change in depth even if it is expanded.

3) Casing pipes with the minimum diameter should be prepared to reach more than 60% of the planned depth.

4) The minimum diameter of cores should be BQ or larger.

5) Collection of Cores and Core Recovery

a) In principle, all cores should be collected except surface soil.

b) Core recovery should be 80% or more even if it is difficult to collect all cores. It is necessary to make efforts at collecting all cores, especially from mineralized rocks, the bottom of holes and ore boundaries.

6) Handling of Cores

a) Collected cores should be put into core boxes and kept at a dry place by specifying their upper and lower sides.

b) Slime should be put into transparent vinyl sacks and then kept in core boxes in the same way as the storage of cores when slime is collected in place of cores.

c) The depth, at which cores and slime are collected, should be indicated inside and outside core boxes.

d) When drilling is over, collected cores should be stored at the place specified by organization concerned in Chile.

7) Survey on Cores and their Analysis

a) Column sections on a scale of 1 to 200 should be drawn by precisely observing cores.

b) Cores should be observed microscopically as required.

c) Each recovered cores should be separated from other core sand then chemically analyzed.

d) Outcrops of mineral deposits should be investigated as required and precisely compared with cores recovered from encountered mineral deposits.

e) Table 1-1-1 (planned) lists the number and quantity of samples required for laboratory tests.

8) The chief geologist should stay there until the site investigation is completed. Other geologist should go home to Japan early enough to obtain the number of days required for analyzing cores in Japan. They should be analyzed in Japan.

(2) Geophysical Survey

<1> **Purpose**

The physical properties of host rock and mineral deposits should be clarified by carrying out geophysical well-logging to formulate the principle of future ore prospecting.

<2> **Geological Survey in Cerro Negro Region**

1) Ten drill holes suitable for achieving the important point should be selected, and geophysical well-logging should then be carried out in the bare parts of these drill holes in principle.

2) They should be measured twice in principle, but if their repeatability is difficult, they should be measured again.

3) The components of measurement should consist of resistivity and frequency effect.

4) Measured values should be recorded in the three-electrode method, and the electrode interval should be 5cm in principle.

5) The magnetic susceptibility of collected cores should be measured.

(3) Analysis of Existing Data (Ore Dressing)

<1> **Purpose**

Existing data on the dressing of copper sulfide ore and copper oxide ore should be collected and analyzed to use their analytical results for planning ore dressing tests expected to be made in the second year.

<2> **Site Investigation**

The site investigation should be made for five days at the related facilities of the organization concerned in Chile.

(3) Analysis of Existing Data (Ore Dressing)

1-3 formation of the investigation group and the period of the investigation

Table 1-1-2 lists the members of the investigation group,consisting of people designing its plan and conducting negotiations for its agreement and participants in the investigation to carry out the investigation.

Table I − 1 − 1 Quantities of the survey

	Planned Survey			Actual Survey		
Drill Hole	Depth (m)	Dir.	Dip	Depth (m)	Dir.	Dip
MJCC- 1	221		-90°	221.70		-90°
MJCC- 2	164		-90°	164.00		-90°
MJCC- 3	165		-90°	165.00		-90°
MJCC- 4	191		-90°	191.35		-90°
MJCC- 5	191		-90°	191.15		-90°
MJCC- 6	160		-90°	161.35		-90°
MJCC- 7	200		-90°	200.10		-90°
MJCC- 8	190		-90°	190.20		-90°
MJCC- 9	215		-90°	215.10		-90°
MJCC-10	160		-90°	160.40		-90°
MJCC-11	191		-90°	191.95		-90°
MJCC-12	169		-90°	169.30		-90°
MJCC-13	240		-90°	240.00		-90°
MJCC-14	204		-90°	204.90		-90°
MJCC-15	200		-90°	200.35		-90°
MJCC-16	216		-90°	216.75		-90°
MJCC-17	160		-90°	160.05		-90°
MJCC-18	184		-90°	184.85		-90°
MJCC-19	165		-90°	165.10		-90°
MJCC-20	187		-90°	187.65		-90°
MJCC-21	300	122°	-50°	300.30	122°	-50°
MJCC-22	165	122°	-50°	165.00	122°	-50°
MJCC-23	165	122°	-60°	165.00	122°	-60°
MJCC-24	388		-90°	388.30		-90°
MJCC-25	225		-90°	225.50		-90°
MJCC-26	184		-90°	184.20		-90°
MJCC-27	500		-90°	500.00		-90°
MJCC-28	198		-90°	198.90		-90°
MJCC-29	230		-90°	230.00		-90°
MJCC-30	298		-90°	298.00		-90°
Total	6426			6436.45		
Laboratory tests	① Thin Section	30 cases		30 cases		
	② Polished Section	30 cases		30 cases		
	③ The number of mineral Chemical analysis (T, Cu, S, Ca, Au, Ag, Fe)	6,409 cases 32,045 components		6,409 cases 32,045 components		

Table Ⅰ-1-2　Members of the Investigation

First year	
Japanese side	Chilean side
Planning of the investigation and its negotiations	Planning of the investigation and its negotiations
Mr. Yasuo Noguchi at Metal Mining Agency of Japan Mr. Ichizo Morikawa at Metal Mining Agency of Japan Mr. Haruhisa Morozumi at Metal Mining Agency of Japan Mr. Ken-ichi Sato at Metal Mining Agency of Japan Mr. Ko Naito at Japan International Cooperation Agency	Mr. Gaston Fernandez M. Empresa Nacional de Mineria Mr. Silvio Girardi Morales Empresa Nacional de Mineria Mr. Julio Chazarro Ortiz Empresa Nacional de Mineria Mr. Mario Serrano Cavieres Empresa Nacional de Mineria Mr. Pedro Iiabaca Ugarte Empresa Nacional de Mineria
Site investigation group	Site investigation group
Mr. Haruhisa Morozumi at Metal Mining Agency of Japan Mr. Fumio Wada (head of the group) at Dowa Engineering Co., Ltd. Mr. Hirofumi Yoshizawa [boring (geology)] at Dowa Engineering Co., Ltd. Mr. Yutaka Kikuchi [boring (geology)] at Dowa Engineering Co., Ltd. Mr. Koji Uchiyama [boring (geology)] at Dowa Engineering Co., Ltd. Mr. Michio Tanahashi (geophysical prospecting) at Dowa Engineering Co., Ltd. Mr. Toshiie Tsubakita (geophysical prospecting) at Dowa Engineering Co., Ltd. Mr. Yoshiaki Karino (geophysical prospecting) at Dowa Engineering Co., Ltd. Mr. Masayuki Hisatsune [analysis of existing data (ore dressing)] at Dowa Engineering Co., Ltd.	

(2) Geophysical Prospecting

Items of Survey	Planned Survey	Actual Survey
Geophysical well-logging	10 holes	10 holes
Magnetic susceptibility of core samples	200 cases	458 cases
IP Measurement of core samples	No case	424 cases

Table I-1-3 Schedule of the Investigation

Items	First year	
	periods	No. of days
Preparations in Japan	From October 30, 1992 to November 6, 1992	8 days
Site investigation (Dolling)	From November 7, 1992 to March 11, 1993	125 days
Site investigation (geophysical prospecting)	From November 28, 1992 to January 27, 1993	61 days
Site investigation [analysis of existing data (ore dressing)]	From January 5, 1993 to January 24, 1993	20 days
Preparation of the analytical report	From January 25, 1993 to March 11, 1993	46 days
Entire investigation period	From October 30, 1992 to March 11, 1993	133 days

CHAPTER 2 TOPOGRAPHY OF THE INVESTIGATION AREA

2–1 location and transportation

The survey area is included in the third province in the northern part of the Republic of Chile. The area is located about 800km north of Santiago, the capital of this country, 25km (land route distance: 35km) north of El Salado which is about 100km away from Copiapo City, the capital of the province, 40km (land route distance: 52km) northwest of Chranal, and easy of access.

2–2 Geography and its River System

The geography of the investigation area is largely divided into the following three zones, which run nearly from south to north. Cerro Negro region belongs in <1> of these zones.

<1> Coostal cordillera

<2> Central depression

<3> Domeyko cordillera

The cordillera in Cerro Negro region consists of mountains running in the NNE–SSW direction, which is slightly oblique to the above–mentioned entire direction. The average altitude of those mountains is 850m to 1,300m. The highest mountain is Cerro Saladito (1,332m) located 10km south of the survey section. This mountain consists of andesite in Los Cerro Florida formation. The shape of mountains varies depending on the kinds of constituent rocks. Andesite in Los Cerro Florida formation forms the steepest mountains with a high altitude while granite and sedimentary rock clearly tend to form gently–sloping mountains. By the way, Cerro Florida Sur regarded as one of the investigation targets in the first year has an altitude of 1,253m.

The river system in the region is affected by the shape of mountains, runs in the NNE–SSW direction in its upper reaches, and flows into the Pacific Ocean changing its direction to east from the middle reaches to the lower reaches. Water actually runs in the river system once every five years on the average.

2–3 Climate and Vegetation

The climate of the survey area differs sharply in<1>, <2> and <3> of the geographically–divided sections mentioned above. <1> where Cerro Negro region belongs in indicates a typical coastal desert climate mentioned below.

<1> There is almost no rainfall through the year.

<2> The humidity is low.

<3> There are many cloudless days.

<4> There is a great difference in daily temperature.

<5> It is often foggy.

<6> It is often windy.

It is comfortable even in summer (December to February)whose temperature is 25 to 27°C. The temperature drops to a minimum of 2 to 5°C in winter (June to August). As for rainfall, it generally rains once (about 20mm) every five years, but it is often foggy through the year. This is the way humidity is maintained. Vegetation is very limited owing to such a climate, and cacti and short plants, which can obtain water from fog, exist barely. Since the food cycle here is not active due to poor vegetation, there are few animals: a small number of guanacos are only seen as plant-eating animals.

CHAPTER 3 EXISTING INFORMATION ON THE GEOLOGY OF THE STUDY AREA

3-1 Outline of Past Investigations

Copper mineralization at the ground surface in Cerro Negro region had arrested attention, but no full-scale exploration activities had been carried out so far. However, based on a proposal made in 1990 by BOTT, ENAMI (Chileian public mining corporation) has made investigations such as the analysis of topography and geology by aerial photographs, geophysical prospecting and preliminary drilling investigations since then. The periods of these investigations and their contents areas listed below.

Table Ⅰ-3-1 List of Past Investigations

Dates of submitting reports	Contents of investigations	Titles of reports
1990/06	① Ground surface investigation ② Proposal for future investigations	1. H.BOTTO HERRERA(1990):EL YACIMIENTO CERRO NEGRO-ENAMI UN PROSPECTO DE COBRE ATRACTIVO PARA UNA ACTIVIDAD DE MEDIANA MINERIA METARICA.
1991/04	① Analysis of topography by aerial photographs (1: 13,900)	1. HERNAN VALENZUELA NOVILLO(1991):ESTUDIO FOTOGEOLOGICO DEL DISTRITO MILLRO CERRO NEGRO (EL SALADO Ⅲ REGION).
1991/06	① Analysis of geology by aerial photographs (1: 13,900)	1. HERNAN VALENZUELA NOVILLO(1991):ESTUDIO FOTOGEOLOGICO DEL DISTRITO MILLRO CERRO NEGRO (EL SALADO Ⅲ REGION).
1991/08	① Magnetic prospecting and I.P. exploration	1. GEODATOS(1991):ESTUDIO MAGNETICO TERRESTRE Y POLARIZACION INDUCIDA SECTOR CERRO NEGRO DISTRITO (EL SALADO Ⅲ REGION).
1991/09	① Geological investigation in the mineralization zone of Los Negros mine claim (1:500 geological map) ② Geological investigation in Negreita mine claim (1:2,000 geological map) ③ Geological investigation in Los Negros mine claim (1:5,000 geological map) ④ Underground geological investigation (1: 250 geological map) ⑤ Mineralization zone investigation (1,200 samples) and petro-geochemical prospecting (650 samples) ⑥ Analysis of geophysical prospecting (magnetic prospecting and I.P. exploration) ⑦ Calculation of ore reserves ⑧ Selection of sites proposed for Dolling	1. EGM SERVICIOS GEOLOGICOS MINEROS LTDA.: EVALUACION GEOLOGICA YACIMIENTO CERRO NEGRO (EL SALADO Ⅲ REGION).
1992/02	① Results of 7 boreholes with(a total depth of 845m) ② Future Dolling plan (20 holes, 2,470m)	1. ENAMI:EXPLORACION GEOLOGICA DEL YACIMIENTO CERRO NEGRO DEL DISTRITO EL SALADO-Ⅲ REGION

Among these past investigations, the outline of the results of drilling invitations, which are related most to the regional development project investigation, is listed below.

Table I-3-2 List of Past Dolling Investigations

Borehole No.	Coordinates	Excavation length (m)	Azimuths Inclinations	Penetration depth (penetration length)	Grades. (T. Cu%)
DTH-1	X:E 373,922.97	1 1 2	0 · -90	36-41 (6m)	0.635
	Y:N7,102,769.29			56-5 1 (2m)	0.825
	Z: 1,099.48				
DTH-2	X:E 373,953.59	1 5 8	N90E · -70	49-58 (10m)	1.030
	Y:N7,102,741.58			75-80 (6m)	0.710
	Z: 1,111.32				
DTH-3	X:E 374,009.22	1 3 0	N90E · -70	12-21 (10m)	0.512
	Y:N7,103,070.16			26-43 (18m)	0.719
	Z: 1,067.67			44-56 (13m)	1.090
				104-109 (6m)	0.738
DTH-4	X:E 374,097.96	1 0 8	N90E · -70	7-12 (6m)	0.536
	Y:N7,103,111.66			39-56 (18m)	0.933
	Z: 1,088.39				
DTH-5	X:				
	Y:	These investigations were not made.			
	Z:				
DTH-6	X:E 374,137.73	1 0 5	N90E · -70	18-35 (18m)	0.564
	Y:N7,103,300.08			36-48 (13m)	1.461
	Z: 1,099.48			62-91 (30m)	1.705
DTH-7	X:E 374,063.22	1 0 2	N90E · -70	3- 7 (5m)	0.504
	Y:N7,102,894.81			22-36 (15m)	0.559
	Z: 1,088.57			41-69 (29m)	0.930
DTH-8	X:E 375,201.98	1 3 0	N60W · -80	79-91 (13m)	0.650
	Y:N7,104,365.09				
	Z: 1,084.65				

3-2 General Geology of the Investigation Area and its Geological Status

3-2-1 Geological Structure of the Andean Cordillera

The Andean cordillera generally consists of the following three zones, which run in parallel from south to north and are located from west to east in the order mentioned below.

* Coastal cordillera
* Los Andes cordillera
* Pre-cordillera

Cerro Negro region, which is the investigation area, is located in the coastal cordillera among these zones. The Andean cordillera has been regarded as an example of cordilleras which formed simply. The outline of its formative history and geographical characteristics is mentioned below.

The Andean cordillera is located along the western edge of the South American continent as a fold-mountain range with a south-north length of about 9,500km and a width of 300 to700km, which upheaved in the late Cenozoic period. The highest mountain is Acongagua with an altitude of 7,021 m which is located in the center of Los Andes cordillera. Los Andes cordillera is seen as three divided zones such as its western, central and eastern parts. However, the northern and southern parts of Los Andes cordillera are inferior in both length and height. Therefore, Los Andes cordillera is not clearly divided as mentioned above.

On the whole, the history of the geographical structure of the Andean cordillera has been believed as mentioned below. It has formed through at least two major geosyncline periods since the Paleozoic period.

<1> The pre-Andean geosyncline belt formed on the eastern side of the present Andean cordillera from the end of the Cambrian period to the mid-Devonian period, marine sediment with a thickness of 10 km accumulated there and the belt became land in the mid-Permian period.

<2> After that, the Andean geosyncline belt started forming together with violent volcanic activities on the western side of the above-mentioned belt at the end of the Triassic period. The Andean batholith consisting mainly of granodiorite gushed out into this geosyncline belt from the Cretaceous period to the Paleogene period, and the belt then started upheaving rapidly in and after the Pliocene period.

The coastal cordillera is a low horst-graven mountain range existing on bedrock consisting mainly of Precambrian and Paleozoic strata and was affected twice by orogenic movements in the Paleozoic period.

Volcanic activities took place mainly through calc-alkali rock series hornblende andesite in the entire Andean cordillera from the Pliocene period to the Quaternary period.

However, the formative history of the Andean cordillera has been realized to be more complicated than mentioned above according to the results of recent analyses of its geological formative history. According to Mpodozis & Ramos (1989), the southwestern tip of the continent of Gondwana was located in and around the edge of present Sierras Pampeanas in Argentina in the early Paleozoic period for example. The area where the present pre–cordillera is located was the continental shelf consisting of carbonate rock at that time. The Chilenia terrane and the continent of Gondwana were separated from each other by these a located on the western side of the shelf.

While this basin was consumed by the subduction zonewhich declined on the eastern side toward the lower part of Sierras Pampeanas in the late Devonian period, the Chilenia terrane moved in the eastern direction and was added to the continent of Gondwana. At that time, a new subduction zone formed on the western side of the added terrane, and a large added prism zone was left behind in the area where the present coastal cordillera is located.Arcuate magma activities created granitoid and rhyolite in the added prism zone and its vicinity from the late Paleozoic period to the early Mesozoic period.

The development of the basin toward the continental edge completed in the late Paleozoic, and arcuate magma basin sand back arc basins developed on bedrock consisting of Paleozoic strata in the early Mesozoic period. Many assemblage in island–arc foreland were removed by continuous subduction erosion and strike–slip fault activities in the Paleozoic period. Since this process was the most active in the northern part of Chile, the results of arcuate magma activities in the Jurassic period formed the present continental frame.

Mpodozis & Ramos (1989) also mentioned magma activities in the Mesozoic period by saying it is very characteristic of the development of the Andean cordillera that it is divided into five segments such as Segment A (21° to 27°S) to Segment E (41° to 49°S), and these segments have different characteristics which were created by geological activities from the Jurassic period to the Cretaceous period, and based on these differences, these segments can be clearly defined.

As for the relationship between the geology of Cerro Negro region and the history of the geological structure of the Andean cordillera for example, the region belongs in Segment A (21° to 27°S), arcuate magma activities in the Jurassic period to the early Cretaceous period contributed greatly to the creation of the constituent rock of the coastal cordillera, and its proof is kept in the present coastal cordillera in the northern part of Chile. Tarapaca basin is located on the eastern side of this coastal cordillera as an extensible back arc basin on the continental crust and the basin is covered with sediment consisting of carbonate rock and clastic.

This is the way the recent analyses of the geological structure history have been explained based on general world geological events. Therefore, mineralization in Cerro Negro region should also be studied in reference to these general world geological events.

3-2-2 Geology of Cerro Negro Region

Rocks, which are distributed in and around Cerro Negro ore deposit region, include horizons from the Paleozoic period to the Quaternary period. The chronological order of horizons is as follows:

a) Basement metasedimentary rock: (Ordovician - Devonian) mainly quartzite, phyllite, metamorphic limestone

b) Pan de Azucar formation: (late Jurassic) limestone,conglomerates

c) La Negra formation: (late Jurassic) andesite, continental sediment

d) Los Cerros Florida formation: (early Cretaceous)andesite, pyroclastic rock

e) Atacama gravel:(Neogene, Miocene) talus sedimentarygrave, grave

f) Alluvium: (Quaternary) mud flow sediment and talus sediment

Besides them, the following three intrusive complexes have been recognized.

a) Cerros del Vetado Btholith: (Permian)

This complex which consists mainly of granite together with the lithofacies of tonalite , granodiorite and adamellite, intrudes into bedrock consisting of metasedimentary rock.

b) Sierra Minillas Batholith: (Jurassic to Cretaceous)

This complex, which has the lithofacies of granodiorite and tonalite, intrudes into La Negra formation.

c) Sierra Pastenes Batholith: (Cretaceous)

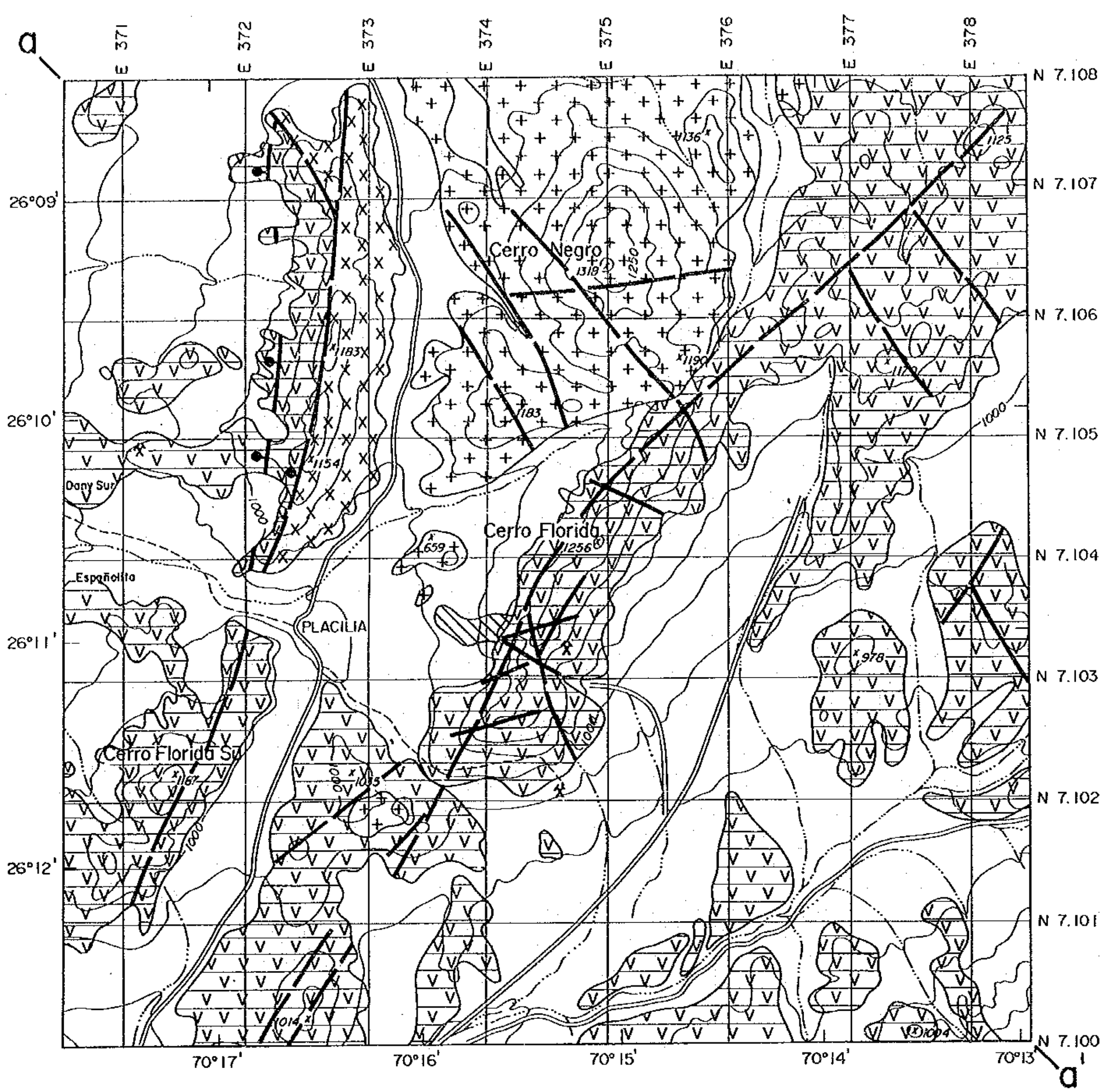
This complex, which has the lithofacies of granodiorite,gabbro, monzonite diorite and tonalite intrudes into Los Cerros Florida formation.

The costal cordillera consists of formations mentioned above. the traces of volcanic activities through andesite,which are considered to have contributed greatly to the creation of ore deposits, are seen in La Negra formation and Los Cerro Florida formation. The outline of these formations is as mentioned below.

La Negra formation runs almost in the N-S direction and declines on its eastern side. The formation consists of andesite, pyroclastic rock of andesite and sandstone being sandwiched between them. Andesite is dark brown and dark red porphyritic ore whose mass is difficult to be distinguished from flown lava. Plagioclase has generally been changed into sericite and clay mineral while mafic mineral has almost completely been changed into opaque mineral. Sandtone exists as brown and red beds with a thickness of 5 to 20 m. The formation is imagined to reach a thickness of 3,000 m, and conformably covers Pan del Azucar formation existing under it.

Los Cerro Florida formation unconformably covers La Negra formation, but its strike and dip are generally similar to those of La Negra formation, and this formation shows a monocline of 20°E. The formation consists of green or gray porphyritic andesite and breccia andesite, but limestone strata with a thickness of 5 to 10 m being sandwiched inside andesite mentioned above are seen in the southern part of Cerro Florida formation. As for alteration, plagioclase has been changed into sericite while mafic mineral (augite) has been partly changed into opaque ore and hornblendite. The formation is imagined to reach a thickness of 2,000m. The formation unconformably covers La Negra formation existing under it. The formation is host rock for Cerro Negro ore deposit. It is the most characteristic of the geological structure of Cerro Negro region that Atacama fault which has a continuation of more than several hundred kilometers with a sense of left-lateral tectonic line exists with.

The average width of the line is 3 to 4 km, and it is believed to reach the deep part of the earth crust. Its activities started in the early Cretaceous period and were repeated until the Quaternary period. These activities created many derivative faults while they caused the displacement of La Negra formation, Los Cerro Florida formation and Batholith in Cerro Negro region. Since Atacama fault is such a distinguished tectonic line, it is quite possible to imagine that this line played an important role in the determination of the location of Cerro Negro ore deposit while it was created.



Regional Geologic Map

Scale 1:50,000

Legend

Quaternary			Alluvial Deposit
Neocomian	Hauterivian		Sierra Pastenes Batholith (Quartz bearing Monzonite)
	Valanginian		Los Cerros Florida Formation (Andesite with intercalation of limestone)
Upper Paleozoic	Permian		Cerros del Vetado Batholith (Pegmatitic monzogranite with tourmaline)

Symboles

- Structural system of the Atacama fault, indicating sunken blocks
- a — a' Geologic profile N 45° W
- Mines
- Hydrothermal alteration
- Unconsolidated sediments
- Quartz bearing Monzonite
- Brecciated andesite, partly amingdaloidal
- Lime stone
- Pegmatitic monzogranite with tourmaline

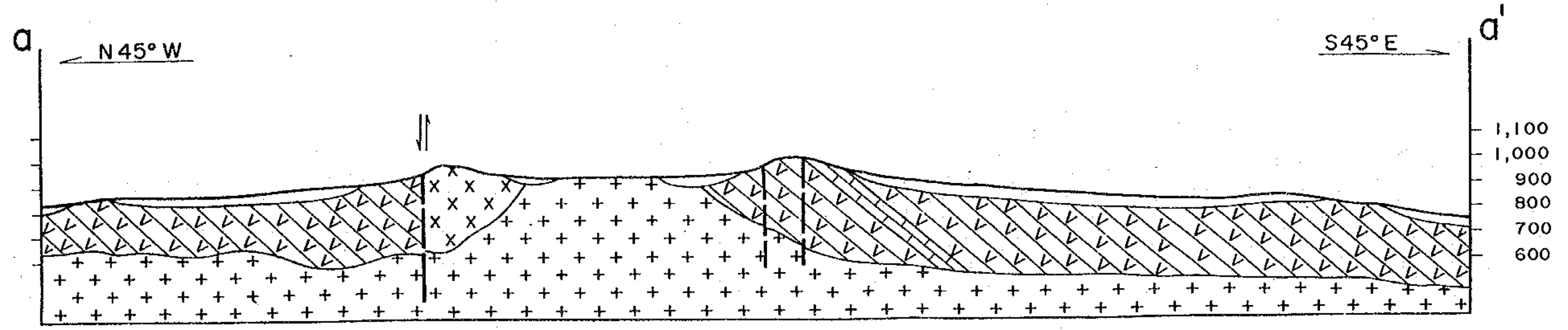


Fig. I -3- 1 A Reagional Geologic Map

Table I-3-3 The Generalized Stratigraphy of the Cerro Negro Area

A G E	F O R M A T I O N	I N T R U S V E S
C E N O Z O I C QUATERNARY	ALLUVIAL DEPOSITS(Qal): Mud flow & terrace deposits.	
TERTIARY	TERRACE DEPOSITS(TTt): Terrace & gravel deposits with 15-20 metres thickness.	
M E S O Z O I C CRETACEOUS	LOS CERROS FLORIDA FORMATION(Kcf): Principally andesitic lava & volcanic sediments.	SIERRA PASTENES BATHOLITH (Ksp): Diorite-gabbro & granodiorite.
J U R A S I C TRIASSIC	LA NEGRA FIRMATION(Jln): Principally andesitic lava & continentel sediments in its lowest part PAN DE AZUCAR FORMATION(Jpa): Principally fossiliferous limestone, conglomerate in its lowest part.	SIERRA MINILLAS BATHOLITH (Jksm): Diorite, granodiorite, monzonite & tonalite.
P A L E O Z O I C	B A S E M E N T(Pzms): Principally quarzite, phyllite & slate.	CERRO DEL VETADO BATHOLITH (Pzcv): Granite

After CARTA GEOLOGICE DE CHILE, zona interior de la conrdillera de la costa entre los 26° 00′ y 26° 20′ (1978).

According to ENAMI (1989), host rock for Cerro Negro ore deposit consists of andesite with a breccia diameter of several mm to several cm, and belongs in Los Cerros Florida formation. Andesite became breccia by being replaced with iron ore consisting mainly of hematite and magnetite.Vertiformes structure was created by thickened metallic mineral. Since the ore deposit was created by filling in breccia cracks, its shape looks irregular in disharmony with its bedding plane. The ore deposit varies in thickness from2m to 5m. Metallic mineral seems to have been thickened selectively in cracks and along joint walls. Cracks which have mineralization is imagined to have been created by the strike slip of Atacama fault in the early Cretaceous period.

Ore bodies consisting of copper oxide ore were created by copper which was deposited in cracks after rainwater and primary copper oxide ore reacted on each other and copper was then dissolved into liquid. The host rock for Cerro Negro ore deposit consists of pyroclastic andesite rock, and generally runs at a strike of N65E and a homocline of 40SE. Ore minerals, which can be observed at land surface, consist of copper oxides. The kinds of these ore minerals are as follows:

Atacamite:	$Cu_2\ (OH)_3Cl$
Malachite:	$Cu_2\ (CO_3)\ (OH)_2$
Chrysocolla:	$CuSiO_3\ .\ 2(H_2O)$
Azurite:	$Cu_3(CO_3)_3(OH)_2$

Chalcopyrite, pyrite, hematite and magnetite have been recognized as primary minerals. In low-temperature hydrothermal alteration zones, minerals such as epidote, chorite, calcite, clay mineral and limonite have formed.

3-3 Outline of the Mining Industrial History in the Investigation Area

The distribution of many mineralization places and mines (including closed mines) in the investigation area is known.They mainly exist in host rock consisting of volcanic rock in Los Cerros Florida formation and La Negra formation. Most mines are small-sized ones, and rarely have records of mining activities in the past. However, Carrizalillo de Las Bombas is regarded as the most important ore deposit in this area, and its potential copper reserves were estimated at 20,000 to 200,000 tons, and its mining operation has been conducted since the 1950s. But there are no reliable records of its total copper output in the past. As for Cerro Negro ore deposit regarded as the investigation target, only small-sized mines have conducted mining activities so far, and no reports on the operation of medium-or-large-sized mines have not been made. The beginning of mining is said to date away back to the 1930s although mining activities have been conducted intermittently on a small scale. Copper oxide ore zones at land surface were mainly regarded as mining targets. However, part of copper sulfide ore zones were probably mined in the southern and southeastern parts of Cerro Florida. There are no records of production and ore grades. The distribution of main ore deposits including Cerro Negro ore deposit, which are located in Carta Geologica de Chile (26°00' –26°20') with a covering area of 925km² as well as their situation, host rock and others areas mentioned below.

Table I -3-4 Mines around the Cerro Negro Area

NAME OF MINE	LOCATION	FORM/ORIENTATION	COUNTRY ROCK	TYPE OF ORE MINERALS
ROSARIO	26° 01.0′ 70° 15.5′	vein /20° E/90°	diorite	Cu oxides
CARRZALILLO DE LA BOMBAS	26° 01.6′ 70° 19.0′	brecciated chimny	monzonite	Cu sulphides Cu/Fe oxides
TONA	26° 05.7′ 70° 24.6′	vein /20° W/90°	metaandesite	Fe oxides
ELIANA	26° 05.8′ 70° 15.5′	vein /20° E/80° E	metaandesite -granite	Cu sulphides Fe oxides
LA SUERTE	26° 10.0′ 70° 15.5′	vein /65° E/90°	metaandesite	Cu oxides/sulphides
DISTRITO MINERO CERRO NEGRO	26° 10.0′ 70° 15.2′	veins with various orientation	andesite	Cu oxides/sulphides Fe oxides
DANNY SUR	26° 10.5′ 70° 15.5′	irregular form with extension to N/E	metaandesite	Fe oxides
ESPANOLITA	26° 10.7′ 70° 18.0′	irregular form with extension to N/S	andesite	Fe oxides
FRESIA	26° 13.5′ 70° 17.2′	irregular form	limestone/ andesite	Cu/Fe oxides
COMPADRE	26° 18.3′ 70° 16.5′	irregular form	andesite	Fe oxides

CHAPTER 4 DISCUSSION OF THE SURVEY RESULT

4-1 Characteristics and Structural Control of Mineralization

(1) Regional geological features

The copper ore deposit in the area of this survey is in Cretaceous Los Cerros Florida formation and copper oxide ore deposit and copper sulfide ore deposit contained in the "hydrothermal breccia"accompanied with a large amount of iron oxide ore, and the distribution condition of the deposit is considered to be a "manto" type copper ore deposit limited by the contained host rock (ENAMI, 1992). The first characteristic of this ore deposits containing a large amount of iron oxide ore, so looking from only the condition of production, probably this can be said to be copper contained iron ore deposit, however the reason of the generation has not been found uniformly. That is, what relationship the copper ore deposit has with the generation of iron oxide ore has not been yet analyzed.

In the Chilean coastal mountain chain, stratum-bound (manto)copper ore deposit and vein copper ore deposit are distributed (Fuller, C.R & Peebles, F.L., 1988) and the area of this survey can be considered to be a member of this ore deposit. On the other hand, in the coastal mountain chain, iron ore deposit tretching over 600 km from the north to the south exists and the area of this survey can be considered to a member of the iron ore deposit because it is located on north end of this area. Actually, a large number of vein or irregular shaped iron ore deposits are distributed in the neighborhood of the are of this survey (see Chapter 3) and can be considered to have some relationship with the deposit in the area of this survey.

(2) Geological structure of the contained host rock

As mentioned before, the copper ore deposit in this area is called "manto type". Thus the geological structure of the Los Cerros Florida formation which is the host rock contained in the ore deposit of this survey area will be considered here. First, existing information are arranged and summarized below.

1) Tectonic movement by the Atacama fault

The atacama fault is a fault zone with sense of left-lateral having the average width of 3 to 4 km, passing longitudinally over several hundreds meters from the north to the south of the Chilean coastal mountain chain and considered to be a large scale tectonic line reaching the deep section of the earth crust(Instituto de Investigaciones Geologias, 1976).This survey area is located at the east end of the Atacama fault zone, where NE-SW system main fault structure and NS and EW systems derivative fault structures are estimated (ENAMI,1992).

2) Diorite rocks

The north west part of this survey area neighbors the Cretaceous Sierra Pastenes batholith composed of mainly diorite or granodiorite and undergoes displacement by the Atacama fault zone mentioned above

(Instituto de Investigaciones Geologias,1976).

3) "Hydrothermal breccia"

The distribution of "hydrothermal breccia" on the surface is limited by the main structure of the above mentioned NE-SW system(ENAMI, 1992).

All these factors are large scale structures associated with the geological structure of this survey area and the structure of the Los Cerros Florida formation which is the host rock contained in the copper ore deposit of this survey area is estimated to have underwent complicated deformation and decomposition.

Next, the geological structure of the host rock contained in the ore deposit of this survey area is interpreted as follows.

1) Los Cerros Florida fault fracture zone

In MJCC-12 and MJCC-16, a strike-slip fault dipped to the west,having a fracture zone 50m - 100m wide derived from the Atacama fault is estimated, which is considered to be the largest tectonic line limiting the geological structure of this survey area.

2) Other faults

In this survey area, a large number of faults other than mentioned above exists (ENAMI, 1992) and the rock facies changes remarkably with the estimated fault (called central branch fault here) branching from the central fault as a border, thus these are considered to largely contribute to the formation of the geological structure of this survey area.

3) Block structure

The geological structure of this survey area can be considered to be divided to small blocks by the above mentioned faults and can be divided to especially three large blocks, that is, central block, west block and east block.

These three large blocks, divided by the Los Cerro Florida fault fracture zone and central branch fault, are narrow blocks stretching in NE-SW direction. The inside of each block is estimated to be divided to subblocks by small faults, however this could not be recognized in this survey.

4) Geological structure inside the block

In the central block, comparing the rock facies relatively continuously is possible. The amygdal structure and plagioclase porphyritic texture characteristic of the massive basaltic andesite produced in the center can be used as the key for the comparison and extensions to the north and south are observed.Andesite tuff is estimated to be distributed continuously,inclined mildly to the south in the upper section of the Los Cerro Florida mountain.

In a part of the west block, the comparison of the rock facies is very difficult because it is located in the fault fracture zone.Additionally, the complicated intrusion of andesite rocks and diorite porphyry in each other makes more difficult this comparison. In the east block, a movement and dip slip accompanied with division to subblocks are estimated.

(3) "Hydrothermal breccia" and copper mineralization

As shown by existing survey result (ENAMI, 1992), in this survey area, a large number of "hydrothermal breccia" and iron oxide ore(specularite, massive hematite and magnetite) are distributed on the surface. This distribution area continues in NE–SW direction,which is considered to be limited by the fault structure mentioned above. The distribution state of iron oxide ore can be considered very important for the consideration of copper sulfide zone. This is because it is estimated that the mineral composition of iron oxide ore is largely concerned with oxidation of the surrounding rocks, having a large relationship with the oxygen and sulfide activities when sulfide is produced. For the reason, the distribution of iron oxide ore is considered to be one of the important reasons for limiting the production of the chalcopyrite and pyrite which are the major component ores of copper sulfide zone.

1) Configuration of "hydrothermal breccia"

Although "hydrothermal breccia" probably can be interpreted to be distributed as the "hydrothermal breccia zone" spread harmoniously with the stratum near the surface, that is, in funnel shape approximately around the center of the drilling survey area,currently the existence of the neck of a funnel shaped"hydrothermal breccia zone" is not clarified. In the north area, the rock facies is estimated to show the state of vein like"hydrothermal breccia" harmonious with the structure of a fault.

On the other hand, because the dissemination of magnetite is remarkably noticed in the section showing amygdal structure of basaltic andesite lava around the "hydrothermal breccia", this indicates that iron dissemination occurred at a place with a relatively large permeability, having amygdal structure by the action accompanied with hydrothermal brecciation.

2) Mineral composition of iron oxide ore

The iron oxide ore in the "hydrothermal breccia" and surrounding host rocks is produced as hematite (specularite), magnetite or the combination of these depending on the difference of the oxidation and the following common points can be found in the distribution state of iron oxide ore.

* Center of "hydrothermal breccia zone" (compact iron ore):hematite (specularite) vein
* Edge of "hydrothermal breccia zone" (accompanied with lithic breccia): magnetite + hematite or magnetite vein
* Surrounding host rock (basaltic andesite lava): magnetite dissemination
* Surrounding host rock (andesite tuff rocks): hematite dissemination

Actually, the center of the "hydrothermal breccia zone" is generally considered to have smaller content of those rocks than the edges.

4-2 Drilling survey and mineralization

(1) Distribution and characteristics of copper mineralization zone

Concerning the characteristics and mineralization control of the Cerro Negro deposit, the features shown in Table 1-4-1 can be pointed out.

The characteristics of mineralization distribution and related control factors are described below. The mineralization zone is classified to copper oxide zone,transition zone and copper sulfide zone.

The copper oxide zone is classified to oxides (1), (2) and (3) depending on the cause of the generation. The characteristics are outlined below.

oxides (1)

Copper oxide ore is originated from oxotic and the host rock has no selectivity. This is recognized in the upper section of MJCC-7and MJCC-17.

oxides (2)

Copper oxide ore is originated from copper sulfide ore and located in situ, characterized in that transition zone and copper sulfide zone exist continuously below this zone. This zone is recognized in the upper section of MJCC-10 and MJCC-13.

oxides (3)

In this case, the generation of copper oxide ore is considered to be due to tectonic reason and this characteristic is not related to the depth so that copper oxide ore appears harmoniously with crushed zone. The grade of the copper oxide zone of this type is generally low. This is recognized in four holes including MJCC-8, indicating that the Cerro Negro mineralization zone was more affected by the structural movement than expected.

The transition zone can be also classified to transition (1), (2) and (3). Each characteristic is as follows.

transition (1)

In this zone, copper oxide ore is originated from exotic and the host rock has no selectivity like oxides (1). Although this zone is difficult to notify strictly, probably no corresponding zone exists in the Cerro Negro mineralization zone.

transition (2)

In this zone, copper oxide ore is originated from copper sulfide ore and located in situ. This zone contains a quite amount of copper sulfide ore and copper sulfide ore zone continues in the lower section of this zone. This zone is recognized in MJCC-7and MJCC-17, characterized in that such copper oxide ore requiring the surface condition for its production as atacamite does not appear. Andesite and andesite "hydrothermal breccia" zone can become its host rock.

transition (3)

The basic concept and genetic condition of this zone are the same as oxides (3). Because the formation of copper oxide ore is due to tectonic reason, copper oxide ore appears regardless of the depth and because copper oxide mineralization is generally insufficient, the copper sulfide ore from which it is originated often coexist. This is a very ordinary phenomenon in the Cerro Negro mineralization zone such as MJCC-8 and MJCC-11.

Like the zones mentioned above, copper sulfide zone can be classified to sulfide (1), (2-1), (2-2), (2-3) and (3) depending on the cause of the formation. They are outline below.

sulfides (1)

In this zone, copper sulfide ore is originated from exotic. No corresponding zone exists in the Cerro Negro mineralization zone.

sulfides (2-1)

The genetic condition of copper sulfide ore is intimately related to the existence of andesite "hydrothermal breccia"zone and the drill holes taken as the objective for consideration from economic viewpoint belongs to this type in most cases. Copper sulfide ore is composed of mainly chalcopyrite and produced as dissemination or veinlets.

sulfide (2-2)

The basic concept and genetic condition of this zone are the same as sulfide (2-1). Although the difference between the both is that the host rock is andesite, this zone is inferior to sulfide (2-1) in the degree of copper mineralization. Although it is superior to the latter in horizontal expansion, the degree of enrichment is weaker. Subeconomical holes such as MJCC-6 and MJCC-8 often indicate this type. The amount of chalcopyrite and pyrite is either chalcopyrite>pyrite or pyrite>chalcopyrite.

sulfide (2-3)

This zone is produced by the mineralization of copper sulfide ore whose host rock is mylonitized andesite recognized in MJCC-12 and MJCC-16 along the Los Cerros Florida fault (NNE-SSW system) considered to be a derivative fault from the Atacama fault and the decomposition accompanied with mineralization is slight.

Inmost cases, the amount of sulfide mineral is chalcopyrite>pyrite. The grade of copper is medium level as a result of drilling survey up to now.

sulfide (3)

The mineralization zone where the production of copper sulfide ore zone is controlled by mainly tectonic reason does not exist in the Cerro Negro mineralization zone.

Looking more widely, the Cerro Negro mineralization is intimately related to the existence of the Atacama fault in its distribution and genesis for the formation. The fact that this zone is located in the range affected by a large tectonic line means that it is also located in volcanic area. We intend to analyze the ore distribution condition of the Cerro Negro mineralization zone in details from this viewpoint next year.

Table I-4-1 Characteristics of Copper Minerarizations

MINERAL ZONING	MODE OF OCCURRENCE	EMPLACEMENT	COPPER MINERALOGY	COPPER GRADE	COUNTRY ROCK	COMMENTS
Oxides(1)	veinlet	exiotic	mal.,chrys.,atac.,etc	high-low	various	MJCC- 7,-17
Oxides(2)	diss/veinlet	in situ	mal.,chrys.,atac.,etc	medium-low	andesites/HIB	MJCC-10,-13
Oxides(3)	diss/veinlet	in situ /tectonic	mal.,chrys.,etc	low	andesites/HIB	MJCC- 8,-11,-12 -20
Transition(1)	-	-	-	-	-	-
Transition(2)	diss/veinlet	in situ	mal.,chrys.,/cp.,(br.,cc.)	medium-low	andesites/HIB	MJCC- 6,- 7,-13
Transition(3)	diss/veinlet	in situ /tectonic	mal.,chrys.,/cp.,(br.,cc.)	low	andesites/HIB	MJCC- 8,-11,-12 -14,-16,-18,-20
sulphides(1)	-	-	-	-	-	-
sulphides(2-1)	diss/veinlet	in situ	cp.,(br.,cc.,cv.)	high-low	HTB	MJCC-10,- 7,-13 -20
sulphides(2-2)	diss/veinlet	in situ	cp.,(br.,cc.,cv.)	low	andesites	MJCC- 6,- 8,-11 -14,-18
sulphides(2-3)	diss/veinlet	in situ /tectonic	cp.,(br.,cc.,cv.)	medium	mylonitic andesites	MJCC-12,-16
sulphides(3)	-	-	-	-	-	-

addreviation:

diss. : dissemination　cp. : chalcopyrite　HTB : 'hydrotermal breccia'

mal. : malachite　br. : bornite　HJCC- : drilling No.

chrys. : chrysocolla　cc. : chalcocite　/ : and

atac. : atacamite　cv. : covelline

Table I -4-2 Mineralized Zones and Copper Grades

MJCC-6

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	39m- 46m	(7m)	0.423	0.081	0.341	8.45	Intermediate zone

MJCC-7

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0m- 15m	(15m)	0.673	0.536	0.137	32.23	Oxidation zone
B	15m- 40m	(25m)	1.023	0.917	0.106	29.23	Oxidation zone
C	46m- 54m	(8m)	0.692	0.492	0.200	31.93	Oxidation zone
D	76m-107m	(31m)	0.306	0.080	0.226	25.89	Intermediate zone
E	125m-154m	(29m)	1.021	0.046	0.975	34.07	Sulfurization zone
Total of mineralization zone	A～E	(108m)	0.744	0.359	0.385	30.19	
Total of the whole hole	0m-154m	(154m)	0.544	0.250	0.294	32.23	

MJCC-8

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0m- 21m	(21m)	0.458	0.208	0.250	27.12	Oxidation zone

MJCC-10

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0m- 45m	(45m)	0.750	0.532	0.218	30.01	Oxidation zone
B	45m- 50m	(5m)	0.748	0.218	0.530	38.06	Intermediate zone
C	50m-105m	(55m)	0.689	0.037	0.652	36.13	Sulfurization zone
Total of mineralization zone	A～C	(105m)	0.706	0.256	0.499	33.12	

MJCC-11

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	30m- 32m	(2m)	1.030	0.945	0.079	32.42	Oxidation zone
B	38m- 39m	(1m)	0.910	0.800	0.110	28.44	Sulfurization zone
C	57m- 59m	(2m)	0.740	0.580	0.160	51.21	Transition zone
D	163m-164m	(1m)	1.750	0.150	1.600	24.63	Oxidation zone
Total of mineralization zone	A～D	(6m)	1.031	0.666	0.365	34.18	

MJCC－12

Mineralization zone	Depth	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	38m- 40m (2m)	0.875	0.810	0.065	7.70	Oxidation zone
B	57m- 68m (11m)	0.409	0.294	0.115	7.43	Intermediate zone
C	79m-107m (28m)	0.409	0.065	0.344	6.43	Sulfurization zone
D	115m-148m (41m)	0.697	0.014	0.683	12.12	Sulfurization zone
Total of mineralization zone	A～D (82m)	0.564	0.088	0.476	9.61	
Total of the whole hole	38m-148m (110m)	0.412	0.079	0.333	8.10	

MJCC－13

Mineralization zone	Depth	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	9m- 17m (8m)	1.089	0.848	0.241	23.68	Oxidation zone
B	20m- 37m (17m)	0.744	0.335	0.408	24.13	Intermediate zone
C	45m- 51m (6m)	1.168	0.312	0.857	38.10	Intermediate zone
D	59m- 74m (15m)	0.472	0.014	0.458	28.78	Sulfurization zone
Total of mineralization zone	A～D (46m)	0.770	0.317	0.454	27.39	
Total of the upper section	0m- 74m (74m)	0.616	0.252	0.363	27.11	
Total of the deep section	115m-172m (57m)	0.114	0.002	0.111	18.64	Sulfide dissemination zone

MJCC－14

Mineralization zone	Depth	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0m-125m (125m)	0.227	0.089	0.138	26.95	Oxidation zone
B	125m-199m (74m)	0.148	0.012	0.137	19.14	Sulfurization zone
Total of the upper section	0m-199m (199m)	0.198	0.061	0.137	24.04	

MJCC－16

Mineralization zone	Depth	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	50m- 93m (44m)	0.548	0.249	0.299	15.58	Intermediate zone
B	93m-111m (18m)	0.451	0.008	0.443	11.83	Sulfurization zone
Total of mineralization zone	A～D (62m)	0.520	0.179	0.341	14.49	

MJCC−17

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0m− 8m	(8m)	0.464	0.201	0.263	13.69	Oxidation zone
B	11m− 22m	(11m)	0.531	0.253	0.278	20.53	Oxidation zone
C	33m− 41m	(8m)	0.464	0.258	0.206	20.21	Oxidation zone
D	41m− 55m	(14m)	0.911	0.573	0.338	22.81	Oxidation zone
Total of mineralization zone	A〜D	(41m)	0.635	0.353	0.282	19.91	
Total of the upper section	0m− 68m	(68m)	0.479	0.240	0.240	19.00	

MJCC−18

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	57m−185m	(128m)	0.060	0.021	0.039	8.72	Oxidation zone

MJCC−20

Mineralization zone	Depth		TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0m− 3m	(3m)	1.170	0.887	0.283	26.67	Oxidation zone
B	6m− 38m	(32m)	0.454	0.208	0.246	21.63	Intermediate zone
C	55m−126m	(71m)	0.407	0.127	0.281	30.35	Sulfurization zone
D	136m−142m	(6m)	0.238	0.045	0.194	16.25	Sulfurization zone
E	154m−188m	(34m)	0.149	0.030	0.120	15.39	Sulfurization zone
Total of mineralization zone	A〜E	(146m)	0.366	0.134	0.232	24.30	
Total of the upper section	0m−126m	(126m)	0.392	0.146	0.246	26.61	

4-3 Result of the calculation of ore reserve

The calculation of ore reserve was performed by dividing the levels by 20m each according to drilling data (total Cu grade) and then calculating composite grade in these sections. As the method,distance inverse-square method was applied and the size of the ore image block was set to 50m (north to south) x 50m (east to west) x 20m (depth).

Upon this calculation, there are a number of the factors seriously affecting the accuracy in that very few drilling data are available(12 holes in the study area), the data concerned with geological and structural trends is insufficient and topographical data had to be created from the altitude data of 12 holes for convenience, thus concerning the estimation of grade distribution,there are many subjects and problems left from the view points of the accuracy, reliability and methodology.

In the estimation result of block grade, the characteristics reflecting these problems are considerably indicated. Although summarizing the estimation result of grade presents the result that the ore reserve is about 200 million tons and the Cu grade is about 0.4%, this is only for reference for the reasons mentioned above, and does not lead to any evaluation of ore deposit.

Generally, to evaluate ore reserve with a reliability to some extent, drilling data measured with at least 100m grid is required.Further to evaluate the ore deposit economic value by pit design, drilling with grids of about 50-m interval around the direction of the high grade trend of the deposit is probably an indispensable condition.

4-4 Ore dressing test

Since the Cerro Negro deposit consists of copper oxide zone, transition zone and sulphide zone, ore dressing methods to treat the ores are some alternatives.

Actual dressing methods must be determined after a sufficient metallurgical test.

Survey Results of the Mineral Processing Plants (summary)

Mineral processing plants	Applicable technique				Ability of mineral processing	
	flotation	LCH/SX/EW	LCH/PREC	FLOT/AGIT	FLOTATION	LEACHING
MANTO VERDE	—	○	—	—		10t/d
EL SALVADOR	○	—	—	—	33,000t/d	
MARTINEZ	○	—	○	—	400t/d	600t/d
FLORIDA	—	○	—	—		200t/d
MATTA	○	—	○	—	2,500t/d	200t/d
VALLENAR	○	—	○	○	670t/d	600t/d
PUDAHUEL	—	○	—	—		2,740t/d

4-5 Relationship between the result of geophysical survey and mineralization

High IP, low resistivity detected by the surface IP and high magnetic susceptibility detected by a survey for magnetism were analyzed according to the result of physical measurement of IP well logging and core sampling.

Consequently, the following points were clarified. (see Fig.4-48)

(1) The cause for high IP, low resistivity is due to the existence of the mineralization zone where pyrite and chalcopyrite are enriched.

(2) The cause for high magnetic susceptibility is due to the enrichment of magnetite.

(3) The distribution of the high IP, low resistivity zone estimated by the simulation model of surface IP anomaly corresponds to the zone of the chalcopyrite mineralization zone clarified by drilling.

(4) Although the overall tendency is almost the same as existing analysis result according to the reanalysis of surface IP anomaly , there is a tendency that the width from the east to the west is narrower in the north part.

(5) According to the reanalysis of magnetic susceptibility, the high magnetic zone is inclined to expand circularly around MJCC-10 and 13.

CHAPTER 5 CONCLUSION AND PROPOSAL5-1 Conclusion

The conclusion of the regional development project in Cerro Negro region, the Republic of Chile in the this year, that is, the first year is as follows:

(1) Drilling Survey

In this year, drilling survey was made in places whose copper deposits are considered highly-potential based on the results of past survey by drilling 30 drills with a total length of 6,436.45m. The locations of drilling targets were selected in consideration of the following items.

1) Mineralization and alteration zones, recognized in surface investigations
2) High IP anomaly zones recognized by geophysical survey (IP method)
3) Low resistivity anomaly zones recognized by geophysical survey (IP method)
4) Medium and high resistivity anomaly zones recognized by geophysical survey (magnetic prospecting)
5) Mineralization zones recognized in past drilling .

As a result of drilling survey made based on the above-mentioned reasons for the selection of drilling locations, the existence of copper oxide ore zones and copper sulfide ore zones was recognized to one degree or another as expected in most drill holes. Host rock for these copper mineralization zones often consists of andesite and hydrothermal breccia in Los Cerros Florida formation. Copper oxide ore zones generally exist near surface at a depth of 60m or less while copper sulfide ore zones often exist at a depth of 50m or more on the contrary. Intermediate zones often exist transition zone consisting of copper oxides and copper sulfides.

Only detailed data on 12 drill holes among 30 drill holes mentioned above were obtained. Details matters for the other drill holes will be mentioned in the next year's report. The important mineralization zones, which were recognized based on detailed data on the 12 drill holes, are mentioned below. As for the largest mineralization zones of the two kinds, the copper oxide ore zone has a thickness of 25m (average Cu grade of 1.023%) while the copper sulfide ore zone has a thickness of 29m (average Cu grade of 1.021%).

Drill Hole	Depth (renge)	TCu%	SCu%	ICu%	TFe%	Mineralization type
MJCC−7	0m- 15m (15m)	0.673	0.536	0.137	32.23	Oxidation zone
MJCC−7	15m- 40m (25m)	1.023	0.917	0.106	29.23	Oxidation zone
MJCC−7	46m- 54m (8m)	0.692	0.492	0.200	31.93	Oxidation zone
MJCC−7	125m- 154m (29m)	1.021	0.046	0.975	34.07	Sulfurization zone
MJCC−8	0m- 21m (21m)	0.458	0.208	0.250	27.12	Oxidation zone
MJCC−10	0m- 45m (45m)	0.750	0.532	0.218	30.01	Oxidation zone
MJCC−10	45m- 50m (5m)	0.748	0.218	0.530	38.06	Intermediate zone
MJCC−10	50m- 105m (55m)	0.689	0.037	0.652	36.13	Sulfurization zone
MJCC−11	30m- 32m (2m)	1.030	0.945	0.079	32.42	Oxidation zone
MJCC−11	38m- 39m (1m)	0.910	0.800	0.110	28.44	Sulfurization zone
MJCC−11	57m- 59m (2m)	0.740	0.580	0.160	51.21	Intermediate zone
MJCC−11	163m- 164m (1m)	1.750	0.150	1.600	24.63	Oxidation zone
MJCC−12	38m- 40m (2m)	0.875	0.810	0.065	7.70	Oxidation zone
MJCC−12	57m- 68m (11m)	0.409	0.294	0.115	7.43	Intermediate zone
MJCC−12	79m- 107m (28m)	0.409	0.065	0.344	6.43	Sulfurization zone
MJCC−12	115m- 148m (41m)	0.697	0.014	0.683	12.12	Sulfurization zone
MJCC−13	9m- 17m (8m)	1.089	0.848	0.241	23.68	Oxidation zone
MJCC−13	20m- 37m (17m)	0.744	0.335	0.408	24.13	Intermediate zone
MJCC−13	45m- 51m (6m)	1.168	0.312	0.857	38.10	Intermediate zone
MJCC−13	59m- 74m (15m)	0.472	0.014	0.458	28.78	Sulfurization zone
MJCC−16	50m- 93m (44m)	0.548	0.249	0.299	15.58	Intermediate zone
MJCC−16	93m- 111m (18m)	0.451	0.008	0.443	11.83	Sulfurization zone
MJCC−17	0m- 8m (8m)	0.464	0.201	0.263	13.69	Oxidation zone
MJCC−17	11m- 22m (11m)	0.531	0.253	0.278	20.53	Oxidation zone
MJCC−17	33m- 41m (8m)	0.464	0.258	0.206	20.21	Oxidation zone
MJCC−17	41m- 55m (14m)	0.911	0.573	0.338	22.81	Oxidation zone
MJCC−20	6m- 38m (32m)	0.454	0.208	0.246	21.63	Intermediate zone
MJCC−20	55m- 126m (71m)	0.407	0.127	0.281	30.35	Sulfurization zone

The host rock for all the copper mineralization zones contains a high percentage of iron oxide ore, and hydrothermal breccia is often equivalent to semi-iron ore. The relationship between such iron oxide ore and copper ore deposits should be studied in later.

Since the study area is located next to the great tectonic line in Chile(Atacama fault zone), the relationship between the tectonic line and the formation of ore deposits will be studied based on other data.

(2) Calculation of ore reserves

Ore reserves was calculated based on composite grade of an assumed block which dimension is 50 m × 50 m × 20 m. Since only 12 drilling data were available for the calculation, an ambiguous results has been obtained.

A study of range of variogram suggests that at least 100 m-grid of drilling intervals are requested from geostatistical point of view.

If feasibility study as a final goal of the survey is needed, more reduced drilling intervals, possibly 50 m × 50 m grid, are recommended for on an essential part of mineralized zone and for the confident ore reserve calculation.

(3) Ore Dressing Tests

Since the Cerro Negro deposit consists of copper oxide zone, transition zone and sulphide zone, ore dressing methods to treat the ores are some alternatives.

Actual dressing methods must be determined after a sufficient metallurgical test.

(4) Geophysical Prospecting

Geophysical survey through the general IP method is effective in studying mineralization zones of these kinds in the study area. Based on ground-surface IP simulation, the distribution of favourable mineralization zones was recognized inside the area of imaginary lines connecting all drill holes such as MJCC-2, 4, 15, 16, 14, 11, 8 and 5. The distribution of them was found to be conformable to the results of the past drilling survey.

5-2 Proposal for the Second Year's Investigation

Based on the conclusion framed by the results of the survey in this year and their analysis, it seems necessary to propose the following surveys for the second year's survey.

(1) Drilling Survey

According to the investigation made in this year, the host rock for copper mineralization zones often consists of andesite and hydrothermal breccia in Los Ceroos Florida formation. Superior copper oxide ore zones are often located at a depth of 60m or less near land surface while superior copper sulfide ore zones are often located at a depth of 50m or more.

By giving consideration to such information and the fact that the situation of mineralization is the best in MJCC-7 and 10 among the investigation target 12 drill holes, the following matters can be proposed for the second year's investigation.

<1> Precise boring investigation should be made around MJCC-7 and 10 to specify the distribution of superior copper mineralization zones.

<2> The relationship between the distribution of andesite and hydrothermal breccia in Los Cerros Florida formation and copper mineralization zones or Atacama fault zone should be further studied in detail to make sure whether copper mineralization zones continue in the vertical direction.

(2) CALCULATION OF ORE RESERVES

Further 30 to 40 drills are required for ore reserve calculation from geostatistical point of view. A modelling of grade distribution based on geological factors and anisotropy of mineralized bodies is also essential for confident ore reserve calculation.

(3) DRESSING TEST

Outline of metallurgical tests proposed for PHASE U is shown in below:

Key Points for the Design of Mineral Processing Tests (Proposal)

METHOD OF TEST	SAMPLE	TERMS (MONTH)								
		0	2	4	6	8	10	12	14	16
1. MINERALOGICAL STUDY		—								
2. FLOTATION (BENCH SCALE)	200~500kg	—	—							
3. LEACHING (COLUMN TEST)	2~6 ton	—	—							
4. FLOWSHEET DEVELOPMENT				—	—					
5. PRE-FEASIBILITY STUDY					—	—				

Tests start mineralogical study and complete pre-feasibility study. These tests require at least 10 months.

4) Geophysical Prospecting

In making precise drilling survey, it seems possible to understand the continuity of mineralization zones consisting mainly of copper sulfide in this area and to prospect for ore deposits at a great depth by using CSAMT.

Since ore deposits in Cerro Negro region consist of oxide ore which mainly contains copper oxide in the surface layer as well as sulfide ore which mainly contains chalcopyrite and pyrite in the next layer under the surface layer, the following geophysical survey methods should be considered to prospect for ore deposits of this kind in other areas in the future.

First Stage

The distribution of high magnetic anomaly zones and low resistivity anomaly zones will be understood by air-borne magnetic survey and air-borne electromagnetic survey to select the mineralization of magnetite and sulfide ore in the wide area.

Second Stage

Rough IP survey will be conducted in the dipole method as ground tracing to evaluate high magnetic and low resistivity anomaly zones selected in the first stage.

Third Stage

Based on the results of evaluation in the second stage precise IP survey is conducted,
After that targets for drilling survey will be selected, and the physical measurement (IP, magnetic susceptibility) of drill cores will further be made to confirm anomaly sources.

Part II Details of the Surveys

CHAPTER 1 DRILLING SURVEY

1-1 Purpose

This survey was intended to grasp the scale and grade of copper oxide ore deposit and copper sulfide ore deposit by coring in the area considered to have a high possibility of the existence of copper ore deposit from the result of synthetic analysis of the existing survey materials. According to the existing survey materials, the copper oxide ore zone by secondary enrichment distributed on the surface of the Los Cerros Florida mountains are classified to the mineralization zones 1 to 6 (ENAMI, 1992). On the other hand, a high resistivity, high IP abnormal zone extending from the north to the south in the west wing of the Los Cerros Florida mountains was recognized by surface physical survey (Geodatos, 1991), which indicates a possibility of the existence of sulfide ore deposit in the lower range of the Los Cerros Florida mountains. The drilling holes for this survey were arranged from the east to the west and from the south to the north so as to surround these abnormal zone (Fig.II-1-1). The coordinate, direction, dip and drilling length of each hole are as follows.

Table II-1-1 Contents of Drilling

Drill Hole	N	E	H	Dir.	Dip	Depth
MJCC- 1	7, 103, 00. 00	374, 00. 00	1, 82. 92	-	-90°	221. 70m
MJCC- 2	7, 102, 400. 81	373, 999. 82	1, 082. 92	-	-90°	164. 00m
MJCC- 3	7, 102, 620. 04	373, 799. 97	1, 081. 72	-	-90°	165. 00m
MJCC- 4	7, 102, 620. 00	373, 999. 99	1, 142. 72	-	-90°	191. 35m
MJCC- 5	7, 102, 619. 68	374, 199. 78	1, 188. 66	-	-90°	191. 15m
MJCC- 6	7, 102, 770. 31	373, 799. 28	1, 057. 86	-	-90°	161. 35m
MJCC- 7	7, 102, 770. 44	373, 995. 12	1, 110. 42	-	-90°	200. 10m
MJCC- 8	7, 102, 771. 62	374, 199. 88	1, 151. 26	-	-90°	190. 20m
MJCC- 9	7, 102, 920. 00	373, 899. 99	1, 057. 00	-	-90°	215. 10m
MJCC-10	7, 102, 920. 69	374, 088. 68	1, 090. 64	-	-90°	160. 40m
MJCC-11	7, 102, 917. 18	374, 298. 81	1, 166. 16	-	-90°	191. 95m
MJCC-12	7, 103, 070. 58	373, 899. 45	1, 052. 07	-	-90°	169. 30m
MJCC-13	7, 103, 072. 74	374, 099. 28	1, 090. 70	-	-90°	240. 00m
MJCC-14	7, 103, 080. 40	374, 309. 22	1, 166. 74	-	-90°	204. 90m
MJCC-15	7, 10 , 00.	37 , . 00	1, 064. 38	-	-90°	200. 35m
MJCC-16	7, 10 , 00.	37 , . 00	1, 123. 45	-	-90°	216. 75m
MJCC-17	7, 10 , 00.	37 , . 00	1, 178. 85	-	-90°	160. 05m
MJCC-18	7, 10 , 00.	37 , . 00	1, .	-	-90°	184. 85m
MJCC-19	7, 10 , 00.	37 , . 00	1, .	-	-90°	165. 10m
MJCC-20	7, 10 , 00.	37 , . 00	1, .	-	-90°	187. 65m
MJCC-21	7, 10 , 00.	37 , . 00	1, .	122°	-50°	300. 30m
MJCC-22	7, 10 , 00.	37 , . 00	1, .	122°	-50°	165. 00m
MJCC-23	7, 10 , 00.	37 , . 00	1, .	122°	-60°	165. 00m
MJCC-24	7, 102, 538. 73	373, 954. 15	1, 113. 56	-	-90°	388. 30m
MJCC-25	7, 102, 620. 00	374, 099. 93	1, 181. 42	-	-90°	225. 50m
MJCC-26	7, 102, 770. 12	373, 910. 36	1, 082. 43	-	-90°	184. 20m
MJCC-27	7, 102, 770. 00	374, 099. 99	1, 126. 57	-	-90°	500. 00m
MJCC-28	7, 102, 920. 00	374, 000. 06	1, 070. 74	-	-90°	198. 90m
MJCC-29	7, 102, 920. 00	374, 199. 96	1, 130. 81	-	-90°	230. 00m
MJCC-30	7, 103, 075. 06	374, 200. 10	1, 144. 76	-	-90°	298. 00m

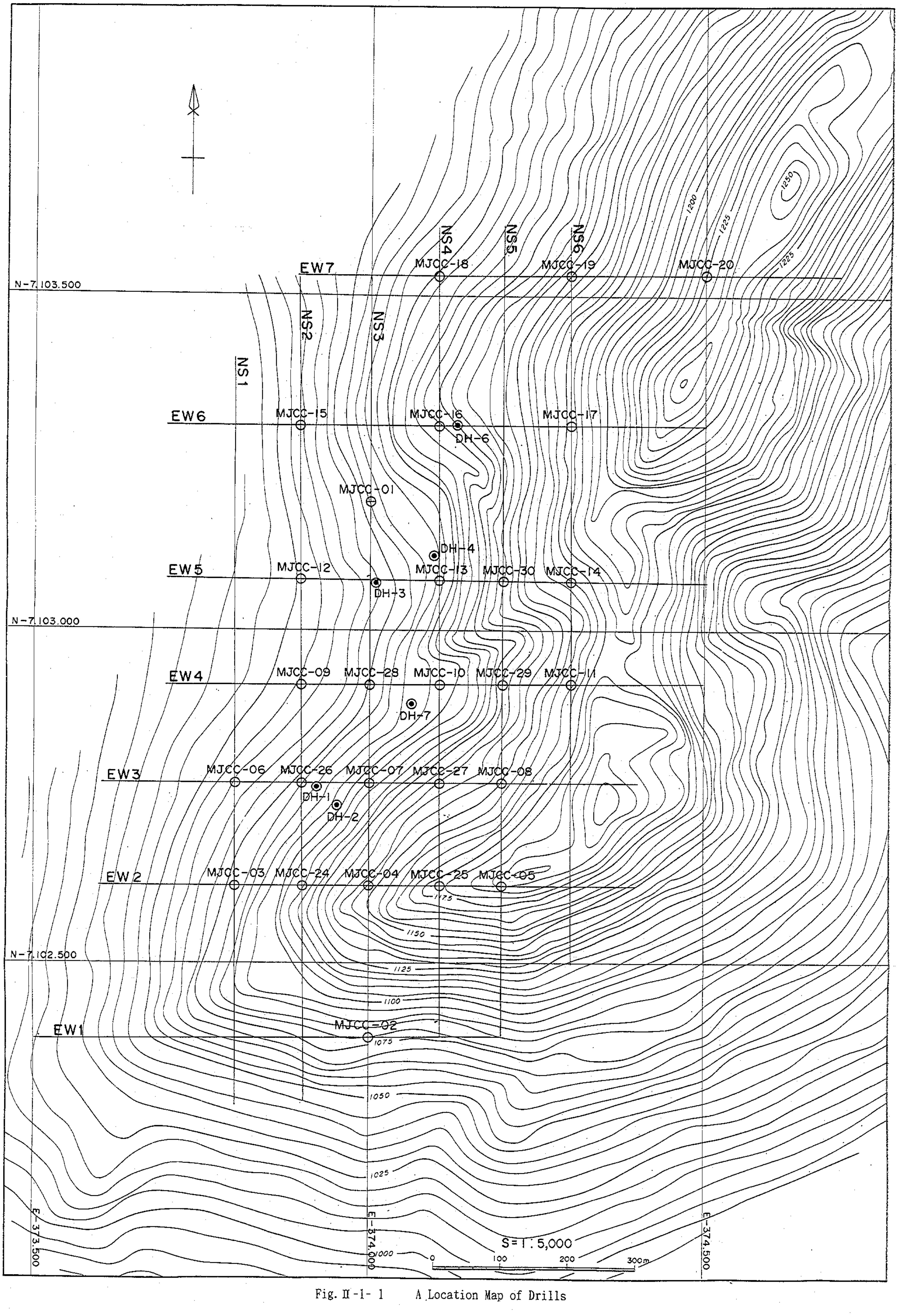


Fig. II-1-1 A Location Map of Drills

1-2 Operation Condition

The period of this drilling survey is from November7, 1992 to February 26, 1993. The period for drilling is from November 23, 1992 to February 26, 1993. The drilling machines and consumption parts used for this drilling are shown in Tables II-1-2 and II-1-3, and the drilling process table and drilling result table of each drilling machine used for this drilling are shown in Tables II-1-4 and II-1-16. The drilling work was performed at the hole diameter of NX as shown in the drilling result table and consequently, the core collection rate of 90.5% to 99.7% (96.7% on average) was achieved about the drilling on the surface and cliff. The drilling efficiency varied largely due to the geological condition, in particular, spring water near fracture zone and rupture system. The average drilling efficiency of each hole was 16.96 to 37.00m/total working day and the average of the whole holes was 26.07m/total working day (statistic about 12 holes).

1-3 Result of the survey

The core collection rate by drilling was satisfactory as mentioned above. About all the cores sampled, color pictures were taken and visual observation was performed and further the collection of the samples for physical survey and ore analysis was performed. The collected samples of 4m apart each were put in wooden boxes with a lid and stored in a warehouse on site. By visual observation of bored core, a bored column diagram on a scale of 1:200 was created. Further, a bored column diagram on a scale of 1:1,000 was creates as summary and shown in the attached figures A at the end of this report. The geological condition and mineralization of each bored hole are described in details in the section describing each bored hole. In the observation of bored cores, the ore and rock considered necessary were collected and the observation of the thin and ground fragments was performed for the reference of the analysis of the bored column diagram and drilling sectional view. The observation result of each sample is shown in Tables 2-1-6 and 2-1-7. For the analysis of ore, all the cores were crushed to half in the unit of 1m for the specimen for analysis. The list of analysis result is shown in the attached figures D and the analysis result graph was shown in the attached figures B.

Table II-1-2 Equipments of Drilling

ITEM	SPECIFICATION	QUANTITY	COMMENT
DRILLING MACHINE	ONRAM-1000	1	
	JOY-22	1	
	LY-34	1	
	DIAMEC-260	1	
	LY-44	1	
DRILLING PUMP	ROYAL BEANS	6	
BOWSER		2	
SHEAR LEGS		6	
DRILL RODS	NX	450	@=300metres
CORE BARREL	NX	21	
CASING	NX	90	@=300metres

Table II-1-3 Articles of Consumption

ITEM	SPECIFICATION	QUANTITY	COMMENT
DIAMOND BIT	NX	36	
REAMING SHELL	NX	6	
CORE SPRING	NX	85	
BASKET	NX	53	
CEMENT		72	SACKS
BENTHONITE		415	SACKS
C.M.C.		34	Kg
POLY-PLUS		48.5	Kg
DIESEL		13,615	Litres
GASOLINE		1,561	Litres
OIL		390	Litres
GREASE		113	Kg

Table II-1-4 Process Table of Drilling

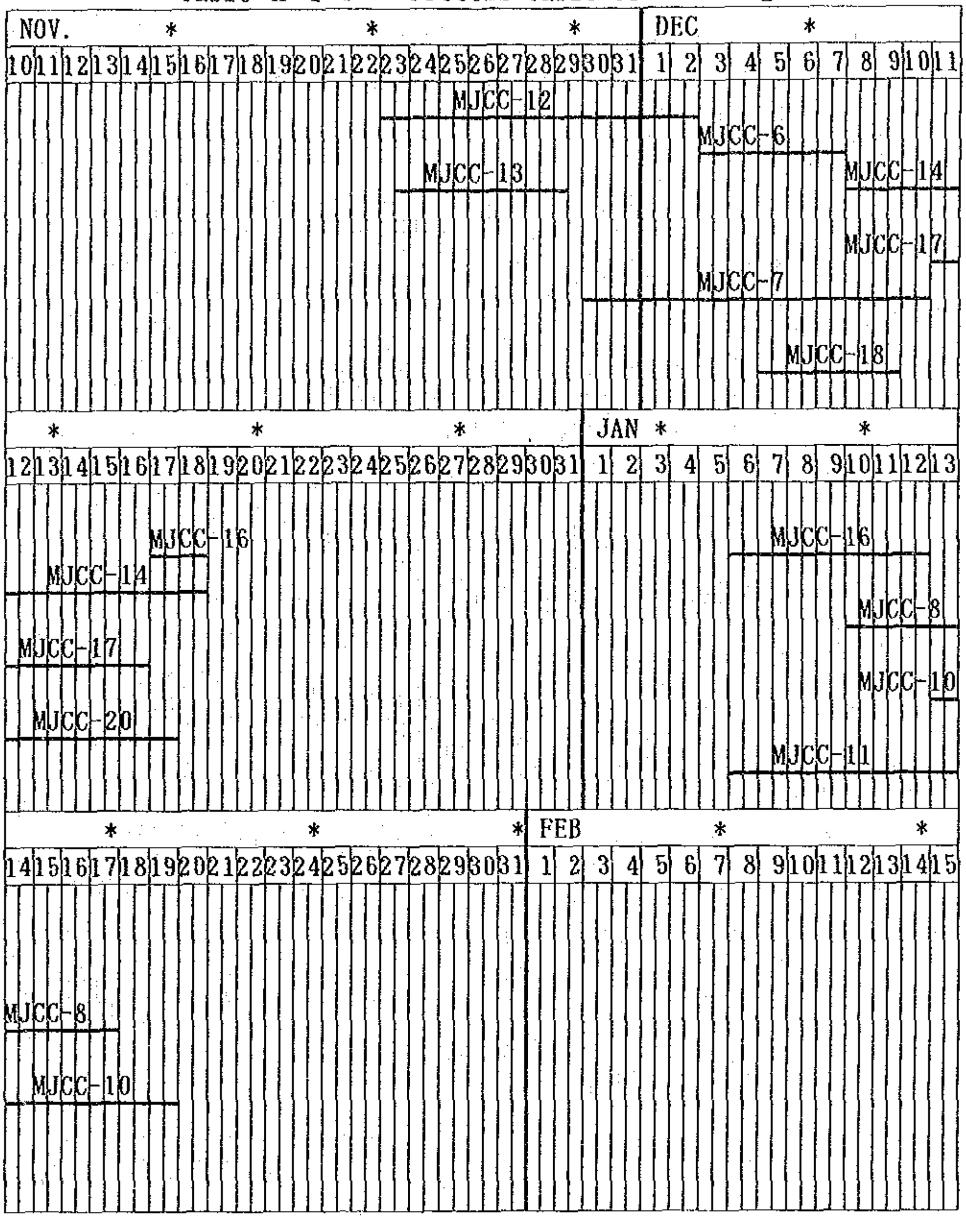


Table II-1-5 Results of Drilling (MJCC- 6)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	DEC. 02	0.5	0.5	0	1.5
DRILLING	DEC. 03-DEC.07	4.5	4.5	0	27
DEMOBILIZATION	DEC. 07	0.5	0.5	0	1.5
TOTAL	DEC. 02-DEC.07	8.0	8.0	0	30
DEPTH PLANNED	160.00m			DEPHT DRILLED	161.35m
OVERBURDEN	6.00m				
CORE LENGTH	159.75m			CORE RECOVERRY	99.0 %
CASING	NX 6.20m				
DRILLING SPEED	35.94m /DRILLING DAY 29.33m /TOTAL WORKING DAY				

Table II-1-6 Results of Drilling (MJCC- 7)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	NOV. 30	0.5	0.5	0	2
DRILLING	NOV. 30-DEC.10	10.0	10.0	0	40
DEMOBILIZATION	DEC. 10	0.5	0.5	0	2
TOTAL	NOV. 23-NOV.29	11.0	11.0	0	44
DEPTH PLANNED	200.00m			DEPHT DRILLED	200.10m
OVERBURDEN	0.00m				
CORE LENGTH	195.75m			CORE RECOVERRY	97.8 %
CASING	NX 3.10m				
DRILLING SPEED	20.01m /DRILLING DAY 18.19m /TOTAL WORKING DAY				

Table II-1-7 Results of Drilling (MJCC- 8)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	JUN. 09	0.5	0.5	0	1
DRILLING	JUN. 11-JUN.16	7.0	7.0	0	24
DEMOBILIZATION	JUN. 17	0.5	0.5	0	1
TOTAL	JUN. 09-JUN.17	8.0	8.0	0	26
DEPTH PLANNED	150.00m			DEPHT DRILLED	190.20m
OVERBURDEN	12.00m				
CORE LENGTH	175.51m			CORE RECOVERRY	92.3 %
CASING	NX 12.35m				
DRILLING SPEED	27.17m /DRILLING DAY 23.78m /TOTAL WORKING DAY				

Table Ⅱ-1-8 Results of Drilling (MJCC-10)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	JUN. 13	0.5	0.5	0	2
DRILLING	JUN. 13-JUN.19	4.5	4.5	0	27
DEMOBILIZATION	JUN. 19	0.5	0.5	0	1
TOTAL	JUN. 13-JUN.19	5.5	5.5	0	30
DEPTH PLANNED	190.00m			DEPHT DRILLED	160.40m
OVERBURDEN	0.00m				
CORE LENGTH	158.95m			CORE RECOVERRY	99.7 %
CASING	NX 0.00m				
DRILLING SPEED	26.73m /DRILLING DAY 22.91m /TOTAL WORKING DAY				

Table Ⅱ-1-9 Results of Drilling (MJCC-11)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	JAN. 06	0.5	0.5	0	2
DRILLING	JAN. 06-JAN.13	7.0	7.0	0	42
DEMOBILIZATION	JAN. 13	0.5	0.5	0	4
TOTAL	JAN. 06-JAN.13	8.0	8.0	0	48
DEPTH PLANNED	160.00m			DEPHT DRILLED	191.95m
OVERBURDEN	6.00m				
CORE LENGTH	182.95m			CORE RECOVERRY	95.3 %
CASING	NX 6.00m				
DRILLING SPEED	27.42m /DRILLING DAY 23.99m /TOTAL WORKING DAY				

Table Ⅱ-1-10 Results of Drilling (MJCC-12)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	NOV. 23	1.0	1.0	0	4
DRILLING	NOV. 23-DEC.02	8.5	8.5	0	51
DEMOBILIZATION	DEC. 02	0.5	0.5	0	2
TOTAL	NOV. 23-DEC.02	10.0	10.0	0	57
DEPTH PLANNED	150.00m			DEPHT DRILLED	169.30m
OVERBURDEN	12.00m				
CORE LENGTH	153.15m			CORE RECOVERRY	90.5 %
CASING	NX 12.30m				
DRILLING SPEED	19.91m /DRILLING DAY 16.96m /TOTAL WORKING DAY				

Table II-1-11 Results of Drilling (MJCC-13)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	NOV. 23	0.5	0.5	0	2
DRILLING	NOV. 23-NOV.29	6.0	6.0	0	24
DEMOBILIZATION	NOV. 29	0.5	0.5	0	2
TOTAL	NOV. 23-NOV.29	7.0	7.0	0	28
DEPTH PLANNED	190.00m			DEPHT DRILLED	240.00m
OVERBURDEN	0.00m				
CORE LENGTH	233.32m			CORE RECOVERRY	97.2 %
CASING	NX 3.00m				
DRILLING SPEED	40.00m /DRILLING DAY 34.28m /TOTAL WORKING DAY				

Table II-1-12 Results of Drilling (MJCC-14)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	DEC. 08-DEC.09	1.5	1.5	0	9
DRILLING	DEC. 10-DEC.17	7.5	7.5	0	45
DEMOBILIZATION	DEC. 18	1.5	1.5	0	6
TOTAL	DEC. 09-DEC.18	10.5	10.5	0	60
DEPTH PLANNED	160.00m			DEPHT DRILLED	204.90m
OVERBURDEN	6.00m				
CORE LENGTH	200.95m			CORE RECOVERRY	98.1 %
CASING	NX 6.00m				
DRILLING SPEED	27.32m /DRILLING DAY 19.51m /TOTAL WORKING DAY				

Table II-1-13 Results of Drilling (MJCC-16)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	DEC. 17	0.5	0.5	0	4
DRILLING	DEC. 17-JUN.10	6.0	6.0	18	36
DEMOBILIZATION	JUN. 10	0.5	0.5	0	2
TOTAL	DEC. 17-JUN.10	7.0	7.0	18	42
DEPTH PLANNED	215.00m			DEPHT DRILLED	216.75m
OVERBURDEN	3.00m				
CORE LENGTH	208.30m			CORE RECOVERRY	96.1 %
CASING	NX 3.00m				
DRILLING SPEED	36.13m /DRILLING DAY 30.96m /TOTAL WORKING DAY				

Table Ⅱ-1-14 Results of Drilling (MJCC-17)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	DEC. 11	0.5	0.5	0	2
DRILLING	DEC. 12-DEC.16	4.5	4.5	0	27
DEMOBILIZATION	DEC. 16	0.5	0.5	0	1
TOTAL	DEC. 11-DEC.16	5.5	5.5	0	30
DEPTH PLANNED	200.00m			DEPHT DRILLED	160.05m
OVERBURDEN	0.00m				
CORE LENGTH	159.45m			CORE RECOVERRY	99.6 %
CASING	NX 3.00m				
DRILLING SPEED	35.57m /DRILLING DAY 29.10m /TOTAL WORKING DAY				

Table Ⅱ-1-15 Results of Drilling (MJCC-18)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	DEC. 05	0.5	0.5	0	6
DRILLING	DEC. 05-DEC.09	4.0	4.0	0	24
DEMOBILIZATION	DEC. 10	0.5	0.5	0	3
TOTAL	NOV. 22-NOV.29	5.0	5.0	0	33
DEPTH PLANNED	200.00m			DEPHT DRILLED	184.85m
OVERBURDEN	6.75m				
CORE LENGTH	179.40m			CORE RECOVERRY	97.1 %
CASING	NX 6.75m				
DRILLING SPEED	46.20m /DRILLING DAY 37.00m /TOTAL WORKING DAY				

Table Ⅱ-1-16 Results of Drilling (MJCC-20)

	PERIOD	NO. OF DAYS	WORKING DAY	DAY OFF	NO. OF WORKERS
MOBILIZATION	DEC. 11	0.5	0.5	0	2
DRILLING	DEC. 11-DEC.17	6.0	6.0	0	24
DEMOBILIZATION	DEC. 10	0.5	0.5	0	2
TOTAL	NOV. 22-NOV.29	7.0	7.0	0	28
DEPTH PLANNED	220.00m			DEPHT DRILLED	187.65m
OVERBURDEN	8.55m				
CORE LENGTH	182.70m			CORE RECOVERRY	97.4 %
CASING	NX 8.55m				
DRILLING SPEED	31.28m /DRILLING DAY 26.81m /TOTAL WORKING DAY				

1-3-1 MJCC-6

1. GENERAL

(1) Reason of the implementation of this survey

This hole is located 200m to the west of MJCC-7. The mineralization zone 3 (ENAMI, 1991) is estimated to continue to the west by surface physical survey (Geodatos, 1991). This survey was intended to grasp the extension of this mineralization zone to the west.

(2) Outline of the result

This hole consists of the falling stratum (depth: 0m – 11m) composed of hematite and magnetite breccias, andesite lava/breccia/tuff (depth: 11m – 54m), andesite "hydrothermal breccia" (depth: 54m–78m) and nonporphyritic andesite lava (depth: 78m – 161.15m) and a weak continuing copper mineralization is recognized at the depth of 40m or more. The coordinate and drilling result are as follows.

	Coordinate	Drilling result	
N:	7,102,770.31	Direction:	---
E:	373,799.28	Dip:	-90°
H:	1,057.86	Depth:	161.35m

2. GEOLOGICAL FEATURE

(1) Rock face and stratigraphy

1) Andesite lava, tuff breccia, tuff (depth: 11m – 54m)

The andesite lava is nonporphyritic and plagioclase porphyritic and the tuff breccia and tuff are considered to be of the same quality, however their original rocks are often difficult to identify because they underwent strong crushing and hydrothermal decomposition.

2) Andesite "hydrothermal breccia" (depth: 54m – 178m)

With andesite as lithic breccia, this rock presents the state that the cracks of the breccias are filled with iron oxide ore in netted vein or fine vein and iron is disseminated in the surrounding host rocks also. The andesite is greenish gray or brownish gray and of lump or breccia state. Although the iron oxide ore is hematite, some secondarily limonitized sections are recognized. Additionally, small cavities considered to be a path of hot water are observed (depth: 65m ±).

3)Nonporphyritic andesite lava (depth: 78m – 161.15m)

This rock is gray lump nonporphyritic lava and its ground mass is not accompanied with so much magnetite. Amygdal structure is recognized on the border of lava flow (depth: 79m ±, 148m ±, 159m ±). Additionally, a large number of small cavities considered to be path of hot water are observed (depth: 110m ±, 130m ±, 140m ±, 150m ±).

(2) Decomposition and deformation

Oxidation from the surface is seen in many places along cracks, teaching the depth of about 70m. Gypsum is observed in many places of the cracks near the surface. Additionally, as for the decomposition due to hot water, small scale decomposition to brown along the cracks as well as argillization to white clay (depth: 10m – 50m) and silicification (depth: 30m – 55m) are recognized.

3. MINERALIZATION

(1) General

Although copper mineralization is recognized in the depth of 40m or more, it is generally weak. Iron mineralization is recognized in the depth of 55m or more. The features are as follows.

Depth	Copper oxide ore	Copper sulfide ore	Hematite	Magnetite	Pyrite
0.00～ 39.00m					Argillization
39.00～ 46.00m	・Crack	△ Dissemination			Silicification
46.00～ 55.00m		・Dissemination			
55.00～ 78.00m		・Dissemination	◎ Network vein		
78.00～161.00m		・Dissemination	△ Micro vein	△ Micro vein	・Dissemination

(2) Particulars

1) Oxidation zone

Copper oxide zone composed of mainly malachite exists in the depth of 39m to 46m (1015mL). Although malachite is disseminated in the cracks of hydrothermally decomposed andesite tuff breccia, it is not disseminated inside of the breccia.

2) Sulfurization zone

Mineralization which can be called copper sulfide ore is not recognized. However, in the depth of 125m ± and 160m ±, weak dissemination of chalcopyrite and pyrite is recognized in andesite ground mass, amygdal and fine vein of magnetite.

4. RESULT OF ORE ANALYSIS

One mineralization zone was captured according to Cu grade. The depth, average grade and mineralization type of the range are as follows.

Mineralization zone	Depth (range)	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	39.00～ 46.00m(7.00m)	0.423	0.081	0.341	8.45	Intermediate zone
Total	37.00～133.00m(97.00m)	0.140	0.023	0.117	17.83	

1-3-2 MJCC-7

1. GENERAL

(1) Reason of the implementation of this survey

This hole is located in the mineralization zone 3 (ENAMI, 1992) and "hydrothermal breccia" accompanied with a large amount of hematite is distributed on the surrounding surface. This zone is classified to low resistivity, high IP zone by surface physical survey (Geodatos, 1991) and located on the east edge of high magnetism abnormal zone. This survey was intended to recognize the distribution condition of secondary enrichment copper oxide zone and copper sulfide zone.

(2) Outline of the result

This hole consists of andesite "hydrothermal breccia" (depth: 0.0m - 156.4m) and nonporphyritic andesite lava (depth: 156.4m - 200.1m) and copper oxide ore (grade: 1.6%Cu) was recognized in the upper section (depth: 0m - 55m) of "hydrothermal breccia" and copper sulfide ore (grade: 1.4%Cu), in the lower section (depth: 125m - 160m).The coordinate and drilling result of this hole are as follows.

	Coordinate	Drilling result	
N:	7,102,770.44	Direction:	---
E:	373,995.12	Dip:	-90°
H:	1,110.42	Depth:	200.00m

2. GEOLOGICAL FEATURES

(1) Rock face and stratigraphy

1) Andesite "hydrothermal breccia" (depth: 0.0m - 156.4m)

With andesite as lithic breccia, this rock presents the state that the cracks of the breccias are filled with iron oxide ore in netted vein or fine vein. Partially (for example, depth of 42m ±), this presents the state of compact iron ore. The andesite breccia is composed of mainly greenish gray nonporphyritic andesite, accompanied with porphyritic plagioclase andesite (depth: 35m ±, 100m ±) and andesite bedded tuff (depth: 60m ±). The iron oxide ore is composed of hematite (specularite) in the upper section (depth: 85m or less), hematite and magnetite in the middle (depth: 85m - 130m) and magnetite in the lower section (depth: 130m or more). In the medium upper section, the breccia fragment is discolored to red to reddish brown due to hematite mineralization.

2) Nonporphyritic andesite lava (depth: 156.4m - 200.1m)

This rock is dark gray lump nonporphyritic lava and features a large amount of fine grained magnetite in the ground mass. This presents amygdal structure on the border of lava flow (depth: 160m ±, 181m ±) and distinguished to 23m and 20m flow units according to the thickness. Additionally, small cavities considered to be path of hot water are observed (depth: 165m ±).

(2) **Decomposition and deformation**

Oxidation from the surface is found in many places along the crack, reaching the depth of about 60m. Any deformation requiring attention after mineralization is not recognized.

3. MINERALIZATION

(1) General

Copper and iron mineralizations are observed continuously from the surface to the hole bottom. The features are as follows.

Depth	Copper oxide ore	Copper sulfide ore	Hematite	Magnetite	Pyrite
0.00～ 55.00m	◎ Crack		◎ Network vein		
55.00～ 85.00m	△ Dissemina-tion	△ Dissemina-tion	◎ Network vein		
85.00～125.00m	△ Dissemina-tion	△ Dissemina-tion	○ Network vein	○ Network vein	· Dissemi-nation
125.00～160.00m		◎ Dissemina-tion		◎ Network vein	○ Dissemi-nation
160.00～200.00m		△ Dissemina-tion		○ Dissemi-nation	△ Dissemi-nation

(2) Particulars

1) Oxidation zone

Copper oxide ore composed of mainly malachite exists in the range from the surface to the depth of 55m (1050mL). Although malachite is disseminated in the cracks of andesite breccias, it is not disseminated inside of the breccias. The coexisting iron ore is specularite.

2) Sulfurization zone

Copper sulfide ore composed of mainly chalcopyrite exists in the range of 125m to 160m deep (975 – 940mL). Chalcopyrite coexists with pyrite and contained in the netted vein composed of mainly magnetite, however is not disseminated in andesite breccia. The combination of ores is (chalcopyrite>pyrite)<<(magnetite>>hematite), however it changes to (pyrite>chalcopyrite) <<<(hematite>>magnetite) toward the upper and lower edges.

4. RESULT OF ORE ANALYSIS

Five mineralization zones were captured according to Cu grade. The depth, average grade and mineralization type of the ranges are as follows.

Mineralization zone	Depth (range)	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0.00~ 15.00m(15.00m)	0.673	0.536	0.137	32.23	Oxidation zone
B	15.00~ 40.00m(25.00m)	1.023	0.917	0.106	29.23	Oxidation zone
C	46.00~ 54.00m(8.00m)	0.692	0.492	0.200	31.93	Oxidation zone
D	76.00~107.00m(31.00m)	0.306	0.080	0.226	25.89	Intermediate zone
E	125.00~154.00m(29.00m)	1.021	0.046	0.975	34.07	Sulfurization zone
Total of mineralization zone	(108.00m)	0.744	0.359	0.385	30.19	
Total of the whole hole	0.00~154.00m(154.00m)	0.544	0.250	0.294	32.23	

1-3-3 MJCC-8

1. GENERAL

(1) Reason of the implementation of this survey

The reason of the implementation of this survey is similar to MJCC-11. Because "hydrothermal breccias" accompanied with hematite (specularite) is distributed on the surface around this hole and it is located on the east edge of the low resistivity, high IP zone captured by surface physical survey (Geodatos, 1991) the survey was intended to recognize the distribution condition of copper oxide zone and copper sulfide zone in the lower range. Additionally, in this survey, investigating of the mineralization zone in the west of Cerro Florida subject to the survey of this year like MJCC-11 and the continuation and development in the east part is meaningful.

(2) Outline of the result

This hole consists of mainly andesite "hydrothermal breccia" zone (depth: 0.00m – 13.50m), nonporphyritic andesite (depth: 13.50m – 50.60m), porphyritic plagioclase andesite (depth: 50.60m – 111.50m) and fine grained andesite tuff/brecciated tuff (depth: 50.60m – 58.60m). Although mineralization is recognized in the whole range from the top to the bottom of this hole, the extent is weak except a part. This hole is almost composed of oxide ore zone and intermediate zone and the distribution has a high possibility of having been affected by the tectonic line passing through this hole like MJCC-11. The coordinate and drilling result of this hole are as follows.

Coordinate		Drilling result	
N:	7,102,771.62	Direction:	---
E:	374,199.88	Dip:	-90°
H:	1,151.26	Depth:	190.20m

2. GEOLOGICAL FEATURES

(1) Rock face and stratigraphy

1) Andesite "hydrothermal breccia" zone (depth: 0.00m – 13.30m)

This is the netted vein of iron oxide ore with andesite (fine grained andesite tuff or nonporphyritic andesite) as the host rock. In the strongly brecciated section, this is mostly composed of hematite (specularite), showing dark brown color. In this hole also, as the kinds of the breccia of andesite, porphyritic plagioclase is recognized only locally and the main part of it is gray nonporphyritic andesite. Additionally, oxidation is considerable.

2) Nonporphyritic andesite (depth: 13.50m – 50.60m)

This rock is dark gray or dark brown and primarily lump nonporphyritic andesite although crushed. Weak hematite mineralization is recognized along the cracks developed by crushing and the magnetism of this rock is weak probably due to hematite mineralization. Amygdal structure is recognized in the upper section of this rock (depth: 14.60m – 18.00m), indicating the existence of lava flow unit.

3) Porphyritic plagioclase andesite (depth: 50.60m – 111.50m)

This is gray or dark gray lump rock, containing amygdal structure (depth: 60.00m – 70.00m) in the upper section. The thickness of the lava flow of a unit estimated from this is as thin as several meters and partially nonporphyritic andesite is sandwiched. In addition with malachite filling the cracks of this rock, a fine amount of malachite is produced in amygdal structure although this is a rare case. In this rock also, hematite mineralization is found in the crushed part.

4) Nonporphyritic andesite (depth: 115.50m – 128.00m)

Basically, this rock also shows the same rock face as the (2) mentioned above, however this rock has more brecciated parts. This tendency is strong in the upper half of this rock in particular.

5) Porphyritic plagioclase andesite (depth: 128.00m – 168.00m)

Basically, this rock also shows the same rock face as (3). The amygdal structure recognized in (3) is not recognized in this rock. In the depth of 137.00m to 140.50m of this rock, a considerable fracture zone exists, thus it is estimated that there is a transition of a little large stratum above and below this.

6) Nonporphyritic andesite (and porphyritic plagioclase andesite) (depth: 168.00m – 190.20m)

This rock indicates the rock face similar to (2), (4) and (3), (5). This nonporphyritic andesite is characterized by amygdal structure filled with pyrite or chalcopyrite.

(2) Decomposition and deformation

The decomposition characterizing this hole is oxidation recognized interruptedly from the surface like MJCC-11. This is often recognized with crushing and inclined to weaken in the deep section, however reaches the hole bottom (depth: 190.20m). However, any trace of deformation requiring special attention after mineralization is not recognized.

3. MINERALIZATION

(1) General

Although mineralization is recognized through the whole hole, the extent is weak like MJCC-11. However, the conditions of mineralization classified according to the copper ore type at each depth are as follows.

Depth	Copper oxide ore	Copper sulfide ore	Hematite	Magnetite	Pyrite
0.00～ 24.00m	△ Dissemination	△ Dissemination	◎ Network vein	· Network vein	· Dissemination
24.00～106.00m	· Crack	· Dissemination	◎ Network vein	○ Network vein	· Dissemination
106.00～190.20m	· Crack	· Dissemination	○ Network vein	◎ Network vein	· Dissemination

Although a weak copper oxide ore is recognized in the upper section (depth: 0.00m – 21.00m) of this hole, this zone is very weak in the deeper section, reaching the hole bottom (depth: 190.20m).

(2) Particulars

1) Oxidation zone

In the depth of 0.00m to 21.00m (1,150 – 1,130mL), copper oxide ore zone composed of a small amount of malachite exists. Malachite is produced in andesite "hydrothermal breccia" zone and nonporphyritic andesite in weak dissemination state. Like other holes, the iron ore coexisting with this is specularite. Considering with oxidation accompanied with crushing recognized in many parts of this hole, this copper oxide ore zone is estimated to be restricted by the tectonic line from the depth where this is produced.

2) Intermediate zone

In the depth of 21.00m to 190.20m (1,130 – 960mL), intermediate zone where copper oxide ore and copper sulfide are mixed is developed although the extent is weak. This intermediate zone has a high possibility of having been restricted by the tectonic line upon production like MJCC-11 because copper oxide ore appears regardless of the depth. The quality ratio of recognized sulfide ore is chalcopyrite<pyrite through the whole hole and pyrite exceeds the former. In this hole, the development range of copper sulfide ore is narrow and the extent is very weak.

4. RESULT OF ORE ANALYSIS

In this survey, no remarkable copper ore zone was captured. The range, average grade and mineralization type of the copper oxide ore zone captured in the upper section of this hole are as follows.

Mineralization zone	Depth (range)	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0.00～ 21.00m(21.00m)	0.458	0.208	0.250	27.12	Oxidation zone
Total of mineralization zone	(21.00m)	0.458	0.208	0.250	27.12	
Total of the whole hole	0.00～190.20m(190.20m)	0.152	0.045	0.106	18.10	

1-3-4 MJCC-10

1. GENERAL

(1) Reason for the implementation of this survey

"Hydrothermal breccia" with hematite (specularite) is distributed on the surface around this hole and surface physical survey (Geodaos, 1991) found that it was located almost in the center of a low resistant, high IP zone. For this reason, this survey was performed to recognize the distribution condition of secondary enrichment copper oxide zone and copper sulfite zone.

(2) Outline of the result

The rock composing this hole is of andesite breccia (depth: 0.00m - 51.90m), andesite hydrothermal breccia" (depth: 51.90 - 119.70m)and nonporphyritic andesite lava containing locally amygdal (depth: 119.70 - 160.40m). Copper sulfite zone (grade: 0.750%Cu) was recognized in andesite breccia (depth: 0.00m - 51.90m) and copper sulfite zone (grade: 0.698%Cu) was, in andesite hydrothermal breccia (depth: 51.90m - 119.70m). Additionally, an intermediate zone (grade: 0.748%) in which oxidation zone and copper sulfite are mixed was also recognized. The coordinate of this hole and actual drilling result are as follow.

Coordinate		Drilling result	
N:	7,102,920.69	Direction:	---
E:	374,088.68	Dip:	-90°
H:	1,090.64	Depth:	160.40m

2. GEOLOGICAL FEATURE

(1) Rock face and stratigraphy

1) Andesite breccia (depth: 0.00m - 51.90m)

This rock is a gray or dark gray breccia composed of mainly nonporphyritic andesite and partially the same quality breccia containing amygdal structure. Partially, netted veins of specularite - magnetite ± quartz are developed. Hematite action occurs in the center (depth: 13.30m - 16.00m) and at the bottom (depth: 37.20m - 46.40m) of this rock, providing brown or reddish brown color and almost entirely copper oxide ore is generated in the crack. In particular, dissemination like concentrated section is noticed near the depth of 37.50m.The dissemination of pyrite is recognized at the lowest section of this rock only by a small amount.

2) Andesite "hydrothermal breccia" (depth: 51.90m - 119.70m)

The cracks in nonporphyritic andesite and the same quality breccia having amygdal structure are filled with specularite, magnetite and pyrite ± chalcopyrite. The quality ratio of the matrix varies much and the section with transition to andesite breccia with the decrease of that amount (depth: 64.00m ±, 110.00m ±) and the section where reverse phenomenon (depth: about 88.00m) occurs are noticed.Chalcopyrite is entirely noticed in rock fragments and matrix.

3) Nonporphyritic andesite (depth: 119.70m–160.40m)

This rock is a gray or dark gray lump nonporphyritic andesite lave, in which amygdal structure is widely noticed. Assuming that the development portion of this amygdal structure is on the top and bottom of lava flow, this rock is concluded to be formed of lava flow several meters to about 10m thick. In this rock, entirely a small amount of pyrite and dissemination of chalcopyrite is noticed and as the secondary ore filling amygdal structure, pyrite – chalcopyrite – quartz are formed.

(2) Decomposition and deformation

Oxidation of the surface (hematite action) is developed locally in the center and bottom of (1) andesite breccia, reaching about 50m in depth. The decomposition accompanied with copper sulfite zone is not noticed and any trace covering a large scale decomposition after mineralization is not noticed.

3. MINERALIZATION

(1) GENERAL

Although the extent of mineralization varies from the surface to the bottom of a hole, it continues. The production by mineralization at each depth is as follows.

Depth	Copper oxide ore	Copper sulfide ore	Hematite	Magnetite	Pyrite
0.00～ 45.00m	○ Crack		◎ Network vein		
45.00～ 50.00m	△ Crack	△ Dissemination	◎ Network vein	△ Network vein	・ Dissemination
50.00～105.00m		◎ Dissemination	○ Network vein	◎ Network vein	△ Dissemination
105.00～160.40m		△ Dissemination	・ Network vein	○ Network vein	△ Dissemination

(2) Particulars

1) Oxidation zone

Oxidation zone composed of mainly malachite is developed in the range from the surface to 45m (1.045mL) in depth. Although malachite is produced in the cracks of andesite hydrothermal breccia zone in fine veins, it does not exist inside of breccia. The coexisting iron ore is specularite.

2) Sulfide ore zone

Copper sulfide ore composed of mainly chalcopyrite exists in the range of 50.00 to 105m (1.040 – 985mL). Chalcopyrite coexists with pyrite and is produced in hydrothermal breccia composed of mainly magnetite in dissemination. However, it is not produced in andesite breccia. Although the quantity ratio of component ore is (chalcopyrite>pyrite)<<(magnetite)>(hematite), it changes to (chalcopyrite <pyrite)<<<(magnetite)>>hematite) toward the outskirts of the bottom.

Intermediate zone (depth: 45.00 – 50.00m) composed of the mixture of copper oxide ore and copper sulfide ore exists in the range from (1) to (2).

4. RESULT OF MINERAL ANALYSIS

Captured mineralization zone can be divided to four types depending on production mechanism and component ore. The depth of the range, average grade and mineralization type are as follow.

Mineralization zone	Depth (range)	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	0.00～ 45.00m(45.00m)	0.750	0.532	0.218	30.01	Oxidation zone
B	45.00～ 50.00m(5.00m)	0.748	0.218	0.530	38.06	Intermediate zone
C	50.00～105.00m(55.00m)	0.689	0.037	0.652	36.13	Sulfurization zone
D	105.00～160.40m(55.40m)	0.155	0.011	0.144	21.93	(Sulfurization zone)
Total of mineralization zone	0.00～105.00m(105.00m)	0.706	0.256	0.449	33.12	
Total of the whole hole	0.00～160.40m(160.40m)	0.513	0.171	0.342	29.09	

1-3-5 MJCC-11

1. GENERAL

(1) Reason for the implementation of this survey

Because "hydrothermal breccia" accompanied with hematite (specularite) is distributed on the surface around this hole and located on the east edge of the low resistivity, high IP zone captured in surface physical survey (Geodatos, 1991). Thus this survey was intended to recognize the distribution condition of copper oxide zone and copper sulfide zone on the bottom. And this is a hole with a high significance in investigating how the mineralization zone in the west of Cerro Florida continues and develops toward the east.

(2) Outline of the result

This hole is composed of andesite "hydrothermal breccia" zone (depth: 0.00m - 13.30m), nonporphyritic andesite (depth: 13.30m - 65.00m) and andesite breccia (depth: 65.00m - 191.95m). Although mineralization is noticed in the range from the top of this hole to the bottom, the extent is weak except a part. Oxidation zone, intermediate zone and copper sulfide zone are noticed in this hole and the distribution has a possibility of being largely affected by the tectonic line passing this hole.The coordinate system and actual drilling result of this hole are as follow.

Coordinate		Drilling result	
N:	7,102,917.18	Direction:	---
E:	374,298.81	Dip:	-90°
H:	1,166.15	Depth:	191.95m

2. GEOLOGICAL FEATURES

(1) Rock face and stratigraphy

1) Andesite "hydrothermal breccia" zone (depth: 0.00m - 13.30m)

This is netted vein or fine vein of iron oxide ore whose host rock is andesite. The section where brecciation occurs heavily is mostly composed of iron oxide ore (specularite). The breccia contained in andesite is composed of mainly gray nonporphyritic andesite, secondarily accompanying porphyritic plagioclase andesite and andesite tuff.

2) Nonporphyritic andesite (depth: 13.30m - 65.00m)

This is dark gray or dark brown lump nonporphyritic andesite and features a large amount of fine hematite behind magnetite contained in the ground mass. This is often accompanied with thin layer (thickness: to 3m) of fine andesite tuff and "hydrothermal breccia". This rock entirely underwent medium level crush and oxidation.

3) Andesite breccia (depth: 65.00m - 191.95m)

This is greenish gray or dark gray and composed of mainly brecciated nonporphyritic andesite, however porphyritic plagioclase andesite breccia is partially noticed. Additionally fine andesite tuff and andesite brecciated tuff also exist while these volcanic detrital rocks are often accompanied with the production of hematite due to oxidation (for example, depth: 136.60m – 142.10m). Further, reddish brown andesite "hydrothermal breccia" is contained in this rock (for example, depth: 156.00m – 163.20m), sometimes accompanied with malachite in the crack.

(2) Decomposition and deformation

The decomposition which this hole features is oxidation noticed intermittently from the surface. This is often recognized with crush, reaching the hole bottom (depth: 191.95m). Silicification zone was also recognized in the depth of andesite breccia about 125.00m. However, no deformation by mineralization and decomposition was noticed.

3. MINERALIZATION

(1) General

Although mineralization is noticed throughout the whole hole, the extent is weak. Copper oxide zone continues up to the hole bottom in the range of 30.00 to 60.00m in depth. However, the section requiring a consideration from economic viewpoint is limited to local area.

The production by mineralization at each depth is as follows.

Depth	Copper oxide ore	Copper sulfide ore	Hematite	Magnetite	Pyrite
0.00～ 30.00m		· Dissemination	◎ Network vein	· Network vein	· Dissemination
30.00～ 58.00m	△ Crack	· Dissemination	◎ Network vein	△ Network vein	· Dissemination
58.00～104.00m		△ Dissemination	○ Network vein	○ Network vein	△ Dissemination
104.00～191.95m	· Crack	· Dissemination	· Network vein	◎ Network vein	· Dissemination

(2) Particulars

1) Oxidation zone

Copper oxide zone composed of mainly malachite exists in the range of 30.00 – 58.00m (1,170m – 1,100mL). Although malachite is produced in the cracks of nonporphyritic andesite in fine grain state, it does not exist inside of breccia. The coexisting iron ore is specularite. This copper oxide zone is noticed in the relation with oxidation accompanied with crush, noticed in many places of this hole and has a high possibility of having been produced by the limit of a tectonic line estimating from the depth where this appears.

2) Intermediate zone

Intermediate zone composed of the mixture of copper oxide ore and copper sulfide ore is developed in the range of 104.00 to 191.95m (1,060 – 975mL) in depth. However, the extent of mineralization is weak. Like the oxidation zone mentioned above, this intermediate zone has a high possibility of having been produced by the limit of tectonic line estimating from the depth where this occurs if oxidation accompanied with crush, noticed in many places of this hole is taken into account.

3) Sulfurization zone

Any production of copper oxide ore is hardly noticed in the range from the surface to 30.00m (1,170 – 1,140mL) and 58.00 to 104.00m (1,100 – 1,060mL), where weak copper sulfide zone composed of chalcopyrite is formed. Chalcopyrite coexists with pyrite and is also formed in dissemination in nonporphyritic andesite and locally accompanying andesite breccia which are the host rock and hydrothermal breccia composed of mainly magnetite. In the copper sulfide ore of this hole, the quantity ratio of component ore is basically (chalcopyrite<chalcopyrite)<< (magnetite>hematite). Throughout all the holes, there is a relationship of chalcopyrite <pyrite.

(3) Result of ore analysis

Although any noticeable mineralization zone could not be captured, the following four sections are extracted although partially and the depth, average grade and mineralization type of that range are shown below.

Mineralization zone	Depth (range)	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	31.00～ 32.00m(2.00m)	1.030	0.954	0.079	32.42	Oxidation zone
B	39.00～ 39.00m(1.00m)	0.910	0.800	0.110	28.44	Sulfurization zone
C	58.00～ 59.00m(2.00m)	0.740	0.580	0.160	51.21	Transition zone
D	164.00～164.00m(1.00m)	1.750	0.150	1.600	24.63	Oxidation zone
Total of mineralization zone	(6.00m)	1.031	0.666	0.365	34.18	
Total of the whole hole	0.00～191.95m(191.95m)	0.172	0.052	0.120	28.38	

1-3-6 MJCC-12

1. GENERAL

(1) Reason of the implementation of this survey

Because the surface around this hole is covered with crumbled layer and out of the objective of surface physical survey (Geodatos, 1991), the related underground information is scarce. However, this is located at the extension of the mineralization zone 2 in the north west, so that an extension of copper mineralization is expected at the deep position.

(2) Outline of the result

This hole is constituted of diorite porphyry holocrystalline medium-grained intermediate rock and cataclastic crushed rock. Copper mineralization was found concentratedly in the crushed section, in the center of which copper oxide (depth: 38m - 100m) was recognized (depth: 38m - 100m) and in the middle and bottom of which copper sulfide ore was recognized (depth: 79m - 148m).

The coordinate and drilling result of this hole are as follows.

	Coordinate	Drilling result	
N:	7,103,070.58	Direction:	---
E:	373,899.45	Dip:	-90°
H:	1,052.07	Depth:	169.30m

2. GEOLOGICAL FEATURE

(1) Rock face and stratigraphy

1) Diorite porphyry (depth: 5m - 54m)

This contains rough-grained plagioclase phenocryst (1 x 2mm), decomposed to pale greenish gray. This shows brecciation due to crushing, accompanied with fine veins of quartz, calcite and gypsum.

2) Crushed rock (depth: 54m - 107m)

This rock contained orange colored felsite diorite and green tuff mixed by cataclastic crush and mylonitization. The fracture face shows an angle as low as 20 degrees, accompanied with pale orange clay.

3) Strong crushed rock (depth: 107m - 147m)

This rock is formed by cataclastic crush or mylonitization and its original structure is completely destroyed. The original rock is considered to be the same as green tuff. Partially felsite is recognized. The mineralizing decomposed section contains a small amount of magnetite dissemination and lens.

4) Diorite porphyry (depth: 147m - 169m)

This rock is dark greenish gray massive rock containing a large amount of rough-grained plagioclase phenocryst (2 x 4mm), containing white fine vein and green mud stone and magnetite fine vein at a high angle.

(2) Decomposition and deformation

Oxidation from the surface is found at many places in cracks, reaching about 40m deep. Although the deformation of ore and mineral due to crush at a low angle is not noticed, magnetite shows mirror like condition on the strike-slip surface at a high angle.

3. MINERALIZATION

(1) General

Copper mineralization is seen continuously in the range of 38m to 150m (1015 - 900mL) deep. The characteristics are as follows.

Depth	Copper oxide ore	Copper sulfide ore	Hematite	Magnetite	Pyrite
38.00～ 79.00m	△ Crack				
79.00～112.00m	· Dissemination	△ Dissemination		· Dissemination	△ Dissemination
112.00～148.00m		○ Dissemination		△ Dissemination	△ Dissemination

(2) Particulars

1) Oxidation zone

Copper oxide ore composed of mainly copper sulfate exists in the range of 38m to 85m (1015 - 965mL) deep, accompanied with gypsum created in cracks. Malacite is noticed in cracks in the range of 90m to 100m (955mL). These oxidized ores do not coexist with magnetite.

2) Sulfurization zone

Copper sulfide is noticed in the range of 79m to 148m (970 - 900mL) deep. Chalcopyrite coexists with magnetite and pyrite and is disseminated in crushed rocks. Concerning sulfide ore, although the top section shows pyrite>chalcopyrite, the bottom section shows chalcopyrite>pyrite and there are found some sections showing small lens filling the fracture face.

4. RESULT OF ORE ANALYSIS

Mineralization zones at four places were captured according to Cu grade. The depth, average grade and mineralization type of these ranges are as follows.

Mineralization zone	Depth (range)	TCu%	SCu%	ICu%	TFe%	Mineralization type
A	38.00～ 40.00m(2.00m)	0.875	0.810	0.065	7.70	Oxidation zone
B	57.00～ 68.00m(11.00m)	0.409	0.294	0.115	7.43	Intermediate zone
C	79.00～107.00m(28.00m)	0.409	0.065	0.344	6.43	Sulfurization zone
D	115.00～148.00m(41.00m)	0.697	0.014	0.683	12.12	Sulfurization zone
Total of mineralization zone	(82.00m)	0.564	0.088	0.476	9.61	
Total of the whole hole	38.00～148.00m(110.95m)	0.412	0.079	0.333	8.10	

1-3-7 MJCC-13

1. GENERAL

(1) Reason of the implementation of this survey

This hole is located in the middle of the mineralization zones 1 and 2 (ENAMI, 1992) and "hydrothermal breccia" accompanied with a small amount of hematite and magnetite on the surrounding surface. Surface physical survey (Geodatos, 1991) classifies this to a low resistivity, high IP zone and high magnetism abnormal zone. Thus, this survey was intended to recognize the distribution condition of secondary enrichment copper oxide zone and copper sulfide.

(2) Outline of the result

This hole is composed of andesite "hydrothermal breccia" (depth: 0m - 78m) and basaltic andesite lave (depth: 78m - 240m). Copper oxide ore (grade: 1.35%Cu max.) exists above "hydrothermal breccia" and copper sulfide (grade: 1.70%Cu max.) exists below it and further weak copper mineralization is recognized to continue up to the deep section. The coordinate and drilling result of this hole are as follow.

	Coordinate	Drilling result	
N:	7,103,071.74	Direction:	---
E:	374,099.28	Dip:	-90°
H:	1,090.70	Depth:	240.00m

2. GEOLOGICAL FEATURE

(1) Rock face and stratigraphy

1) Andesite "hydrothermal breccia" (depth: 0m - 78m)

This rock contains andesite as lithic breccia and the cracks in the breccia are filled with iron oxide ore in netted vein or fine vein. In part of the strong breccia (depth: 45m±), compact iron ore is produced. The andesite breccia is composed of mainly greenish gray nonporphyritic andesite, accompanied with porphyritic plagioclase andesite (depth: 35m ±) or andesite bedded tuff (depth: 68m ±). Iron oxide andesite has the relation of hematite (specularite)>magnetite in the center of the breccia zone (depth: 40m - 51m) and this changes to magnetite>hematite in the higher and lower rocks. In the center, the section where breccia fragments are changed to red to reddish brown is observed.

2) Basaltic andesite lave (depth: 78m - 240m)

This rock is composed of repeated dark gray lave flows and features a large amount of fine grain magnetite contained in the ground mass. Amygdal structure and self crushed structure are presented on the border of the lave flow and the thickness of the lava flow is 10m to 30m. Although the upper section of this rock is nonporphyritic, plagioclase phenocryst is accompanied in the center and rough-grained plagioclase is presented in the lower section. Additionally, small holes considered to be a path of hot water are observed (depth: 140m ±).

(2) Decomposition and deformation

Oxidation from the surface is found in many places along cracks, reaching about 50m deep. The cracks are accompanied with white clay in the range of 30m to 60m. In basaltic andesite lave, a small amount of quartz and fine vein of magnetite is observed. A strike-slip surface at a high angle formed after decomposition by mineralization is observed.

3. MINERALIZATION

(1) General

Copper mineralization and iron mineralization are observed to continue from the surface to the hole bottom. The characteristics are as follows.

Depth	Copper oxide ore	Copper sulfide ore	Hematite	Magnetite	Pyrite
0.00～ 40.00m	◎ Crack		○ Network vein	◎ Network vein	
40.00～ 51.00m	△ Crack	· Dissemination	◎ Network vein	○ Network vein	· Dissemination
51.00～ 78.00m	· Crack	○ Dissemination	○ Network vein	◎ Network vein	○ Dissemination
78.00～116.00m		· Dissemination		△ Dissemination	· Dissemination
116.00～168.00m		△ Dissemination		○ Dissemination	△ Dissemination
168.00～240.40m		· Dissemination		△ Dissemination	△ Dissemination

(2) Particulars

1) Oxidation zone

Copper oxide ore composed of mainly malachite and chrysocolla exists in the range from the surface to the depth of 62m (1025mL). Although malachite and chrysocolla are disseminated in the cracks of andesite breccia in fine vein, they are disseminated only partially inside of the breccia. They coexist with hematite (specularite) and magnetite and overlap with sulfurization zone in the depth of 35m or more.

2) Sulfurization zone

Copper sulfide composed of mainly chalcopyrite exists in the range of 35m – 240m (1050 – 845mL) deep and coexists with pyrite. It overlaps with oxidation zone in the depth of 62m or less. Although it is contained in netted vein composed of mainly magnetite in "hydrothermal breccia", it is not disseminated in andesite breccia. In basaltic andesite lave, it is disseminated in the ground mass and amygdal. Although the combination of ores is (chalcopyrite>pyrite)<<(magnetite>>hematite) in the center of mineralization, it changes to (pyrite>chalcopyrite)<<<(hematite>>magnetite) toward the edge.

4. RESULT OF ORE ANALYSIS