REPORT
ON
THE MINERAL EXPLORATION
IN
THE BOLIVAR AREA
REPUBLIC OF ECUADOR

(PHASE II)

MARCH 1991

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

REPORT

ON

THE MINERAL EXPLORATION

IN

WUTAI-TAOYUAN AREA

(1/5000)

MARCH 1981

TAIWAN PROVINCIAL GEOLOGICAL SURVEY

TAIWAN

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PREFACE

In response to the request of the Government of the Republic of Ecuador, the Japanese Government decided to conduct a Mineral Exploration Project in the Bolivar area 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 the Republic of Ecuador a survey team headed by Dr. Hideo Kuroda from July 3 to Decenber 1, 1990.

The team exchanged views with the officials concerned of the Government of the Republic of Ecuador and conducted a field survey in the Bolivar area. After the team 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 the Republic of Ecuador for their close cooperation extended to the team.

February 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

Genichi Fukuhara
President
Metal Mining Agency of Japan

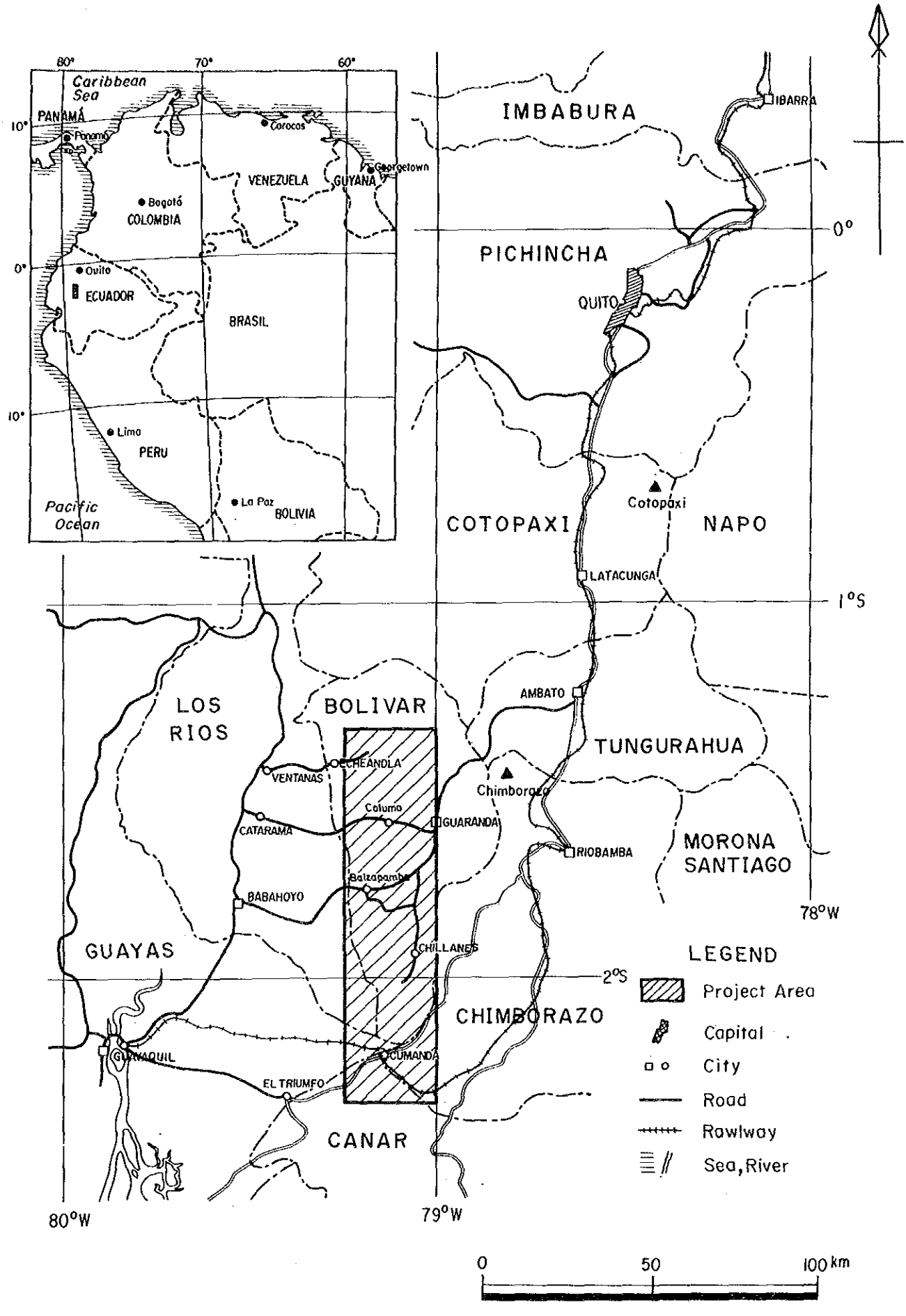


Fig.I Location map of the project area

ABSTRACT

The third year survey of the Bolivar Project, in the Republic of Ecuador, was conducted for the purpose of delineating mineral deposits by clarifying surrounding geology in the following two areas, the Osohuayco zone of Balzapamba area and the Northeast zone of Telimbela area:

For the Osohuayco, Balzapamba area, detailed geological survey and drilling survey were carried out and for the Northeast, Telimbela area, detailed geological survey, geophysical survey (IP method) and drilling survey were also carried out. The results of the survey are as follows:

(1) The Osohuayco zone, Balzapamba area

The geology of the area consists of Macuchi Formation and granodiorite which intruded into Macuchi Formation.

Two mineralized zones are recognized in this area, one is Osohuayco North mineralized zone and the other Osohuayco South mineralized zone. Drilling survey was carried out to disclose geological and mineralogical conditions of the IP anomaly which showed high apparent resistivity and high FE (more than 5 %) around the Osohuayco South mineralized zone, as a result of previous year geophysical survey. Any mineralization, however, associating with skarnization was not encountered. Drill hole intersected disseminated mineralized zone of chalcopyrite and pyrite in hornfelsinized andesite of Macuchi Formation (AAn). The assay discolsed the grade of the minerqlized zone to be very low at a whole, actual range was 0.01 to 0.18 Cu (average 0.05 % Cu).

(2) Northeast zone, Telimbela area

The geology of the area consists of Macuchi Formation and Granites which intruded into the Macuchi Formation. Granites are composed of Hornblende-biotite quartzdiorite, hornblende qurtzdiorite, melanocratic qurtzdiorite dike and coarse quartzdiorite dike. Those rock bodies are distributed and arranged in the NE-SW direction.

Porphyry copper type mineralized zone in the surveyed area is proved to be as a dissemination and metwork zone of chalcopyrite and pyrite.

These mineralized zones are macroscopically lined up in the direction of NE-SW and mineralization is centered in Hornblende quartzdiorite and affects thoroughly such country rocks as Macuchi Formation intensely.

Mineralized outcrops scatter in the area of 1.5 km X 1.0 km in and along Q. Ugshacocha

and Q. Ashuaca, high grade ores are notably destributed in an area of 400 m X 600 m close to the Ashuaca achool, where dissemination and network zone of chalcopyrite and pyrite are recognized to exist not only in quartzdiorite but also in Macuchi Formation intensely. Moreover, molibdenite is observed in forms of dissemination and/or films scattered.

The assay revealed that southern mineralized part cropping out along Q. Ugshacocha contains 0.71 to 1.38 % Cu and that northern mineralized part cropping out along Q. Ashuaca 0.78 to 0.89 % Cu.

Outer part of the mineralized zone is to be dissemination and network zone of pyrite only. As a result of IP method electric survey, distinguished were 6 of high FE anomalies. FE anomaly corresponds generally to mineralization, while high resistivity anomaly to silicification and low resistivity to argillization.

Drilling survey was conducted at the west and east of the Ashuaca school, results of which are as follows: On the drill hole core MJE-8, intense dissemination of chalcopyrite and pyrite was observed through the hole (from the surface to the bottom).

Principal mineralized zones encountered by drill hole are interval between 21 to 102 m in depth with 0.02 to 0.72 % Cu (average, 0.468 % Cu). Adding this, several other intervals are recognized to show copper contents more than 0.10 %.

Mineralization tends to be dominant in the parts of angular xenoliths of andesite and in the the parts of auto-brecciated zone of quartzdiorite.

On the drill core MJE-9, intense mineralization of chalcopyrite and pyrite was observed through the hole from the surface to the bottom (205.00 m in depth).

Principal mineralized zones encountered by drill hole are intervals between 80 to 105 m in depth with a grade of 0.10 to 0.33 % cu (average, 0.229 % Cu) and between 124 to 161 m with a grade of 0.08 to 0.55 % Cu (average, 0.207 % cu). Adding those mineraization, several intervals are also recognized, which show copper contents more than 0.10 %.

As a whole, MJE-9 contains less andesite breccias and shows less auto-brecciation. Therefore, average grade of mineralized parts of MJE-9 was relatively lower than that of MJE-8.

To conclude data and information described above following three mineralized zones are delineated as potential zones of mineralization:

1) "Ashuaca mineralized zone"

As a result of geological survey, a number of intense mineralization of chalcopyrite and pyrite have been recognized around Ashuaca school. IP method electric survey disclosed that the deep low resistivity-high FE anomaly "A" which corrresponds to the "Ashuaca

mineralized zone".

Moreover, low apparent-resistivity anomaly was recognized at the intense mineralized parts of chalcopyrite-pyrite in and along Quebradas, west and south of Ashuaca.

2) Ugshacocha mineralized zone

Ugshacocha mineralized zone distributes about 500 m southeast of Ashuaca school. Through detailed geological survey, recognized is intense mineralization of chalcopyrite-pyrite, while this mineralization is confirmed to be corresponded to low resistivity-high FE zone "A" which has been selected as a tangue shape anomalous zone extendiong from the Northeast of the Ashuaca to the Southeast.

3) Las Tres Cruces minerlized zone

Las Tres Cruces mineralized zone is distributed about 600 m western northwest of Ashuaca school.

As a result of geological survey, intense pyrite dissemination accompanying chalcopyrite are recognized. Furthermore, low resistivity-high FE anomaly "B" is delineated as a narrow and elongated zone with the dirrection of NNE-SSW by IP method electric survey.

This anomaly implies that hidden mineralized zone may exist in the depth of Macuchi Formation.

Based on the findings of Phase III survey, the following recommendations are made for the future survey:

(1) Osohuzyco zone, Balzapamba area (Fig. III-2-1)

The Osohuayco North mineralized zone, mineralized outcrops of which are confirmed through geological survey of Phase III, is extensive in scale and comparatively high grade in copper content.

This mineralized zone occurs in hornblende-biotite granodiorite (Gd). Distribution area of these mineralized outcrops corresponds with the IP anomaly area delineated on the high resistivity-high FE values of Phase II geophysical survey.

Therefore, drilling survey is recommended to disclose the condition and extent of mineralization in detail, the locations of which are shown in Fig III-2-1. For example, 300 m deep X 2 holes in Osohuayco North mineralized zone.

(2) Northeast zone, Telimbela area (Fig III-2-2)

"The Ashuaca mineralized zone", which is confirmed thoroughly by Phase III geological, geophysical and drilling survey, is extensive in scale and high in grade of metal (copper) content. This mineralized zone is also peoved to have close relationship of distribution with hornblende quartzdiorite (HQd). Adding this, potential areas have been delineated around "Ashuaca mineralized zone".

Furthermore, through geophysical survey, IP anomlies are distinguished in the depth of "Ashuaca mineralized zone" where recognized are chain of mineralized outcrops.

Therefore, drilling survey is recommended to disclose the condition and extent of mineralization in detail, the locations of which are shown in fig.III-2-2 . For example, 200 m deep X 3 holes in "ashuaca mineralized zone"; 200 m deep X 2 holes in Ugshacocha mineralized zone; and 200 m deep X 1 hole in Las Tre Cruces mineralized zone.

CONTENTS

PART II DETAILS

PART III CONCLUSIONS AND RECOMMENDATIONS

PART I GENERAL

Chapter 1 Introduction

1-1 Background of survey

The Bolivar project area lies in the western flank of Occidental Cordillera of Ecuador, where traverses a porphyry copper belt which is known to run continuously from North America to South America (Fig. 1).

The Ecuadorian Government has given a top priority politically to develop metallic mineral resources for reconstructing the nation's economy through promotion of exports of those commodities, and has requested the Japanese Government in 1984 to provide technical cooperation for conducting mineral exploration in the Bolivar area.

In response to this request, the Japanese Government sent a mission to Ecuador from May 15 to 24, 1988, which composed representatives of the Japan International Cooperation Agency (JICA), the Metal Mining Agency of Japan (MMAJ), the Ministry of Foreign Affairs, and the Ministry of International Trade and Industry.

The mission concluded a SCOPE OF WORK agreement with INEMIN for mineral exploration in the Bolivar area.

The survey of this year is conducted for Phase III.

1-1 Conclusions and recommendations of Phase II survey

1-2-1 Conclusions of Phase II survey (Fig.I-1-1)

(1) El Torneado zone, Balzapamba area

The porphyry copper mineralized zone in the El Torneado zone is divided into a "dissemination" zone and a "network" vein zone on the basis of their modes of occurrence. The former extends over an area of 400 m x 400 m, and the latter is distributed in the direction of NNE-SSW at a scale of 40 m to 70 m in width and 70 m to 350 m in length. Ore grades are generally low. The Phase II geophysical surveys revealed the conditions of occurrence of sulfide minerals in the lower part of the both mineralized zones, "dissemination" and "network". Since the Phase II drilling penetrated the lower limit of the "network", moreover, disclosed that the "dissemination" zone be about reaching the lower part of the mineralization. Consequently, it may be assumed that the center of mineralization in the El Torneado have been subjected to erosion, and that the lower most part of mineralization be exposed at the present ground surface. Therefore, the mineralized zone of the area has been proved to be low grade, and may not be a target for future mining based on the results

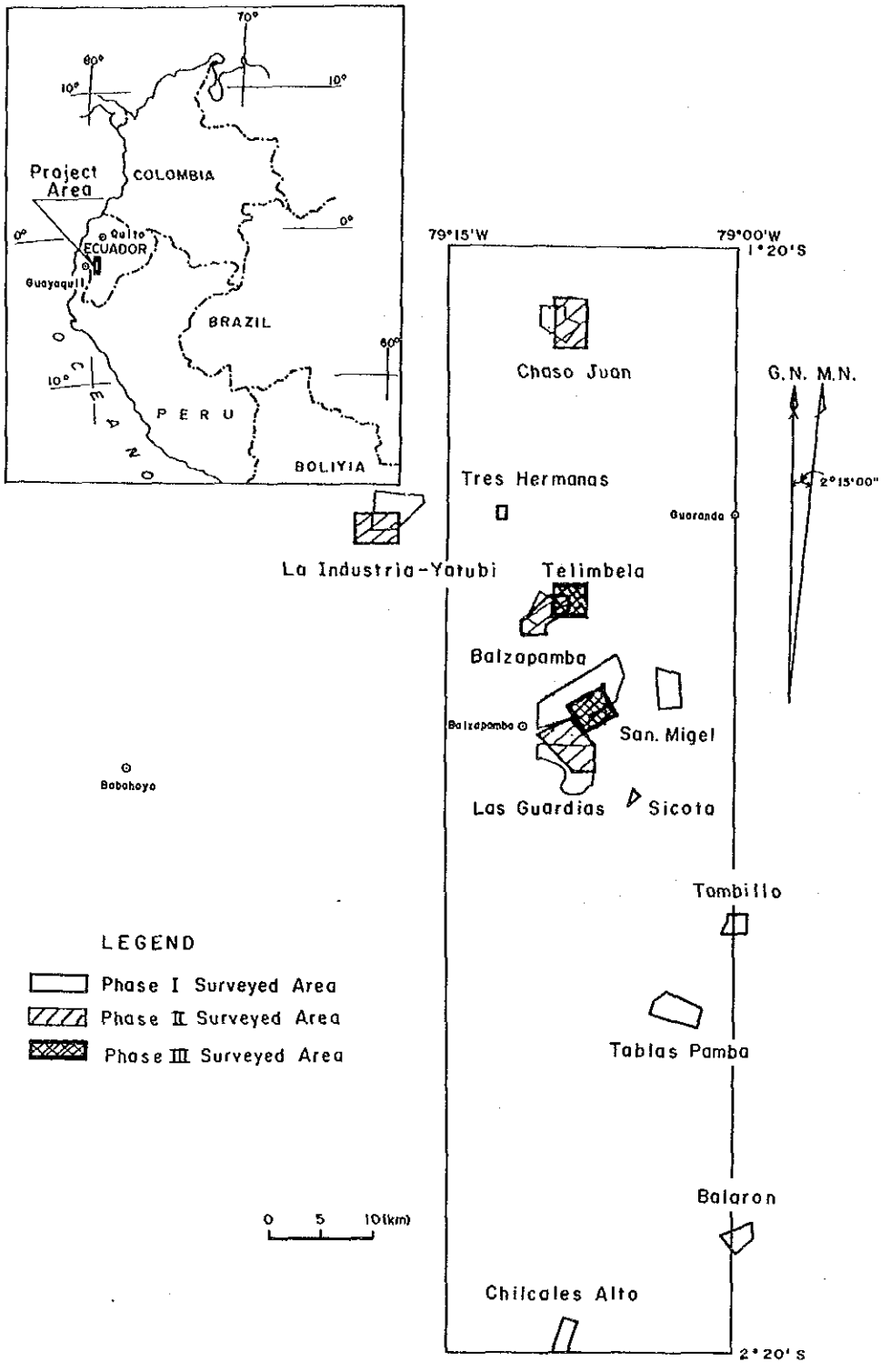


Fig.I-1-1 Location map of the surveyed area

of the Phase I and II survey.

(2) Osohuayco zone, Balzapamba area

The mineralized zone in granodiorite over an area of 100 m x 200 m, and the two stripes of mineralization distributed at a width of about 10 meters in the Macuchi Formation, are considered to extend to a further depth with a dip toward southeast. In the northeastern part of the Osohuayco zone, a wide zone of anomaly with low resistivity and high FE (more than 8 %) was detected, suggesting the existence of a concealed mineralized zone in the lower part.

(3) Chaso Juan area

The porphyry copper mineralization in the Chaso Juan area is recognized at four zones. They are, however, distributed discontinuously at a small scale. Geophysical exploration conducted in this area revealed the existence of IP anomalous zones between the Central and South zones, and at and to the south and north of the West zone. The former anomalous zone reflects the extent of the South zone and the latter reflects the West zone. In terms of mineral exploration, the former anomalous zone is more important than the latter.

(4) Telimbala area

In this area, the porphyry copper mineralization is recognized at seven zones. The scale of mineralization is the largest in the entire Bolivar area, and its strong mineralization extends to the Macuchi Formation. Pyrite dissemination and veinlets are widely distributed in granitic rocks, centering around each of the seven mineralized zones. Macroscopically, the mineralized zones in this area are generally distributed in the direction of NE-SW. The largest one is the North zone, where exist Zone V extending over an area of 400 m x 1,200 m, and Zone VI over a length of about 400 m. Maximum Cu contents are 0.8 % in Zone V and 1.65 % in Zone VI.

(5) La Industria-Yatubi area

Outcrops, similar to the hot-spring type Au mineralization, were identified in the vicinities of two mountaintops (Cerro Barranco Amarillo and Caimito South). To find mineralized outcrops is the significant target of the Phase II survey. The scale of the outcrops mineralized are approximate 100 m in length. The assay result shows the Maximum

Au content of 0.3 g/t. These outcrops are recognized to be silicified strongly, and the silicified part turns to a white alteration zone which is just below the mountaintops. Since the silicified zone was largely eroded, the silicified rocks remained at the mountaintops are assumed to be the relics of the silicified part formed near the lower limit of mineralization.

(6) Las guardias area

In this area, the major porphyry copper mineralization are distributed along melanocratic diorite intrusive rocks and faults in the direction of NW-SE. This direction is in a marked contrast to the NE-SW direction of the mineralized zones and of intrusive rocks in other areas.

Mineral showings, which are sporadic and small in scale compared with the other areas, are recognized at 12 locations. Most of which are distributed over a length of less than 100 meters. Maximum Cu content is 0.47 %.

1-2-2 Recommendations for Phase III survey

(1) Osohuayco zone, Balzapamba area

It is recommended to conduct further geological exploration, including pit and trench survey, and geophysical surveys (IP method) along additional two survey lines, in order to grasp the full details of the geophysical anomalous zone which was detected in the northeastern part of the Osohuayco zone. Drilling is also recommended to disclose the geophysical anomalous zone in the northeastern part and to clarify more precisely the features and conditions of the mineralized zones in the Macuchi Formation in the southern area. The data analyzed thereby will support exploration as guidelines for future survey work in the Macuchi Formation within the Republic of Ecuador.

(2) Telimbela area

It is recommended to conduct further geological investigation, including pit and trench survey, in order to grasp the full details of the mineralized zones in the northeastern part of the Telimbela area, where mineralization and alteration were confirmed. Geophysical exploration (IP method) and drilling are also recommended to disclose the condition and extent of mineralization in the lower part.

1-3 Outline of the Phase III survey

1-3-1 Survey area

The Phase III work covered following two areas: Osohuayco zone of the Balzapamba area and Northeast zone of Telimbela area. These areas were recommended on the result of the Phase II survey (Fig.1 and Fig.I-1-1).

1-3-2 Purpose of the survey

The purpose of the survey is to determine the possible occurrence of ore deposits through careful clarification of geology and geological structure in the Bolivar area.

1-3-3 Method of the survey

The objectives of the geological survey were as follows: first to clarify the relationship among mineralization, geological structures and volcanic activities in order to delineate promising mineralized zones; second to select one for further investigation by means of geophysical and drilling survey; third to obtain necessary information for interpreting data acquired; and fourth to summarize characteristics of mineralization in the area.

The geophysical survey was planned to pursue lateral and vertical extension of porphyry copper type mineralization in the Northeast zone of Telimbela area so as to collect essential information for selecting drilling sites.

Drilling survey aimed to confirm intensity and characteristics of mineralization in depth, and to acquire geological and mineralogical information for estimating economical potential of mineralized zones in Osohuayco zone of Balzapamba area and Northeast zone of Telimbela area. Drill holes were all vertical.

Survey amounts and laboratory works are listed on Tables I-1-1 and I-1-2.

1-3-4 Organization of survey team

Following tables are the members who participated in planning and administrating the survey (Table I-1-3), and those who proceeded field survey (Table I-1-4).

Table I－1－1　List of survey amounts

Items	Quantity		
1. Geological and geochemical survey	Area (km^2)	Survey length(km)	Pit
(1) Osohuayco, Balzapamba area	10	27.2	5
(2) Northeast, Telimbela area	9	38.3	10
2. Geophysical survey	Area (km^2)	Survey length(km)	
(1) Northeast, Telimbela area	2.4	9.6	
3. Drilling	Depth (m)	Dip(°)	
(1) Dsohuayco, Balzapamba area	305.00	-90 °	
1) MJE-7			
(2) Northeast, Telimbela area			
1) MJE-8	301.00	-90 °	
2) MJE-9	205.00	-90 °	

Table I－1－2　List of lavolatory works

Method / Area	Thin section	Polished section	Chemical Analyses: Ore (Au, Ag, Cu, Pb, An, Mo, W)	X-ray diffractive analysis	Resistivity
Drill core	5	5	120	20	0
Osohuayco	5	3	20	10	0
Telimbela	6	7	40	30	21
Total	16	15	180	60	21

Table I－1－3 Member list of project administration

Japanese Counterparts	Ecuadorian Counterparts
Kyoichi Koyama MMAJ	Leonardo Elizalde INEMIN
Hideya Metsugi MMAJ	Wilson Santamaria INEMIN
	Marco Marin INEMIN
	Edgar Lopez INEMIN
	Luis Quevedo INEMIN

MMAJ: Metal Mining Agency of Japan

Table I－1－4 Member list of survey team

Japanese Counterparts			Ecuadorian Counterparts	
Hideo Kuroda	Leader Geological survey	BEC	Alfred Zamora	INEMIN
Hiroshi Kusaka	Geological survey	BEC	Bolivar Carelo	INEMIN
Motomu Goto	Geological survey	BEC	Gabriel Varensuela	INEMIN
Manabu Kaku	Geophysical survey	BEC	Victor Citinbaiyo	INEMIN
Kazuto Matsukubo	Geophysical survey	BEC	Edger Lopez	INEMIN
Nobuyuki Sasaki	Drilling	BEC	Luis de la Torre	INEMIN
Takashi Matsuoka	Drilling	BEC	Alfonso Vaca	INEMIN
TSUKASA Ambo	Drilling	BEC	Cesar Cardenas	INEMIN

BEC: Bishimetal Exploration Co.Ltd.

1-3-5 Survey period

Field survey:

From July 7 to November 25, 1990

Geological survey: From July 7 to August 15, 1990

Geophysical survey : From July 19 to August 15, 1990

Drilling : From August 22 to November 25, 1990

Data analysis and documentaion:

From August 22, 1990 to February 20, 1990

Chapter 2 Geography of survey area

2-1 Location and access

The project area is situated in the central western part of the Republic of Ecuador (Fig.I and Fig.I-1-1).

Balzapamba, the base of this survey, is located about 190 km to the south-southwest of Quito, the capital of Ecuador, and is accessible in about 7 hour drive via Ambato and Guaranda. Balzapamba is also located about 130 km northeast of Guayaquil, the largest city and port, and is accessible in about 3 hour drive via Babahoyo.

In the project area, there are two East-West trunk roads: Quito-Guayaquil highway (via Babahoyo) and Quito-Guaranda-Guayaquil highway (via San Miguel, Balzapamba and Baba hoyo).

Though unpaved, feeder roads are developed east-west direction. However, north-south roads are seldom due to well developed east-west drainage system.

The road distance and necessary time between Balzapamba and each surveyed area are as follows:

Osohuayco zone of Balzapamba area:

By car and on foot (5 km and 2 km) 0.3 hour and 1.0 hours

Northeast zone of Telimbela area:

By car and on foot (135 km and 3 km) 3.0 hours and 1.o hour

2-2 Topography and drainage

The project area is situated in the western marginal zone of the Occidental (Western) Cordillera and individual survey areas are scattered at an altitude of 1,100 to 2,300 m. Mt. Chimborazo (6,267 m), the highest peak in Ecuador, rises in the northeastern outside of the project area. The area is steep in rugged mountainous terrain, and relative heights between the highest altitude and the lowest in each survey area vary from 600 m to 1,000 m. Particularly, the average slope is as high as 40 degrees in the Chaso Juan and Las Guardias areas, where precipitous cliffs form numerous waterfalls. Some waterfalls continue for 400 m in head. Topographic features well reflect different lithology as a result of differential errosion. Generally, granitic rocks form relatively gentle land form, on the contrary Macuchi Formation makes steep and rigged crest. Major rivers rise in the Occidental Cordillera and flow down westward or southwestward. Numerous

branches, which flow as northwest-southeast and/or north-south systems, join to those major rivers.

2-3 Climate and vegetation

Climate in the survey area is tropical,high humidity in lowlands and temperate, dry in highlands. The rainy season runs from December to April. The records show that annual temperature varies from 15°C to 29°C and that annual humidity varies from 65 % to 85 %.

The monthly mean temperature and precipitation are shown in Table I-2-1.

Vegetation mainly consists of jungles. Orange, banana, coffee, cacao, and a few other crop plantations exist in lowlands while corn fields, ranches, etc. are developed in some highland areas.

Table I-2-1 Temperature and precipitation of the project area

	1984		1985		1986		1987		1988	
	Temp (°C)	Precip (mm)	Temp (°C)	Precip (mm)	Temp (°C)	Precip (mm)	Temp (°C)	Precip (mm)	Temp (°C)	Precip (mm)
Jan	20.8	101.7	19.8	155.6	20.4	41.8	21.1	-	21.0	209.9
Feb	20.9	406.4	20.4	113.6	21.2	44.2	21.6	204.0	21.4	362.6
Mar	21.1	462.6	20.8	243.2	21.1	60.0	21.8	484.5	20.9	89.3
Apr	20.9	370.4	20.5	124.4	22.3	18.5	21.4	283.9	22.6	263.0
May	20.6	18.6	20.4	54.3	20.9	16.5	21.2	178.9	21.2	143.5
Jun	20.5	22.8	20.0	19.0	19.7	-	20.7	4.0	20.2	18.8
Jul	19.1	5.1	19.5	2.1	20.4	4.0	21.2	5.7	20.0	6.5
Aug	20.0	4.2	19.8	13.1	20.1	-	20.9	16.2	20.5	5.1
Sep	20.1	33.5	-	-	20.6	-	20.9	13.7	20.4	22.3
Oct	20.4	33.1	20.1	12.5	20.4	5.0	21.2	19.3	20.5	23.3
Nov	20.1	41.5	19.9	8.1	21.8	8.3	22.3	13.8	-	28.3
Dec	20.3	117.5	20.2	151.0	20.1	-	20.0	50.7	20.1	59.0

Around Babahoyo

Chapter 3 General Geology

In termes of geological structure, Ecuador belongs to so-called mobile belt of the Andes geocyncline which formed in a narrow stripe along the western margin of the Guiana-Brazil shield.

The geology of the Bolivar area mainly consists of basic to intermediate volcanic rocks of the Macuchi formation of Late Cretaceous period, thickness of which is estimated to be about 5,000 m (NRNE/DGGM, 1979, 1982). These rocks are intruded by acidic tointermediate plutonic rocks.

Stratigrahic correlation around the project area is shown in Fig.II-3-1.

Henderson (1979) stated that the Macuchi Formation contains marine fossil fauna and foraminifer of Late Cretaceous, and foraminifers of Eocene, and that K-Ar isotopic ages of the Macuchi indicated 51.5±2.5 Ma (early Eocene). Furthermore, K-Ar isotopic ages were determined to be 19.2±3 Ma to 30.8±1 Ma for plutonic rocks from the Las guardias area.

The principal geological structure runs in NNE-SSW to NE-SW direction, for extreme instance Guayaquil-Pallatanga fault.

Ecuador has two major metallogenic provinces, Oriental and Occidental metallogenic provinces, each of which is subdivided into three and five metallogenic zones respectively. The classification of these zones is interpreted in Table.I-3-1, and their distribution in Fig.I-3-2.

The Bolivar area is situated in the metallogenic zone VII, a anticlinorium-synclinorium of Occidental metallogenic province. The zone VII has a high potential of porphyry
copper type ore deposits.

Mineralization in this area comprises following three types: (1) Porphyry copper type Cu-Mo mineralization observed mainly in intrusive rocks and adjacent country rocks of the Macuchi Formation (Balzapamba, Chaso Juan, Telimbela and Las Guardias areas); (2) Vein type sulfide minerals-quartz mineralization found in the Macuchi Formation (El Cristal area) and in the Lourdes volcanic rocks (San Miguel area); and (3) Hot spring type mineralization consisting of hematite-silica sinter-quartz network, accompanied with acidic hydrothermal alteration, in the Lourdes volcanic rocks (San Miguel area) and that of hematite-quartz network in plutonic rocks (La Industria-Yatubi area).

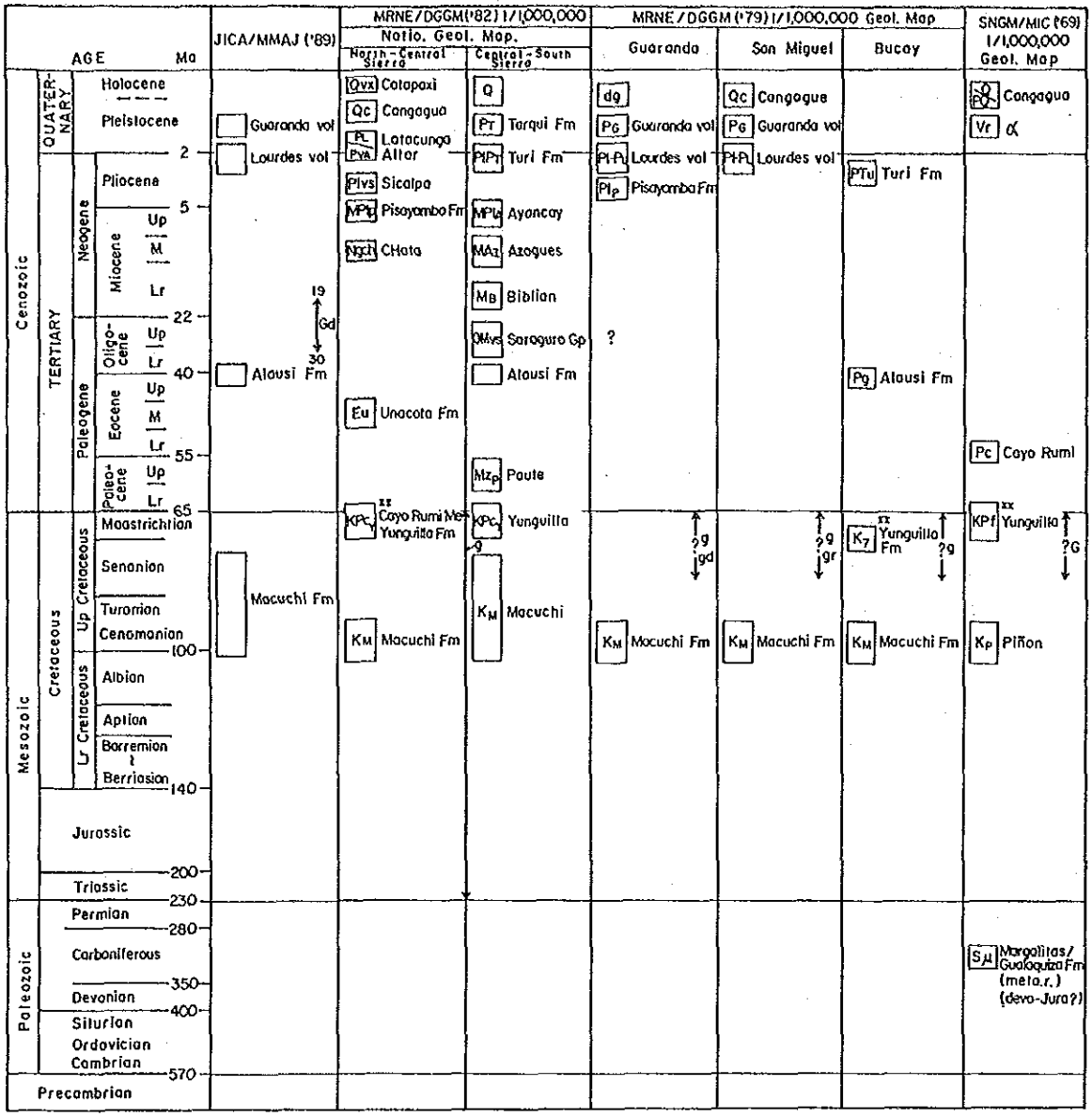


Fig.I-3-1 Stratigraphic correlation around the project area

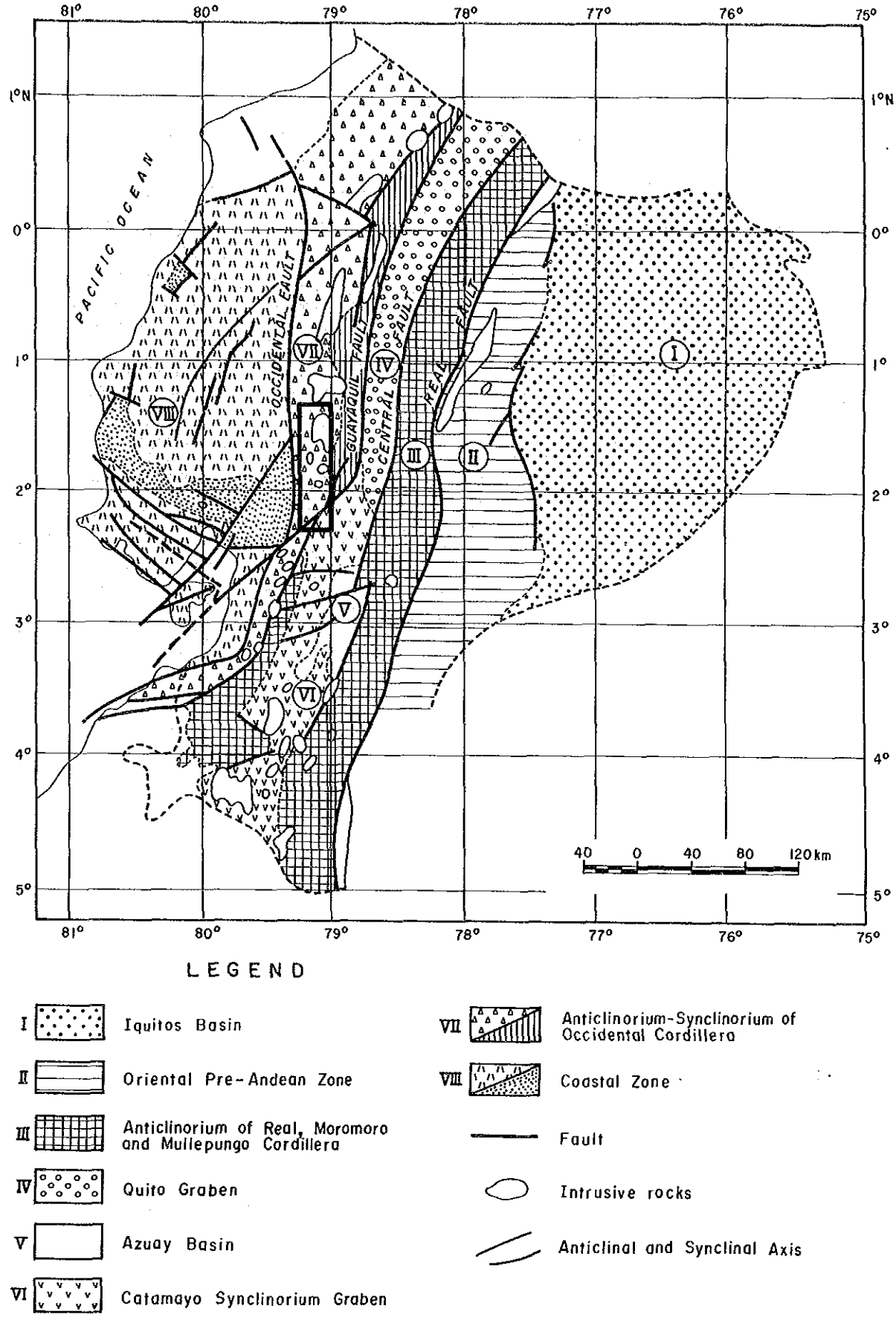


Fig.I.3-2 Geotectonic and metalogenic zone map of Ecuador

Table I-3-1 Classification of metallogenic zones

Topography		Geology	Metallo-genic Province	Metallogenic Zone	Metallogenic Sub-Province
Galapagos Islands		Pliocene ~ Quaternary			Cu-Ni-Co Sub-Province of Ocean Floor (Quaternary)
Coast		Pre-Cretaceous ~ Pleistocene (Pinion Formation)	Occidental (Ocean Crust, Eugeosyncline)	VIII. Coastal Zone	Fe-Ti-Pt Sub-Province of Coast (Jura ~ Early Cretaceous)
Mountain Range	Occidental Cordillera	Cretaceous ~ Paleocene (flysh) (Macuchi Formation)		VII. Anticlinorium-Synclinorium of Occidental Cordillera	Cu Sub-Province of Occidental Cordillera (Cretaceous ~ Miocene)
	Interandean Depression	Neogene ~ Holocene		VI. Catamayo Synclinorium Graben	Polymetalic Sub-Province of High Plateau (Paleocene ~ Quaternary)
				V. Azuay Basin	
				IV. Quito Graben	
	Real Cordillera	Metamorphic Rocks of Paleozoic and Mesozoic	Oriental (Continental Crust, Miogeosyncline)	III. Anticlinorium of Real, Moromoro and Mullepungo Cordillera	Sn-W-U Sub-Province of Real Cordillela (Later Paleozoic)
Orient		Carboniferous ~ Cretaceous		II. Oriental Pre-Andean Zone	Au Sub-Province of Orient Basin (Mesozoic ~ Cenozoic)
		Tertiary ~ Quaternary		I. Iquitos Basin	

Chapter 4 general discussion on the survey results

4-1 Survey results in each survey area

4-1-1 Osohuayco, Balzapamba area

Two types of mineralization were recognized in the Osohuayco zone Balzapamba area, one is mineralization in granodiorite and the other in Macuchi Formation.

In this survey area, two IP anomalies have been selected through Phase II geophysical survey. Outline of them is as follows:

1) Osohuayco North IP anomaly indicates an anomaly in granodiorite and a relationship with dissemination or network veinlets of chalcopyrite and pyrite, known as porphyry copper type mineralization (hereinafter refereed Osohuayco North mineralized zone).

2) Osohuayco South IP anomaly indicates anomalies found in grandioite, which was considered to be a part of porphyry copper type mineralized zone (hereinafter refers as Osohuayco South mineralized zone north side) and anomalies found in Macuchi Formation, which was considered to be skarn mineralized zone (hereinafter refers Osohuayco South mineralized zone south side) of dissemmination and networky thin veins of chalcopyrite and pyrite.

Osohuayco North mineralized zone

This mineralized zone distributed in an area of 900 m x 400 m.

Outcrops distributed in the eastern part of the mineralized zone show dissemination and veinlets of chalcopyrite and pyrite partly or entirely in the brecciated parts of granodiorite.

Characteristics of alteration are silicification and chloritization through outcrops. Silicification are recognized in two different forms: Secondary quartz shows chalcedonic one in the western part of the mineralized zone and crystalline in the eastern part. Quartz replaces rock forming minerals as segregated dots of secondary quartz.

Furthermore, Dissemination of chalcopyrite were recognized locally even in Macuchi Formation toward the eastern ridge and branch river, though only a few mineralized outcrops were available to observe because of weathering.

Assay results of chip sample from the eastern part of the mineralized zone were 1.18% Cu.

Pit survey was adopted to delineate the potential area between eastern and western mineralized outcrops. Each pit revealed limonite veinlets and such intense alteration as chloritization and argillization.

Results of chemical analysis for channel-samples showed 0.06% to 0.17%. These Cu-content values were high enough to distinguish anomalous zone from background (generally under 0.01% Cu.)

Osohuayco South mineralized zone

(North side)

Mineralized parts in granodiorite shows dissemination and veinlets of chalcopyrite and pyrite, and distributes in an area of 200 m x 300 m.

Chip sample from disseminated mineralized zone assayed and proved to be 0.08% Cu.

(South side)

Mineralized parts occurred in Macuchi Formation are mainly limited in siliceous fine tuff and medium to fine tuff. Several thin calcareous beds among these layers are recognized, a part of which is skarnized and accompanied by such sulfide minerals as chalcopyrite and pyrite. Some of these minerals occur in forms of dissemination such spotted or ameba like, and the other in forms of veins (10cm in width) of chalcopyrite-pyrite-calcocite-grossular-quartz.

The outcrops scattered in and along three branch rivers in the vicinity of drill hole site MJE-7. Two principal mineralized horizon are recognized and lower one may be more important with various thickness from 2m to 10m. Chip sample from the lower horizon assayed to be 2.60 % Cu. No mineralized outcrops were confirmed on the ridge between two outcrops.

Drilling survey (MJE-7) was carried out to confirm the IP anomaly (high resistivity and high FE). Drill hole encountered the calcareous fine tuff bed of Macuchi formation at the depth that was estimated by geological mapping and intersected a part of skarnigation. No sulfide mineralization, however, were observed in the calcareous and skarnized part of the drill hole core.

The mineralized zone confirmed by the drill hole core was thought to correspond approximately to IP anomaly (high resistivity and high FE) delineated in Macuchi Formation. The mineralized part showed dissemination actually in the hornfels from andesite mineralyzed zone, which was considered to be principal, were not accompanied by skarn minerals. Therefore, the mineralization should be a porphyry copper type, and the actual mineralized part could be considered to be a extended part of porphyry copper type

mineralized zone.

Mineralized zones distributed in the survey area are arranged, macroscopically, in the N-S direction. El Tornedo mineralized zone, Osohuayco North mineralized zone and Osohuayco South mineralized zone, for example, distribute on the straight line from north to South . A N-S fault is recognized,macroscopically, in the western fringe of El Torneado mineralized zone and two other N-S faults are estimated to the west of Osohuayco North mineralized zone.

As the survey result in Osohuayco zone of Balapamba area, no sulfide mineralization in the calcareous beds and the mineralized zone corresponding to IP anomaly in the deep of Macuchi Formation were assayed and revealed to be low grade such as 0.05% Cu in average.

Therefore, the surveyed area has low priority and requires no further exploration.

4-1-2 Northeast zone, Telimbela area

The type of mineralization of the surveyed area is porphyry copper type which distributes around Ashuaca and is recognized not only in granitic rocks but also in Macuchi Formation.

Mineralized zones are confirmed in an area of 1.5km x 1.0km along Ugshacocha and Ashuaca branch rivers (hereinafter refers Northeast mineralized zone). Especially intense mineralized parts within the Northeast mineralized zone is delineated as an area of 400m X 600m in the central part of the surveyed area and named "Ashuaca mineralyzed zone".

"Ashuaca mineralized zone", which is conposed of chalcopyrite and pyrite, occurs in forms of dissemination and network veinlets not only in granitic rocks but also in Macuchi Formation. Molibdenite is also recognized locally in the mineralized zone.

Outer part of the Northeast mineralized zone dominates dissemination and networky veinlets of pyrite mineral only. Amount of pyrite in the disseminated mineralyzed zone is greater in southern fringe than in any other parts.

Drilling survey (2 holes) were carried out to "Asuhuaca mineralized zone". The results of the 2 holes are as follows:

In MJE-8 hole, considerable amount of chalcopyrite are observed even in naked eyes from the surface to the bottom. A assay result is as follows: from 21 to 102 m ; core length 81m; tr to 6.0 g/t of Ag; 0.02 to 0.72 % of Cu, average 0.468 % of Cu.

Intensely Cu-mineralized part of the hole are recogniged not only where the host rock contains a number of brecccias of Macuchi Formation but also where the host rock is brecciated itself completely. Cu-mineralization is confirmed to continue down to the bot-

tom of the hole.

In the MJE-9 hole, large amount of pyrite and small amount of chalcopyrite are observed in naked eyes throughout the hole. A assay result is as follows: from 80 to 105m; core length 25m; tr to 2.6 g/t of Ag; 0.10 to 0.33 % of Cu, average 0.229 % of Cu.
from 124 to 161m: core length 37m; 0.1 to 4.7 g/t of Ag; 0.08 to 0.55 %oof Cu, average 0.207 % of Cu.

Comparatively, mineralization of drill hole MJE-8 is more intense than that of MJE-9. The reason of which may be that the hole MJE-9 shows less brecciation and includes only a few fragment or breccias of the country rocks.

Deformed rock forming minerals are, however, recognized in both holes under microscopic observation.
Intensely mineralized parts are observed in the zone of the intense propilitization.
Mineralization of chalcopyrite, pyrite and molibdenite continues vertically down to the bottom of each hole, MJE-8 and 9, it means that mineralization continues downward at least 180m below the river floor of Q.Ugshacocha where "Ashuaca mineralized zone" is centered.

4-2 General discussion

4-2-1 Characteristics of igneous activities and mineralization

Igneous activities recognized in Project area, Bolivar Province in Ecuador, are as follows: Macuchi Formation of Marine sediments and Pyrocrastics in Late Cretaceous was deformed by Andean Orogeny movement during the period from Eocene through Oligocene. Activities of Plutonic rocks intruded in the period from Oligocene through Miocene is charatcerized that each intrusive body is arranged in the N-S direction.

Age determination of intrusive rocks revealed that Granodiorite botholith in balzapamba area be 20 to 30 Ma, Quartzdiorite in Telimbela area be 19 to 20 Ma, and such dike or stock as melanocratic quartzdiorite, hornblende quartzdiorite and porphyritic quartzdiorite be 15 to 18 Ma.

Hydrothermal activities in the surveyed area are recognized intermittently in the period between Miocene and Pleistocene. The activities are grouped into 3 stages:

1st stage: activities with sulfide minerals in the peiod between Miocene and Pliocene (all of the ignerous activities mentioned above are included in this stage)

2nd stage: activities with acidic alteration and accompanying hematite in the period between pliocene and pleistocene.

3rd stage: activities with acidic alteration only in the period of Holocene.

Three types of mineralization are recognized in the Bolivar Project area; they are porphyry copper type, vein type, and hot spring type.

Generalized stratigraphy of the project area is shown in Fig.I-4-1 and summary results on both surveyed area, Osohuayco zone of Balzapamba area and Northeast zone of Telimbela area, are listed on Table I-4-1.

4-2-2 Possibilities of locating ore deposits

The mineralization on both surveyed areas are porphyry copper type. Possibilities of locating ore deposits is higher in Northeast zone of Telimbela area than in Osohuayco zone of Balzapamba area.

The mineralized zone in Northeast, Telimbela area is extensive and of high grade of metal contents which is proved by assaying chip samples obtained from mineralized outcrops. Drilling survey has revealed that chalcopyrite dissemination zone continues down to the depth, from surface to the bottom of each hole.

Moreover, mineralized zone is considered to be extensive horizontally, mineralization confirmed by drill holes, therefore, may be important indication for further exploration. Followings are the order of mineralized zones in the view point of potentiality.

1) "Ashuaca mineralized zone"

(corresponds to a part of IP anomaly A) (400 m X 600 m)

-a number of mineralized outcrops of chalcopyrite and pyrite are confirmed through detailed geological survey.

-IP anomaly (low resistivity and high FE) is delineated by IP method electrical survey

-mineralized parts are confirmed to be continue to the depth by drilling core.

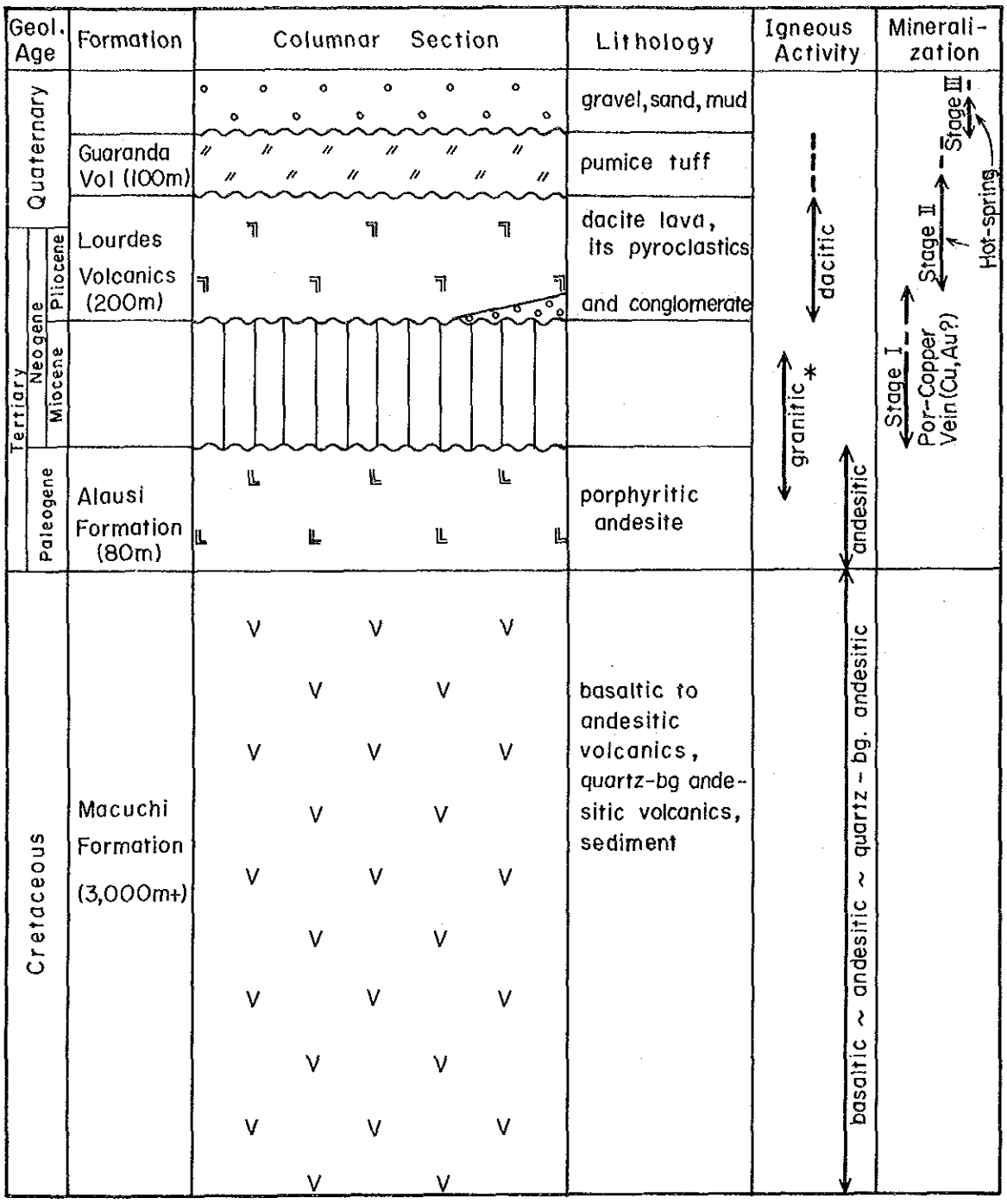
2) Ugshacocha mineralized zone

(corresponds also to a part of IP anomaly A) (300 m X 500 m)

-Intense pyrite mineralization accompaning chalcopyrite is recognized through geological survey

-This mineralized zone is considered to be the other part of "Ashuaca mineralized zone", because IP anomaly shows these two mineralized zones as a continuous one anomaly.

3) Las Tre Cruces mineralized zone (100 m X 500 M)



* Las Guardias batholith (25.7 ± 0.9 Ma) (30.1 ± 1.1Ma)
Chaso Juan batholith (20.9 ± 0.7 Ma)
La Industria batholith (25.5 ± 0.9 Ma)
Telimbela batholith (19.4 ± 0.6 Ma)

Fig.I-4-1 Generalized stratigraphy of the project area

Table I-4-1 Summary of survey results with mineral showings

Type of Survey	Name of Area Investigated	Area (Km2)	Geology	Mineralization						Assay Results							Evaluation
				Name of Zone	Type	Lateral Extension	Constituent Minerals	Host Rock	Alter-ation	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Mo (%)	W (%)	
Detailed Survey	Osohuauco of Balzapamba	10	Macuchi Formation of andesite, q-andesite and their pyroclastics, thin calcareous beds, hornfels near grano-diorite.	North	diss	900mx400m	Cp, Py, Mo	Gd	Sil	0.2	13.1	4.89	0.00	0.03	0.00	—	Required further investigation by meam of Drilling survey
									arg.	Tr	Tr	0.55	0.00	0.01	0.00	—	
					film				Bio	0.5	4.1	0.41	0.00	0.00	0.01	—	
									Chl.	0.2	6.5	1.18	0.00	0.01	0.01	—	
				South (N-side)	diss	200mx300m	Cp, Py	Gd	Sil	Tr	Tr	0.08	0.00	0.01	0.01	—	
					film		(Mo)	Horn									
			Intrusire rock of melanocratic grano-diorite.	(S-side)	diss	300m long & 10m wide	Cp, Py, Mo, Bn	f, Tf	Sil	0.4	27.8	2.60	0.00	0.10	0.00	0.00	
					film				Cal	Tr	Tr	0.05	0.00	0.00	0.00	0.00	
Detailed Survey	Northeast of Telimbela	9	Macuchi Formation of andesite and its pyro-clastics; hornfels near quartz-diorite	Ashuaca	diss	400mx600m	Cp, Py, Mo	HQd	Sil	0.2	6.1	1.38	0.00	0.02	0.08	—	Required further investigation by means of Drilling survey
					film			Qd	Prop	Tr	3.6	0.71	0.00	0.01	0.01	—	
					patch			Horn	Bio	0.1	10.4	0.86	0.00	0.02	0.01	—	
									Epi	Tr	6.1	0.76	0.00	0.02	0.01	—	
									Chl	0.2	2.1	0.89	0.00	0.00	0.02		
				Zone V and VI	diss	1.5kmx1.0km	Cp, Py, Mo	Qd	Sil	0.2	7.5	0.78	0.01	0.07	0.00	—	
					film			Horn	Rio	Tr	Tr	0.14	0.00	0.00	0.00	—	
					(patch)			Helarro	Epi	Tr	Tr	0.58	0.00	0.01	0.01	—	
									Chl								

This mineralized zone situates about 600 m western northwest of Ashuaca school.

- Intense pyrite mineralization accompaning chalcopyrite is recognized through detailed geological survey.

-This mineralized zone is delineated by IP method electrical survey as a elongated anomalous zone of low-resistivity and high FE in the NNE-SSW direction.

And following is another potential area selected in Osohuayco zone, Balzapamba area.

4) Osohuayco North mineralized zone (corresponds to a northeast end of IP anomaly 1)
Mineralization of chalcopyrite and pyrite is confirmed in the east side and west side of this mineralized zone through detailed geological survey.

-IP anomaly (low resistivity and high FE) is delineated at the near surface by IP method electrical survey.

4-2-3 Evaluation of survey methods

(1) Magnetic susceptibility measurement

Through Phase I and II survey, magnetic susceptibility measurement proved that demagnetization accompanying mineralization was distinguishable from the variety of its value depend on the difference of rock type. Range of magnetic susceptibility value for each rock type is as follows:

Granodiorite: from 20 to 60 X 10^{-3} SIU; Melanocratic Quartzdiorite: from 40 to 156 X 10^{-3} SIU; Andesite of Macuchi Formation: from 50 to 70 X 10^{-3} SIU; Tuff and sedimentary rocks: under 10 X 10^{-3} SIU. While, Intense mineralized zone: from o.1 to 20 X 10^{-3} SIU; Weak mineralized zone: from 10 to 40 X 10^{-3} SIU.

The survey areas for Phase III were selected on the results of the criterion mentioned above, general tendency of demagnetization is not clear whithin the surveyed area. Fractuation of measured value are distinctive depend on the position of a single outcrop. Magnetic susceptibility measurement is apparently useful to delineate and select potential area in the early atage of exploration for mineral deposits which are considered to be accompanying demagnetization. Especially, this survey method presents that mineralized zone could be treated and selected semi-quantitatively for field consideration in the early atage of exploration.

For further adaptability, it would be desirable to clarify conditions of demagnetization and to consider wheather or not condition of demagnetization of individual outcrops be recognizable.

(2) IP method electric exploration

IP method electric exploration was carried out in Northeast,Telimbela area. In the survey area common combinations of anomalies are high resistivity and low FE, or low resistivity and high FE.

This means that the more argillized zone would be the more mineralized zone. Mineralized zone can be detected out as a IP anomaly of low resistivity and high FE. The topography of the surveyed area is so rugged and steep that the S/N was recognized to be decreased, especially signal was weak near the valley. Furthermore, dependability of information for the depth may be decreased by the influence of electro-magnetic coppling or of artifitial structure.

Therefore, these conditions were taken into account for analysing data at the depth. As the result of such consideration, geophysical analysis on IP data is able to clarify the situation of sulfide minerals at the depth correctly. IP method electric exploration was proved to be very effective mean as a exploration means.

Chapter 5 Conclusion

5-1 Conclusions

(1) The Osohuayco zone, Balzapamba area

The geology of the area consists of Macuchi Formation and granodiorite which intruded into Macuchi Formation.

Two mineralized zones are recognized in this area, one is Osohuayco North mineralized zone and the other Osohuayco South mineralized zone. Drilling survey was carried out to disclose geological and mineralogical conditions of the IP anomaly which showed high apparent resistivity and high FE (more than 5 %) around the Osohuayco South mineralized zone, as a result of previous year geophysical survey. Any mineralization, however, associating with skarnization was not encountered. Drill hole intersected disseminated mineralized zone of chalcopyrite and pyrite in hornfelsinized andesite of Macuchi Formation (AAn). The assay discolsed the grade of the minerqlized zone to be very low at a whole, actual range was 0.01 to 0.18 Cu (average 0.05 % Cu).

(2) Northeast zone, Telimbela area

The geology of the area consists of Macuchi Formation and Granites which intruded into the Macuchi Formation. Granites are composed of Hornblende-biotite quartzdiorite, hornblend qurtzdiorite, melanocratic qurtzdiorite dike and coarse quartzdiorite dike. Those rock bodies are distributed and arranged in the NE-SW direction.

Porphyry copper type mineralized zone in the surveyed area is proved to be as a dissemination and metwork zone of chalcopyrite and pyrite.

These mineralized zones are macroscopically lined up in the direction of NE-SW and mineralization is centered in Hornblende quartzdiorite and affects thoroughly such country rocks as Macuchi Formation intensely.

Mineralized outcrops scatter in the area of 1.5 km X 1.0 km in and along Q. Ugshacocha and Q. Ashuaca, high grade ores are notably destributed in an area of 400 m X 600 m close to the Ashuaca achool, where dissemination and network zone of chalcopyrite and pyrite are recognized to exist not only in quartzdiorite but also in Macuchi Formation intensely. Moreover, molibdenite is observed in forms of dissemination and/or films scattered.

The assay revealed that southern mineralized part cropping out along Q. Ugshacocha contains 0.71 to 1.38 % Cu and that northern mineralized part cropping out along Q. Ashuaca 0.78 to 0.89 % Cu.

Outer part of the mineralized zone is to be dissemination and network zone of pyrite only. As a result of IP method electric survey, distinguished were 6 of high FE anomalies. FE anomaly corresponds generally to mineralization, while high resistivity anomaly to silicification and low resistivity to argilization.

Drilling survey was conducted at the west and east of the Ashuaca school, results of which are as follows: On the drill hole core MJE-8, intense dissemination of chalcopyrite and pyrite was observed through the hole (from the surface to the bottom).

Principal mineralized zones encountered by drill hole are interval between 21 to 102 m in depth with 0.02 to 0.72 % Cu (average, 0.468 % Cu). Adding this, several other intervals are recognized to show copper contents more than 0.10 %.

Mineralization tends to be dominant in the parts of angular xenoliths of andesite and in the the parts of auto-brecciated zone of quartzdiorite.

On the drill core MJE-9, intense mineralization of chalcopyrite and pyrite was observed through the hole from the surface to the bottom (205.00 m in depth).

Principal mineralized zones encountered by drill hole are intervals between 80 to 105 m in depth with a grade of 0.10 to 0.33 % cu (average, 0.229 % Cu) and between 124 to 161 m with a grade of 0.08 to 0.55 % Cu (average, 0.207 % cu). Adding those mineraization, several intervals are also recognized, which show copper contents more than 0.10 %.

As a whole, MJE-9 contains less andesite breccias and shows less auto-brecciation. Therefore, average grade of mineralized parts of MJE-9 was relatively lower than that of MJE-8.

To conclude data and information described above following three mineralized zones are delineated as potential zones of mineralization:

1) "Ashuaca mineralized zone"

As a result of geological survey, a number of intense mineralization of chalcopyrite and pyrite have been recognized around Ashuaca school. IP method electric survey disclosed that the deep low resistivity-high FE anomaly "A" which corrresponds to the "Ashuaca mineralized zone".

Moreover, low apparent-resistivity anomaly was recognized at the intense mineralized parts of chalcopyrite-pyrite in and along Quebradas, west and south of Ashuaca.

2) Ugshacocha mineralized zone

Ugshacocha mineralized zone distributes about 500 m southeast of Ashuaca school. Through detailed geological survey, recognized is intense mineralization of chalcopyrite-

pyrite, while this mineralization is confirmed to be corresponded to low resistivity-high FE zone "A" which has been selected as a tangue shape anomalous zone extendiong from the Northeast of the Ashuaca to the Southeast.

3) Las Tres Cruces minerlized zone

Las Tres Cruces mineralized zone is distributed about 600 m western northwest of Ashuaca school.

As a result of geological survey, intense pyrite dissemination accompanying chalcopyrite are recognized. Furthermore, low resistivity-high FE anomaly "B" is delineated as a narrow and elongated zone with the dirrection of NNE-SSW by IP method electric survey.

This anomaly implies that hidden mineralized zone may exist in the depth of Macuchi Formation.

5-2 Recommendations for the future survey

Based on the findings of Phase III survey, the following recommendations are made for the future survey.

(1) Osohuayco zone, Balzapamba area (Fig. III-2-1)

The Osohuayco North mineralized zone, mineralized outcrops of which are confirmed through geological survey of Phase III, is extensive in scale and comparatively high grade in copper content.

This mineralized zone occurs in hornblende-biotite granodiorite (Gd). Distribution area of these mineralized outcrops corresponds with the IP anomaly area delineated on the high resistivity-high FE values of Phase II geophysical survey.

Therefore, drilling survey is recommended to disclose the condition and extent of mineralization in detail, the locations of which are shown in Fig III-2-1. For example, 300 m deep X 2 holes in Osohuayco North mineralized zone.

(2) Northeast zone, Telimbela area (Fig III-2-2)

"The Ashuaca mineralized zone", which is confirmed thoroughly by Phase III geological, geophysical and drilling survey, is extensive in scale and high in grade of metal (copper) content. This mineralized zone is also peoved to have close relationship of distribution with hornblende quartzdiorite (HQd). Adding this, potential areas have been delineated around "Ashuaca mineralized zone".

Furthermore, through geophysical survey, IP anomlies are distinguished in the depth of "Ashuaca mineralized zone" where recognized are chain of mineralized outcrops.

Therefore, drilling survey is recommended to disclose the condition and extent of mineralization in detail, the locations of which are shown in fig.III-2-2 . For example, 200 m deep X 3 holes in "ashuaca mineralized zone"; 200 m deep X 2 holes in Ugshacocha mineralized zone; and 200 m deep X 1 hole in Las Tre Cruces mineralized zone.

PART II DETEILES

Chapter 1 Osohuayco zone of Balzapamba area

1-1 Geological survey

1-1-1 Purpose and method of survey

The purpose of the Phase III survey is to clarify the relationship among mineralization, geological structure and igneous activities, and to confirm geological and mineralogical conditions in an area of IP anomalous zone delineated by Phase II geophysical survey in granodiorite in Osohuayco North zone and in Macuchi formation in Osohuayco South zone.

The surveyed area is 10 km^2. Before starting the survey, the routes of geological investigation were selected based on the existing data. We used a topographic map for route map at a scale of 1 to 2,500 which was enlarged from topographic map at a scale of 1 to 10,000 prepared for Phase III survey by MMAJ.

Aerophotographs are also refered for data analysis and compilation. The results of geological survey were put together on geological map at a scale of 1 to 5,000.

Magnetic susceptibility was also measured on each outcrops along the main survey routes with a portable magnetometer simultaneously with the geological investigation. The relationship between mineralization and magnetic susceptibility was considered.

Small pits were digged to observe inside geologically on fresh rock surface, and to collect samples for chemical analysis. The results of chemical analysis made it possible to estimate intensity of mineralization, and its characteristics, and to consider mineralogical and geological situation of the mineralized zone.

Location maps of samples for various test and analysis are shown in Figure A-1 at the end of this report and results of the test and analyses are listed on Appendixes tables at the end.

1-1-2 Geology

The Geology of Osohuayco zone of Balzapamba area consists of Macuchi Formation and Intrusive rocks (Plate II-1-1, Figs.II-1-1 and II-1-2)

(1) Stratigraphy

1) Macuchi Formation

a) Distribution

Macuchi Formation is mainly distributed in the northeastern part (Osohuayco North) and southern part (Osohuayco South) of the surveyed area. Macuchi Formation is intruded by

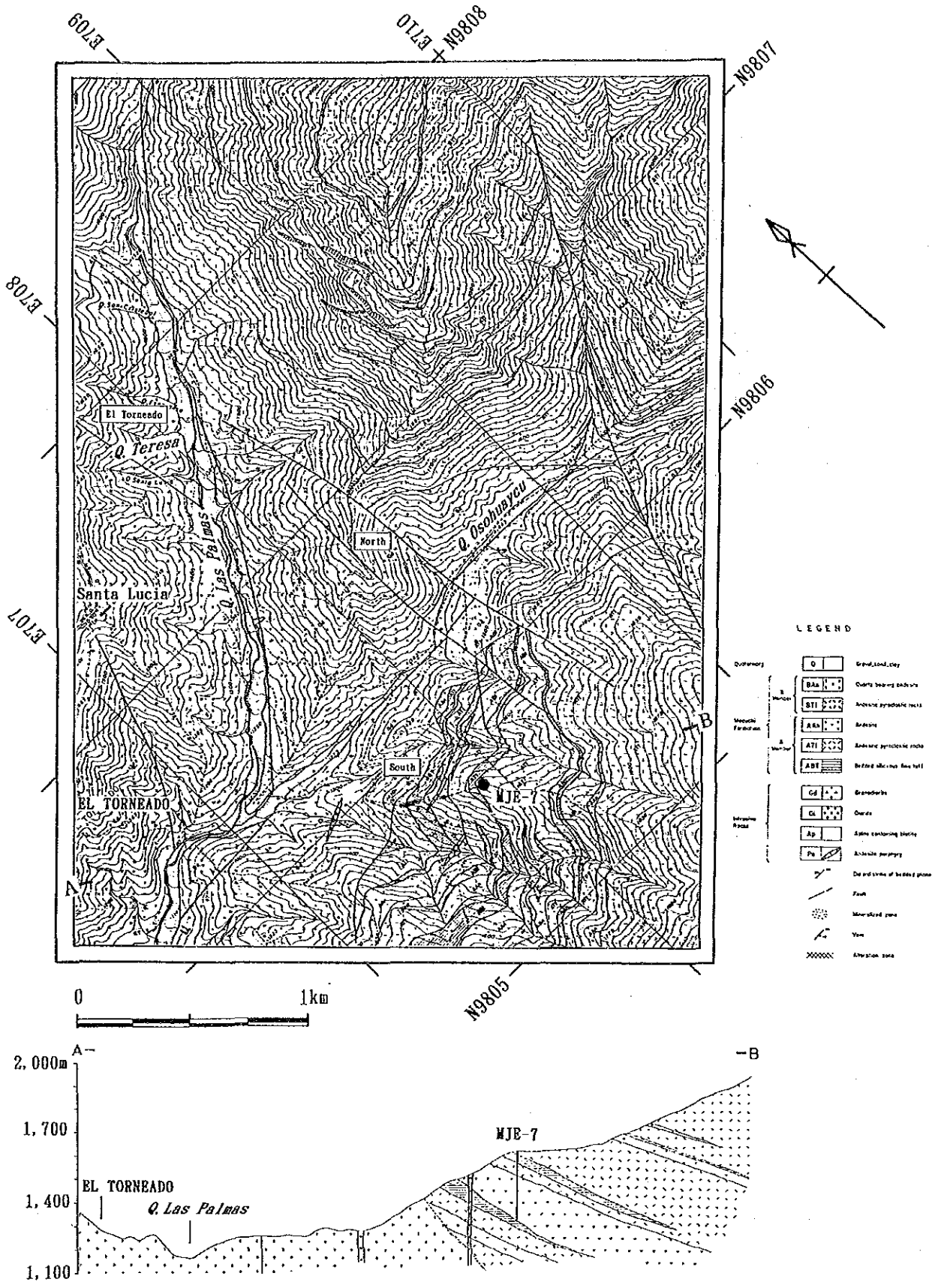


Fig.II-1-1 Geological map of the Osohuayco, Balzapamba are

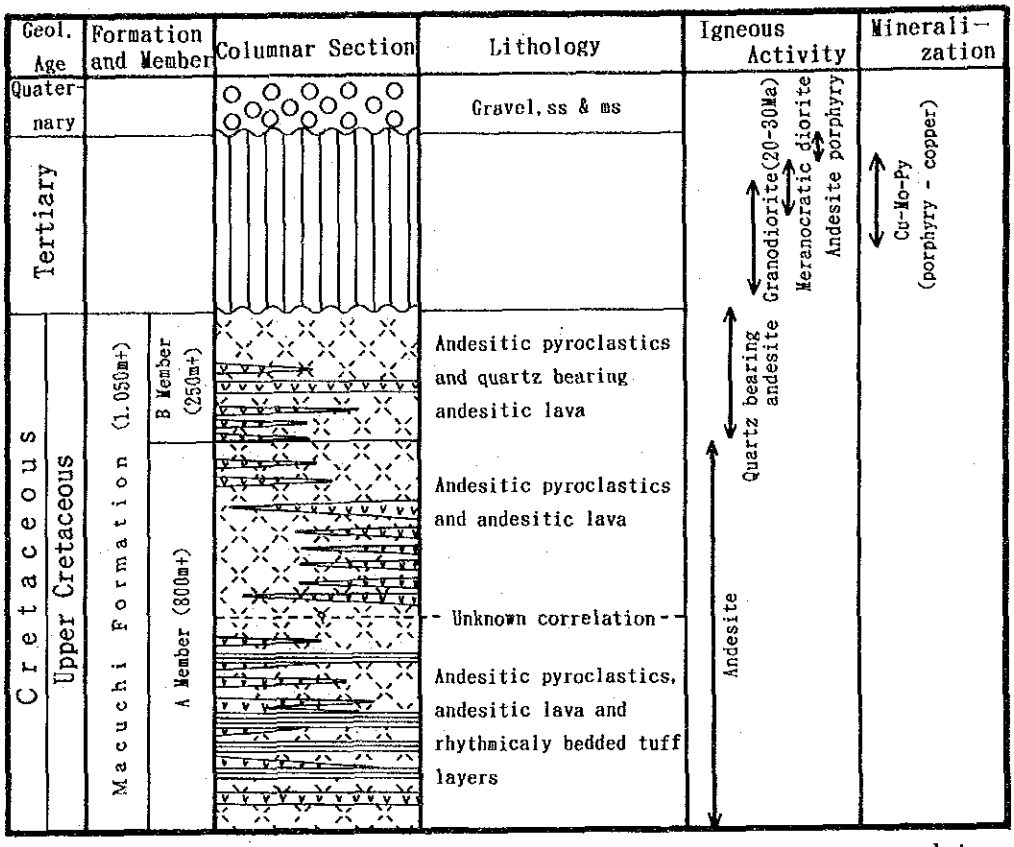


Fig.II-1-2 Generalized stratigraphic section of the Osohuayco, Balzapamba area

granodiorite in the central part.

b) Thickness

More than 800 m in the northeastern part and over 750 m in the southern part.

c) Lithology

Macuchi Formation consists of member A and B. Member A is composed of andesitic lavas (AAn) and their pyroclastics (ATf). Member B is composed of quartz grain bearing andesitic lavas (BAn) and their pyroclastics (BTf).

Pyroclastic portion (Tf) is dominate generally in the survey area, and lava portion are recognized as intercalated layers in the pyroclastics. Pyroclastics include following rock types: volcanic breccia, tuff breccia, lapili tuff, coarse tuff, crystalline tuff, and alternation of fine tuff and siliceous fine tuff. These rock facies indicates change of volcanic activities.

Member B distributes in a small area only near the eastern edge of the surveyed area, and its rock facies are described in Fig. II-1-3.

Change of rock facies around Mt. Bunque Lome in the northeastern part of the survey area and around Q. Osohuayco in the eastern part of the surveyed area are shown in Figs. II-1-3 and II-1-4 respectively. Rock facies change in southwestern area is shown in Fig.II-1-5.

Every geologic column shows several volcanic activities, and three or four alternation units of fine tuff and siliceous tuff which intercalate calcareous thin layers. These calcareous thin layers intercalated may imply pauses of volcanic activities.

The microscopic characteristics of andesite lava (AAn) and its pyroclastics (Atf) are as follows:

Andesite lava (AAn) (C3060)

Location: About 2.5 km eastern southeast of Santa Lucia, at the corner of bend where Q. Osohuayco turns direction from NE-SW to E-W.

Texture: Porphyritic.

Constituent minerals: Plageoclase hornblende apatite and opaque minerals.

Alteration minerals: Biotite, quartz muscovite albite, epidote, chlorite, limonite.

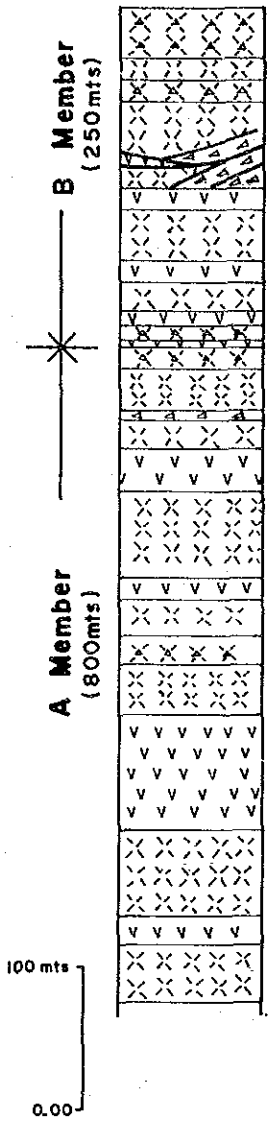
Andesitic tuff (ATf) (C3069)

Location: about 2.5 km eastern southeast of Santa Lucia, along the E-W ridge.

Texture: vitrious, bearing lithic fragments.

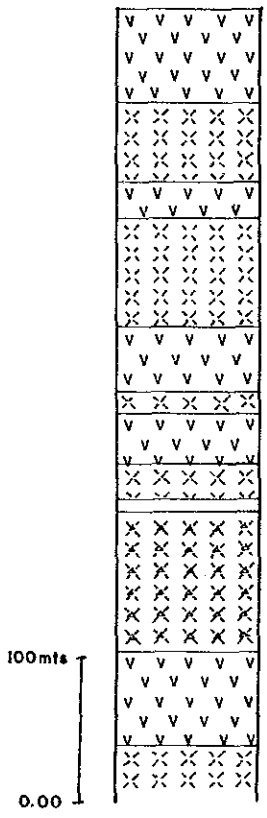
Fragments and matrix: quartz and opaque minerals.

Alteration m;inerals: quartz muscovite biotite.



Grey andesitic lapilli tuff~coarse tuff, fragments compased of whit tuff, andesite, Ø2-8mm, subangular~subround, poorly sorted
Grey fine tuff, compact, massive
Light grey lapilli tuff~coarse tuff
Grey fine tuff, compact, massive
Grey~dark grey volcanic breccia, tuff breccia, and porphyritic Andesite (pheno= pl, ho)
Dark grey aphanitic andesite
Dark grey, fine tuff, compact, massive
Dark grey quartz bearing andesite (Ø 0.5~1mm)
Dark grey, fine tuff, compact, massive
Dark brownish grey, quartz bearing andesite (Ø 0.5~1mm)
Grey lapilli tuff
Dark brownish grey, quartz bearing andesite
Dark grey lapilli tuff
Dark grey fine tuff, compact, massive
Dark grey, tuff breccia, (Ø 1cm~10cm, subangular, poorly sorted
Dark greenish grey, coarse tuff
Grey aphanitic andesite~porphyritic andesite (pheno, pl, ho, px)
Light greenish grey~dark grey, coarse tuff~fine tuff, massive, compact
Dark grey porphyritic andesite phenocrystals composed of plagioclasas
Light greenish grey fine tuff
Grey lapilli tuff, andesitic fragment and tuff
Grey coarse tuff~fine tuff, massive, compact, silicified
Dark brownish grey, porphyritic andesite phenocrystals composed of plagioclasas and hornblendes
Greenish grey~light grey, coarse tuff, fine tuff, including crystalline graina and lithics
Dark grey aphanitic andesite
Grey silicified fine tuff, massive, compact

Fig. II-1-3 GEOLOGIC COLUMN OF Mt. BUNQUE LOMA



Grey px - andesite aphanitic

Light grey coarse tuff with dark grey patches

Grey aphanitic andesite

Dark grey fine tuff

Dark grey aphanitic px - andesite

Dark grey fine tuff

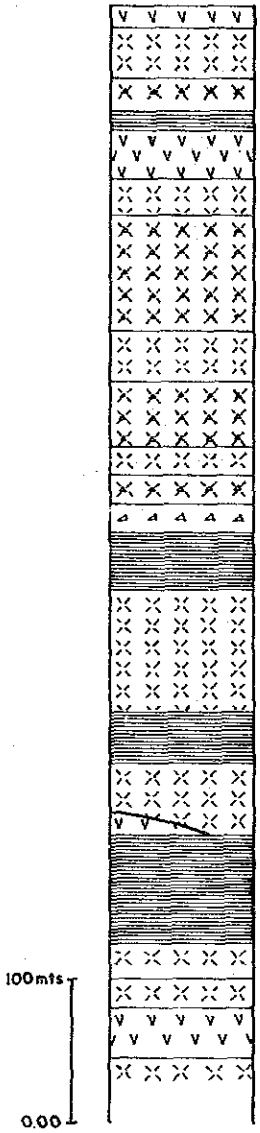
Dark grey aphanitic andesite

Blueish dark grey coarse tuff, lapilli tuff, tuff breccia
Blueish grey aphanitic andesite

Light greenish grey andesitic lapilli tuff
frag, Ø 5mm ~ 2cm, tuff > andesite > mucly rock

Brownish grey, quartz-bearing px-andesite,
phenocrystals; plagioclasas 20 %, quartz 5 %

Fig.II-1-4 GEOLOGIC COLUMN IN QUEBRADA OSOHUAYCO



Brown silicified andesite
Pale green fine tuff ~ coarse tuff
Pale green lapille tuff
Grey silicified bedded tuff
Dark grey aphanitic andesite
Dark grey, crystalline tuff
Grey andesitic lapilli tuff
Dark grey fine tuff
Grey andesitic llapilli tuff
Grey fine tuff
Grey lapilli tuff with quartz grains
Grey tuff breccia
Grey bedded siliceous fine tuff
Dark grey coarse tuff ~ fine tuff
Light brown silicified bedded tuff, well rhythmic beds
Grey compact, massive tuff
Grey ~ brownish grey, bedded, siliceous fine tuff, Ti 10cm ~ 20cm, well bedded, rhythmic bed, hard, compact partly skarn
Grey silicified fine tuff
Grey lapilli tuff
Dark grey ~ grey andesite

Fig. II-1-5 GEOLOGIC COLUMN OF OSOHUAYCO AREA

In the southern part (Osohuayco South) of the the surveyed area, alternation units (ATf) of fine tuff and siliceous fine tuff are o served at least four. Calcareous part of Alteration units are suffered skarnization partly and skarn minerals associated slightly with dissemination or veinlets of chalcopyrite-pyrite-(quartz). Skarnization may be a part of contact metamorphism and resulted from intrusion of batholith granodiorite (Gd) or dike melanocratic granodiorite (Di).

The microscopic characteristics of a calcareous part of this units are as follows:

Calcareous altered rock (ATf) (C3098)

Location: about 1.5 km southern southeast of Santa Lucia, along NW-SE ridge.

Texture: massive, equi-granular.

Constituent minerals:---

Alteration minerals: Garnet epidote.

(2) Intrusive rocks

Intrusive rocks are in the order of activities: granodiorite botholith (Gd), Melanocratic diorite stocks or dikes (Di), Tracky andesite dike (Tr) and Aplite dike (Ap).

1) Granodiorite (Gd)

a) Distribution

Granodiorite (Gd) distributes in the western part (West of Las Palmas branch river) of the surveyed area and the central part (Q. Osohuayco river), showing a shape of distribution, letter "L".

b) Lithology

Granodiorite (Gd) shows massive,light gray to greenish gray in color, and medium to coarse grain equi-granular. Brecciated parts of this rock body are observed in El Torneado zone and in an area about 1.5 km south of it where surrounded by Q. Las Palmas river and Q. Osohuayco river.

In and along fractures of brecciated parts, mineralization of chalcopyrite and pyrite are recognized.

Plageoclase quartz are observed as felsic minerals and hornblende biotite as mafic minerals. Mafic minerals are altered partly to chlorite and/or epidote. Chalcopyrite are scatters where green altered minerals are concentrated.

The microscopic characteristics of granodiorite are as follows:

Granodiorite (Fd) (B3040)

Location: about 1.5 km eastern southeast of Santa Lucia, along branch river running

to south.

Texture: Holocrystalline, equi-granular.

Constituent minerals: Plageoclase biotite, hornblende quartz apatite, titanite and opaque minerals.

Alteration minerals: Small amount of albite, muscovite, epidote, and chlorite.

The microscopic characteristics of brecciated part are as follows:

Granodiorite (Gd) (B3043)

Location: about 1.5 km eastern southeast of Santa Lucia, along branch river running to the south.

Texture: Holocrystalline, equi-granular.

Constituent minerals: Plageoclase quartz Hornblende and opaque minerals (pyrite dissemination).

Alteration minerals: Biotite epidote, chlorite, and limonite.

Pyrite rich portion of the sample (B3043) mentioned above was also analyzed with X-ray powderly diffractive analysis. Following minerals were identified:

Granodiorite (Gd) (B3043)

Identified minerals: Quartz biotite, plageoclase hornblende.

2) Melanocratic diorite (Di)

a) Distribution

Melanocratic diorite (Di) intruded into Macuchi Formation (AAn and ATf) in the south-western part of the surveyed area. Four sheets of this dikes are observed in Osohuayco South. Direction and inclination suspected were as follows: the direction was ENE-WSW, the width was 10 to 30 m and the length 50 m for shorter and 500 m for longest one.

b) Lithology

Melanocratic granodiorite shows massive, gray to light gray in color and medium to coarse grain as size of rock forming minerals.

At the contact, child margin is formed in which hornblende, biotite and plageoclase are observed.

3) Aplite (Ap)

a) Distribution

Aplite (Ap) intruded into granodiorite (Gd) as three dikes in the up stream of Q. Terresa branch river. Direction of intrution is N50°W 70°NE and N40°E 90°. Width is 20 t0

50 m.

b) Lithology

Aplite (Ap) shows massive, light gray to white in color and fine grain holocrystalline. Micro grains of biotite are observed as mafic minerals.

4) Porphyritic andesite (Pa)

a) Distribution

Porphyritic andesite (Pa) distributes as a dike at the up stream of Q. Terresa branch river in the northwestern part of the surveyed area, just east ofwhich granodiorite (Gd) batholith is brecciated, altered and mineralyzed.

Direction and inclination of dike is approximately N20°E 90° though the dike shows bending slightly. width is 50 to 100 cm.

b) Lithology

Porphyritic andesite shows massive, gray in color and fine grained porphyritic texture. Phenocrists are hornblende, biotite and quartz. The rock body is also mineralyzed with chalcopyrite and pyrite. chalcopyrite are concentrated where hornblendes are altered to green minerals.

1-1-3 Geological structure

(1) Lineaments

Lineaments were analyzed with aerophotograph (1 to 60,000) in the survey area. The result of the analysis is shown on topographic map at a scale of 1 to 20,000 in Figure A-4.

As Figure A-4 shows, prominent system of lineaments is of NE-SW direction. Principal lineaments are two: one is along Q. Las Palmas river and the other along Q. Osohuayco river. The former is NNE-SSW direction and has a branch, NNW-SSE direction. The latter directs E-W, the same direction as Q. Osohuayco river. The E-W lineament is dislocated by N-S lineament and NNE-SSW lineaments.

Where distribution density of lineaments is comparatively high situates in an area of 3 km X 1 km including El Torneado mineralized zone and Osohuayco North mineralized zone. Within this area, two lineament systems (NNE-SSW and E-W) intersect each other.

(2) Faults

Following lineaments were interpreted as faults in surveyed area:

a) NNE-SSW lineament of Q. Las Palmas river, which is prominent among lineament systems.

b) NNW-SSE lineament, a branch of NNE-SSW lineament mentioned above.

c) E-W lineament of Q. Osohuayco river.

d) N-S and NNE-SSW lineaments, which dislocates E-W lineament mentioned above.

The reason of interpretation is as follows:

- Silicified and white argillized zone was actually observed on the ridge extending E-W direction in up stream of Q. Osohuayco river, adding this breccia zone which may have been formed associating with faulting was also at about 500 m north of silicified and argillized zone described above, confirmed on the floor of river.

- White argillized zone (partly accompanying silicification) was observed at the contact of Macuchi Formation and granodiorite batholith (Gd) on the ridge (1,720 m to 1,740 m ASL) between Q. Las Palmas river and Q. Osohuayco river.

Following is the result of X-ray powdery diffractive analysis on the sample collected from white argillized zone which may be results of faulting.

White argillized rock (partly silicified) (C3070)

Identified minerals: Quartz plageoclase hornblende, sericite.

1-1-4 Mineralization and alteration

(1) Type of mineralization

The mineralization confirmed in the surveyed area are of two types: one is observed in granodiorite, and the other observed in Macuchi Formation.

Phase II geophysical survey delineated two major IP anomalies. One is distributed in the Osohuayco North where dissemination and network veinlets of chalcopyrite-pyrite are observed in and along branch rivers and confimed to be porphyry copper type (hereinafter refers Osohuayco North mineralized zone).

The other is distributed in the Osohuayco South, northern portion of Osohuayco South anomaly is porphyry copper type mineralization embarrassed in granodiorite, while southern portion is dissemination and networky veinlets of chalcopyrite (hereinafter refers Osohuayco South mineralized zone north side) and pyrite embarrassed in Macuchi Formation (hereinafter refers Osohuayco South mineralized zone south side).

(2) Occurrence of mineralized zone

Osohuayco mineralized zone

The extension of the Osohuayco north mineralized zone is about 900m X 400 m.

In the eastern outcrops, granodiorite is partly brecciated where observed are dissemination and networky veinlets of chalcopyrite and pyrite. While in the western outcrops no brecciation is recognized and sulfide minerals exist in networky veinlets zone.

Alteration are all, macroscopically, silicification and chloritization. Silicification includes two different types: replacement of rock forming minerals and segregation of micro grained secondary quartz. Secondary quartz shows calcedonic in western putcrops and crystolline quartz in eastern putcops.

Assay result of chip samples collected from eastern outcrops was 1.18 % Cu. Though only a few outcrops are available to the east of Osohuayco North mineralized zone, mineralization accompning chalcopyrite are recognized locally in Macuchi Formaion along the ridge and branches of Q. Osohuayco river.

Osohuayco South mineralized zone

(North side)

This mineralized zone occur as dissemination and networky veinlets of chalcopyrite and pyrite in granodiorite in an area of 200 m X 300 m. Disseminated ore assayed to be 0.08 % Cu.

(South side)

This mineralized zone occurs in alternation units of fine tuff and siliceous fine tuff of Macuchi Formation. Skarn minerals are observed, partly and characteristically, in calcareous part of alternation units which show distinctive laminas of fine tuff and siliceous fine tuff.

Chalcopyrite and pyrite are associating with skarn minerals in forms of dotted and ameba of dissemination or veins (1 to 10 cm in width) of chalcopyrite-pyrite-calcocite-grossular-quartz. Mineralized outcrops of this mineralized zone distribute in three branch rivers running to northwest. Two principal mineralized horizons are recognized, and lower one is predominant in mineralization.

Thickness of lower one varies from 2 to 10 m. Chip ore samples collected in this horizon assayed to be 2.60 % Cu. No sulfide minerals have been observed in the outcrops on and along the ridge which situates between two mineralized outcrops.

(3) structural control of mineralization

All of the mineralized zone recognized in the surveyed area are arranged macroscopically in a N-S direction. Actually, line up El Torneado mineralized zone, Osohuayco North mineralized zone and Osohuayco South mineralized zone from north to south.

Furthermore, N-S fault is confirmed and mapped at the western edge of El Torneado mineralized zone. Adding this, two N-S faults are also suspected to be around Osohuayco North mineralized zone. Mineralized horizone in Osohuayco South, however, shows apparently N20° to 30°E in direction and 20° to 45°SE in inclination.

1-1-5 Magnetic susceptibility measurement

To determine quantitatively demagnetization due to mineralization, magnetic susceptibility was measured, using a potable magnetometer. This measurement was made through the area. The magnetometer was Kappameter Model KT-5 of Czechoslovakia with measurement susceptibility of 1×10^{-3} SIU.

At the measurement, efforts were made to completely scrape weathered portions off and surface unevenness. each measurements are the average of three values disregarding the highest and lowest ones.

Location and measured value are shown in Figure A-2.

Measured values in this surveyed area showed generally the magetic susceptibility that each rock possess originally. On the contrary demagnetization due to mineralization was not clear. Fig.II-1-6 shows a example, that is relationship between quartz thin vein and magnetic susceptibility observed at lower stream of Q. terresa branch river in the northeastern part of surveyed area.

In the sketched outcrop. quartz thin vein exists in the country rocks (grnodiorite Gd) with E-W, 70°E, influence of quartz thin vein to host rock is not grater than 1 m. El Torneado mineralized zone situates within a 100 meter from the outcrop. to the up stream. Magnetic susceptibility did not indicate halo of demagnetization. In Osohuayco North mineralized zone, demagnetization was not recognized even on the mineralized outcrops.

Mineralization and alteration are, therefore, considered to be less in the surveyed area.

Magnetic susceptibility was also measured inside of pits to obtain data for decreasing susceptibility through weathering. At pit number PO-05, fresh biotite-hornblende granodiorite vs weathered one were 43.3×10^{-3} SIU and 25.4×10^{-3} SIU respectively.

One hundredth was the decrease order of magnetic susceptibility as discussed on demagnetization in the Phase I and II survey.

To measure magnetic susceptibility, therefore, still has applicability for early stage of exploration.

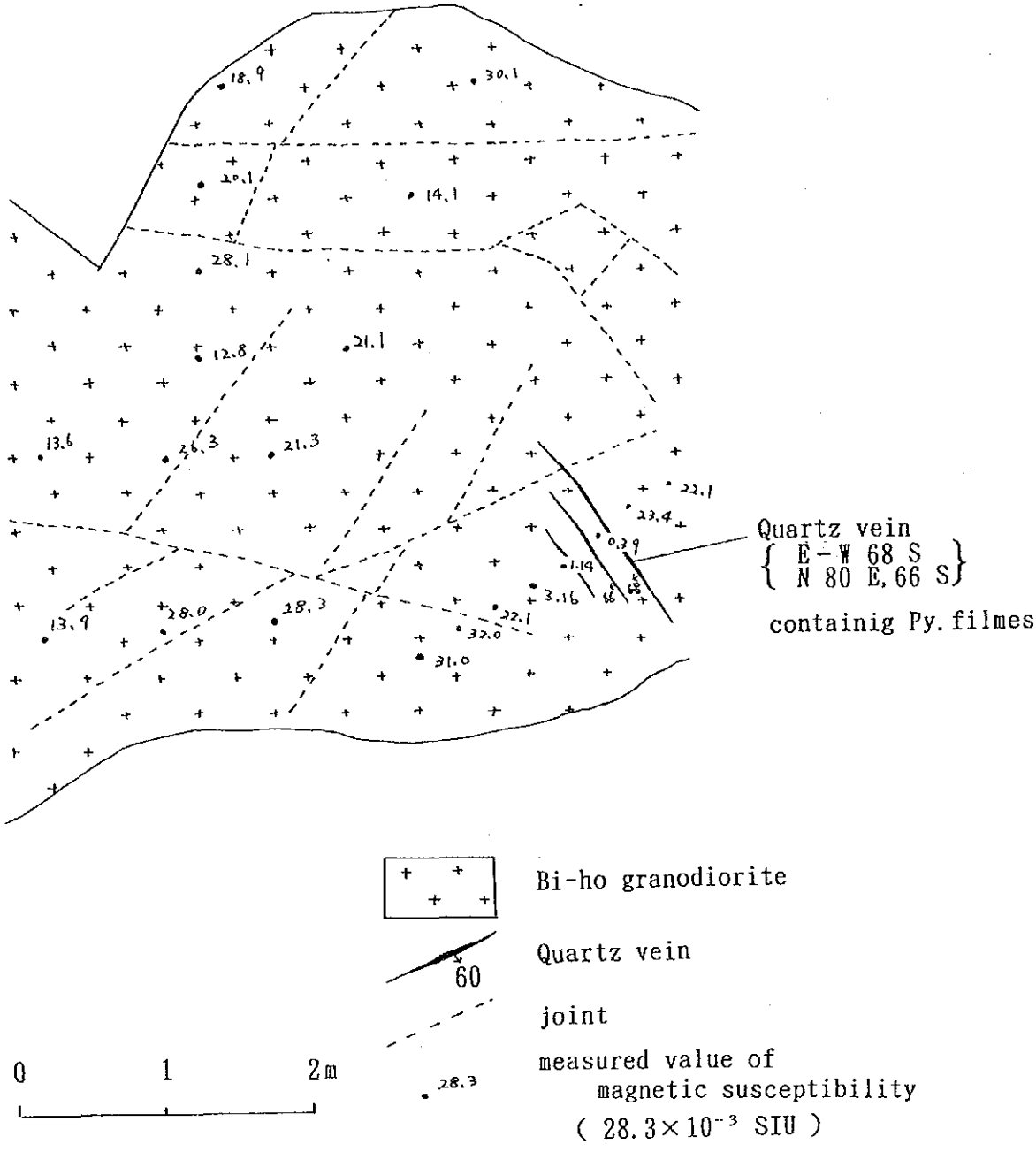


Fig.II-1-6 Mineralization and magnetic susceptibility on a outcorp along Q. Teresa

1-2 Drilling survey

1-2-1 Purpose of drilling survey

The purpose of the drilling survey to clarify the mineralyzing condition in the depth of two mineralized horizons (Osohuayco South mineralized zone south side) delineated on IP anomaly detected through Phase II geophysical survey, in the Macuchi Fromation in southern part of the surveyed area.

1-2-2 Details of drilling survey

(1) Area for drilling work

The Osohuayco south mineralyzed zone south side (where drilling was carried out) locates about 2 km south of Santa Lucia, a center part of Balzapamba survey area. Drilling site is on a steep sidge, altitution is 1,620 m ASL.

This site was determined considering results of geological survey and CSAMT survey of Phase I and IP method electrical survey of Phase II. The location of the drill hole site is shown in Fig.II-1-1.

(2) Outline of drilling work

For this work, main drilling machine and equipments including water pumps were donated from Japan, and drilling tools, bits, rods and mud materials were brought in from Japan, mud pumps and other supplemental materials from INEMIN. Drilling work was conducted through a period from September 7 to 26 of 1990.

The model of drilling machine used was the Longyear Model L-38. Works for site preparation and equipment dismantling were proceeded on a daytime shift only. Drilling work was carried out, as a rule, for 24 hours a day. Wireline process was adopted to improve recovery of drill cores and efficiency of other works. Through the drilling survey required appropriate camp facilities for laborers.

Drilling performance of the hole is listed on Table A-6.

(3) Delivery of materials and equipments, and preparation of drilling site

Materials and equipments supplied from Japan and INEMIN were delivered to the base in Santa Lucia, which base is heliport constructed for Phase III survey. Most of machines and

materials such as drilling machine, pumps, mastle, rods and etc. were transported from the base to the drilling site by helicopter. Only a few tools and materials were delivered in with manpower.

water required for drilling work was supplied with water pipeline (1 to 1/2 inch polyethylene pipe) by natural flowing from an reservoir dam which was prepared at up stream of a branch river running eastern side of the drill hole site.

(4) Drilling work

Actual drilling work is shown in Fig.II-1-7, the progress of drilling work for MJE-7 is shown on Table A-7, and the frilling equipments and consumed materials are listed up on Table A-8.

Detailed work of MJE-7 is as follows:

0to 16.50 m

(hole diameter 101 mm, with NQ-NU casing down to the depth of 16.50 m)

To drill surface soil and gravel layers, 101 mm metal bits and diamond shoe were used with bentonite mud water. When reached the country rock at 16.50 m NQ-NU casing was inserted.

16.50 to 151.00 m

(hole diameter 75.7 mm of NQWL with BW casing down to 151.00 m)

Through NQWL process, drilling was conducted using bentonite and TK60B with fresh water. Lithology was hard (siliceous) dine tuff with intercalation of granodiorite sheets (o.5 to 2.0 m in thickness) down to 104.70 m. Drilling work faced a difficulty because drill hole intersected fracture zone where wall rock of the hole collapsed frequently and circulating mud water was lose completely.

To recover the condition, mud oil or other oil was added to the ordinal mud water. BW casing was inserted at the depth of 151.oo m.

151.00 to 305.00 m

(hole diameter 60.00 mm of BQWL)

Through BQWL process, drilling was conducted with mud water of TK60B and fresh water. Lithology was mainly dark blue andesite. Below 190 m hornfels dominates down to the bottom. Hole was competed at the depth of 305.00 m.

(5) Examination of drill cores

For MJE-7 hole, drill dore examination was conducted simultaneously with drilling op-

eration at the drilling site and Balzapamba base camp. Result of this examination were compiled in columnar section (Plate II-1-2) and geologic section (Fig.II-1-8).

Drill cores were split with diamond cutter after completing the drill hole. One half of them was taken for test samples and the other left for duplicate.

1-2-3 Results of drilling survey

Followings are the results of examination on the drill hole core of MJE-7 (see Plate II-1-2 for detail):

0.0 to 30.0 m

Siliceous, grayish white fine tuff. Fractures are developed. No sulfide minerals was recognized.

30.0 to 40.0 m

Siliceous, grayish white, banded fine tuff. No sulfide minerals was recognized.

40.0 to 79.3 m

Siliceous, grayish white fine tuff. Fractures are developed. Intercalation of medium-fine grained biotite granodiorite (0.8 to 3.3 m in core length).

Sulfide minerals in forms of films of patches. Principal ore mineral is fine grained pyrie.

79.3 to 91.1 m

Siliceous, grayish white and pale green banded fine tuff. Fine grained pyrite, epidote, and chlorite are recognized in and/or along fractures of the host rock.

91.1 to 104.7 m

Siliceous and calcareous,grayish white fine tuff. the result of microscopic obsevation for sample collected at the depth of 98.00 m, observed are skarn minerals: a large amount of garnet and a small amount of zoisite. Furthermore, calcite was observed in fractures of host rock, opaque minerals, however, was not confirmed.

104.7 to 305.0 m

Dark bluish green andesite (partly hornfels)

Below 120 m, epidote is common and secondary biotite apperas occasionally.

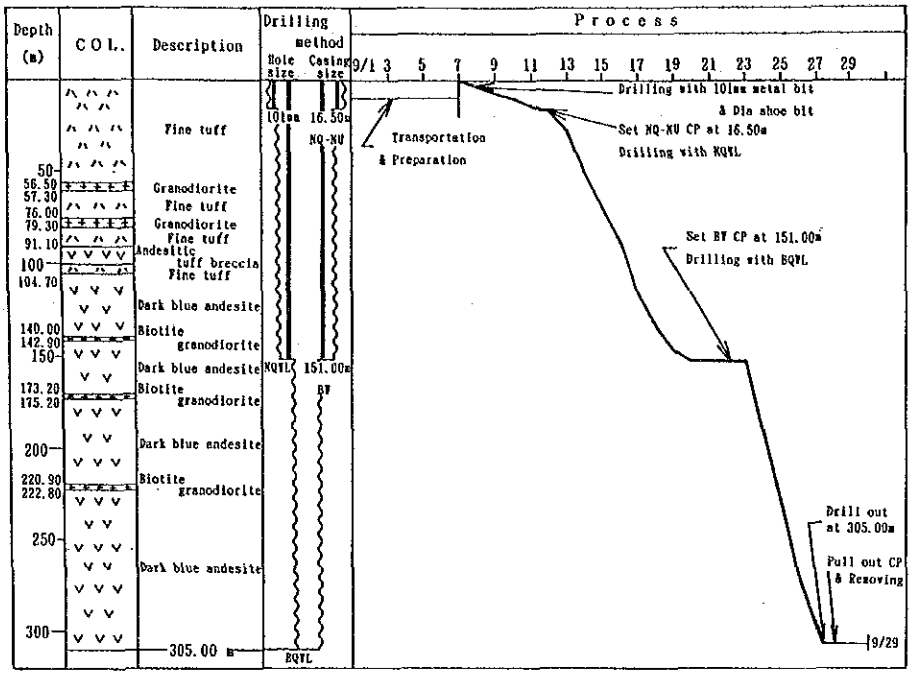


Fig.II-1-7 Progress record of Mje-7 of the Osohuayco, Balzapamba area

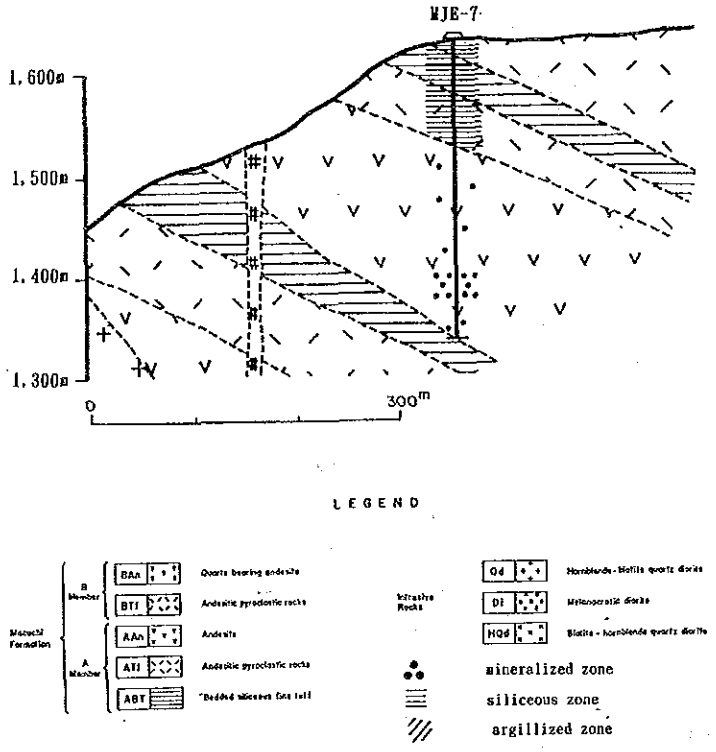


Fig.II-1-8 Geologic section of MJE-7 of the Osohuayco, Balzapamba area

Below 190 m, secondary biotite occupies nearly 50 % of the rock forming mineral in volum. The microscopic observation on the sample collected at the depth of 267.3 m revealed that secondary biotite is 0.2 to 0.3 mm in size and distributes uniformly in the field of scope. This is considered to be the results of contact metasomatism (hornfels) caused by intrusion of granodiorite into Macuchi Formation.

In fractures of andesite (including hornfels) film and/or veinlets of pyrite-chalcopyrite-chlorite-quartz are recognized, especially below 190 m dissemination and patch of pyrite and chalcopyrite were dominate.

Polished section of 245.5 m and 267.4 m were studied carefully, chalcopyrite, bornite, pyrite and magnetite were identified. where chalcopyrite shows patchy in form (at the depth of 245.3 m), bornite occurs as primary mineral and associates as a assembly of chalcopyrite-bornite-(pyrite)-quartz. Magnetite occurs in rock forming minerals in form of micro grain such as 0.01 to 0.02 mm in diameter.

These samples were assayed to be 0.03 % Cu and 0.01 % Zn.

Where hornfels is predominant micro chalcopyrite dots distribute in secondary biotite (at the depth of 267.4 m). Rounded chalcopyrite was included into pyrite. Pyrite includes magnetie too. Where chalcopyrie associates with magnetite, chalcopyrite includes magnetite.

The assay result are as follows:

From 261.4 to 264.3 m: 0.9 g/t Ag, 0.14 to 0.16 % Cu, 0.01 % Zn;

From 267.9 to 270.9 m: 0.01 to 0.02 % Cu, and 0.01 % Zn.

Principal mineralized zone is from 231.4 m to 264.3 m in depth. A average grade in this interval is Au: Tr, Ag: up to 1.2 g/t, Cu: o.o1 to o.18 (average 0.05 %), Pb: 0.00 %, Zn: 0.01 %, Mo: 0.00 %

Molibdenite was not recognized neither in nakid eye nor under microscopic observation.

1-2-4 Discussion

MJE-7 hole intersected calcareous thin bed which intercalated into fine tuff units of Macuchi Formation at the very depths of geological estimation. Calcareous thin bed was partly suffered skarnization but no sulfide minerals were associated with skarn minerals.

The mineralized zone confirmed by the MJE-7 hole exists in hornfels or andesite of macuchi Formation in forms of dissemination and films of chalcopyrite and pyrite. This mineralized zone may be considered to be a part of porphyry copper type, and through fracture system mineralized parts be connected between mineralized zone in granodiorite and those in Macuchi Formation.

The depth of themineralized zone intersected corresponds to the depth of IP anomaly (high resistivity and high FE). IP anomaly detected dissemination of chalcopyrite-pyrite as corresponds to high FE in hornfels-andesite as corresponds to high resistibity.

The grade of mineralized zone, however, was too low for further survey.

1-3 Consideration of survey results in Osohuayco zone, Balzapamba area

Follows are the characteristics of mineralization in this surveyed area obtained as a result of geological and geochemical survey, and magnetic susceptibility measurement, geophysical survey (CSAMT method, and IP method) and Drilling survey:

Porphyry copper type mineralization in the surveyed area has two different host rocks. One is granodiorite: examples of mineralized zones are Osohuayco North mineralized zone, and Osohuayco South mineralized zone north side. The other is Macuchi Formation: examples are Osohuayco south mineralized zone south side. These mineralized zones are line up in North-south direction, adding this El Torneado mineralized zone situates on te same straight line about 1.7 km north of Osohuayco north mineralized zone.

During field survey, however, it had not been able to sub-divide granodiorite batholith or distinguish apropriate stocks for mineraization. Therefore igneous rocks which have close relationship with mineralization have not yet been identified.

On the other hand, MJE-7 hole was carried out to clarify the geological condition in the depth at the Osohuayco South mineralized zone south side, and the hole encountered dissemination zone of chalcopyrite and pyrite between 230m and 280 m in depth within the andesite or hornfels of Macuchi Formation.

This mineralized zone, encountered by the Drill hole, was different from what previously assumed but similar to or a part of the mineralization which is recognized at Osohuayco South mineralized zone north side as a porphyry copper type in granodiorite.

These mineralized zones situate along and/or in the vicinity of N-S geological structure, and intersection of N-S principal lineament and E-W local lineament.

To conclude, mineralization associating with skarn minerals in the Macuchi Formation (Osohuayco South mineralized zone south side) may be limitted and local, neither extensive holizontally nor vertically. This mineralized zone may have less potential.

For the future survey, Osohuayco North mineralized zone may still have potential because analytical data are required more to evaluate.

Chapter 2 Northeast zone of Telimbela area

The Northeast zone of telimbela area is located 10 km north of the Balzapamba area. The access by road is available from Balzapamba via babahoyo. It takes 3 hours approximately by car. The detailed geological survey has been conducted in the area.

2-1 Geological survey

2-1-1 Purpose and method of survey

The purpose of the Phase III survey is to clarify the relationship between mineralization, geological structure and igneous activity, to prepare appropriate and sufficient information for selecting prosperous mineralized zones showings geologically for further geophysical survey and drilling survey.

The surveyed area is 9 km2. Before starting the survey, the routes of geological investigation were selected bases on the existing data. We used the topographic map at a scale of 1 to 10,000 scale which had been prepared especially for this year survey by MMAJ.

The results of the survey were summarized on a topographic map at a scale of 1 to 5,000. Through the compilation of geological data, we referred some information of aerial photograph analysis

Magnetic susceptibility was also measured on each outcrops along the main survey routes with a portable magnetometer simultaneously with the geological investigation. The relationship between mineralization and magnetic susceptibility was considered.

Small pits were digged to observe inside geologically on fresh rock faces, and to collect samples for chemical analysis. Location of pits and their sketches of walls are shown in Figures A-3 and A-4. Channel sampling method was adopted as a rule when collects them.

Location maps of samples for various test and analysis are shown in Figure A-1 at the end of this report and the results of the test and analysis are listed on Appendixes tables at the end.

2-1-2 Geology

The Northeast zone of the Telimbela area is underlain by the Macuchi formation and granitic rocks which were emplaced in the Macuchi formation (Plate II-2-1, Figs.II-2-1 and II-2-2).

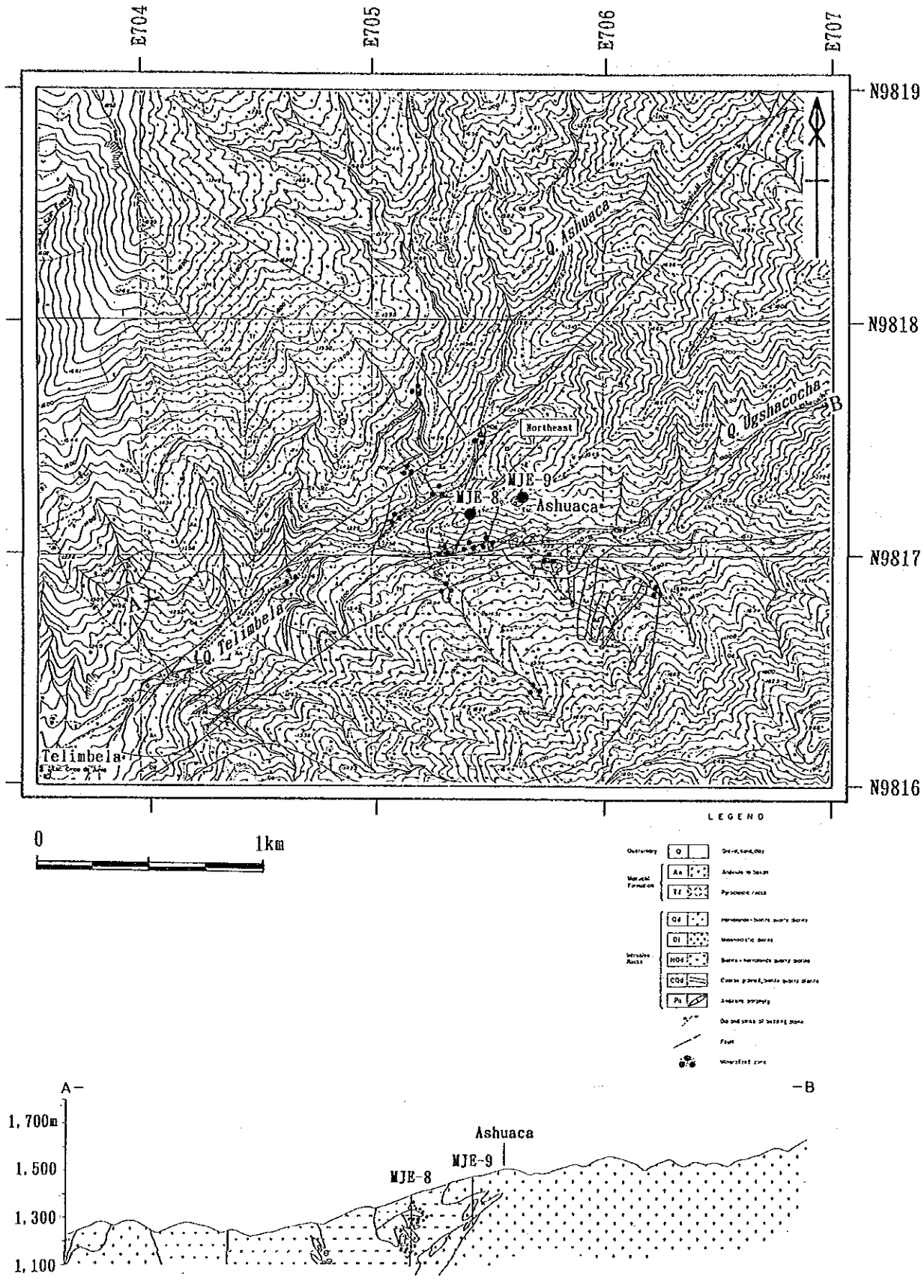


Fig.II-2-1 Geological map of the Telimbela area

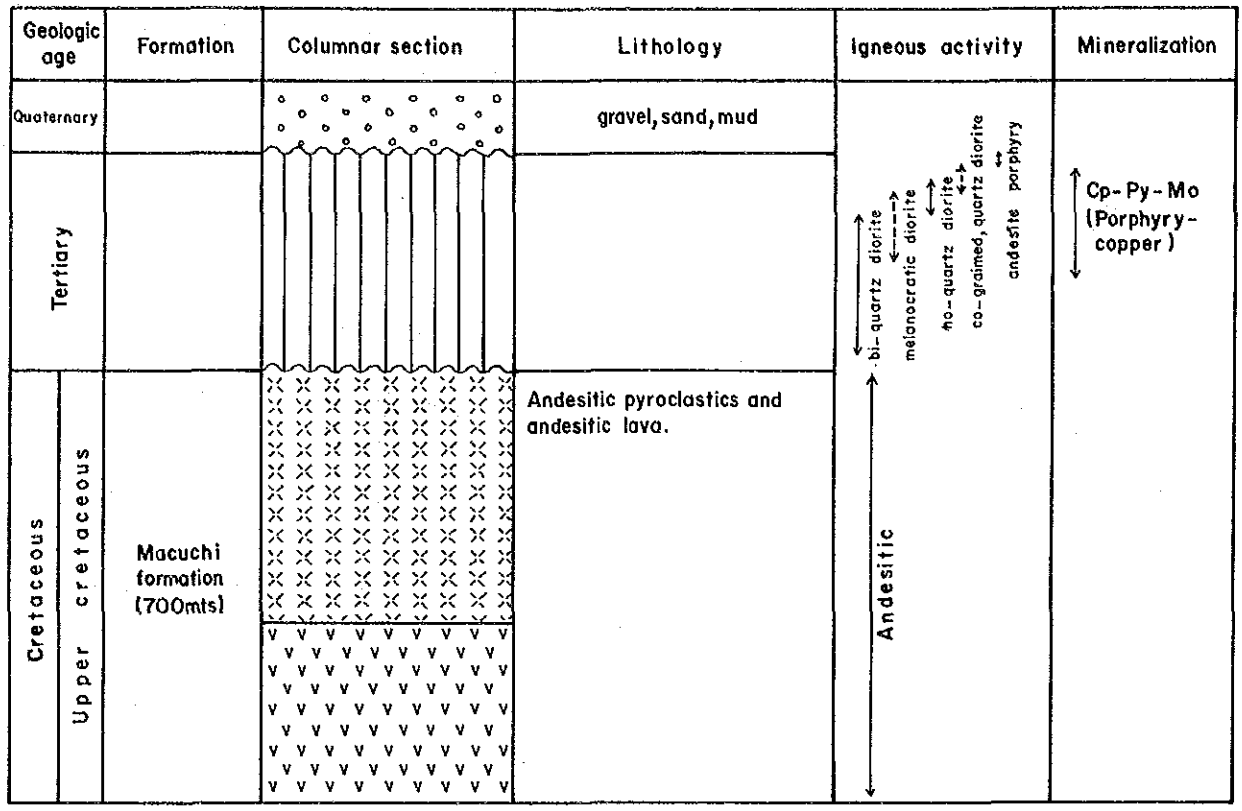


Fig. II-2-2 STRATIGRAPHIC SECTION IN THE TELIMBELA AREA

(1) Stratigraphy

1) Macuchi Formation

a) Distribution

Macuchi Formation is mainly distributed in the western part of the surveyed area, in the central part (about 500 m west of Ashuaca), small blocks of which are also observed in the vicinity of Ashuaca as xenoblocks in the batholith of hornblende-biotite quartzdiorite (Qd) and stocks of hornblende-quartzdiorite (HQd).

b) Thickness

More than 700 m in the western part of the surveyed area.

c) Lithology

The Macuchi Formation Consists of andesite lava AAn) and the lower part of the thick piles of these igneous rocks is composed of lavas 220 m thick, which intercalates 2 or 3 sheets of pyroclastics. In the Upper part of it, pyroclastic sediments develop and pile up more than 460 m thick.

Principal constituents of the Macuchi Formation are coarse tuff, crystalline tuff and fine tuff. Geologic column investigated in western part of the surveyed area, northeast of Telimbela village, is shown in Fig.II-2-3. Lava which is common in the lower part shows dark greenish gray in color with typical amygdaroidal structure, and cavities, diameter of which is 3 to 6 mm, are observed to be filled with quartz.

The formation has been suffered thermal metamorphism and turned partially to hornfels, therefore it is difficult to suspect the original rock facies.

The microscopic characteristics of andesite lava and its pyroclastics are as follows:

Andesite (An) (C3050)

Location: 1 km west of Ashuaca, along a branch river flowing to the south

Texture: Blastoporphyritic, partly granoblastic

Constituent minerals: Plageoclase hornblende and opaque minerals

Alteration minerals: Actinolite, biotite, quartz chlorite epidote

Fine tuff (Tf) (C3053)

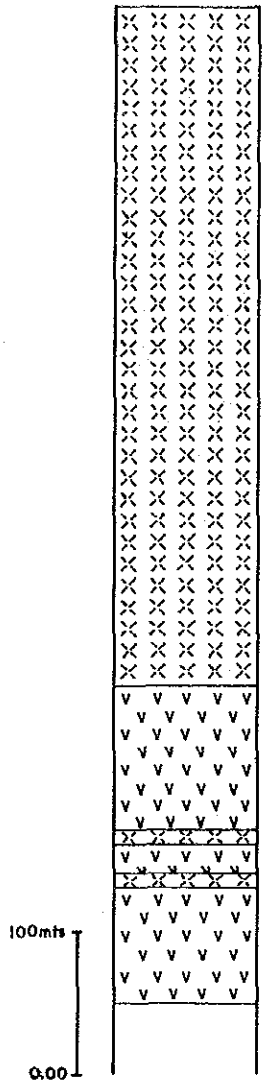
Location: 1 km west of Ashuaca, along a branch river flowing to the south

Texture: Partly granoblastic

Fragments and matrix: Matrix consists of micro-laths of actinolite, epidote, chlorite, size of lath is 0.01 mm in width and 0.1 mm in length approximately.

(2) Granitic rocks

Granitic rocks are almost distributed in the entire area surveyed, and consist of



Dark blueish grey~grey, coarse tuff~fine tuff

Dark blueish grey~grey, andesite to basalt, showing amigdaloidal texture filled by secondary quartz

Blueish grey fine tuff
Dark greenish grey, andesite to basalt, showing amigdaloidal texture
Dark grey fine tuff to coarse tuff

Dark grey, andesite to basalt, showing amigdaloidal texture

Fig. II-2-3 GEOLOGIC COLUMN OF TELIMBELA AREA

hornblende-biotite quartzdiorite batholith (Qd), melanocratic quartzdiorite (Di), hornblende quartzdiorite stocks (HQd), coarse quartzdiorite dikes (CQd), and porphyritic andesite dikes (Pa).

1) Hornblende-biotite quartzdiorite

a) Distribution

Hornblende-biotite quartzdiorite (Qd) is distributed in the southeastern part and northeastern part of the surveyed area.

b) Lithology

Rock facies is light gray to gray in color, and massive, medium grain and equigranular. Color index of the rock is between 15 % and 20 %. Rock forming minerals are recognized in naked eyes plageoclase and quartz as feltic minerals and hornblende and biotite as mafic minerals. Mafic minerals have been occasionally altered to chlorite etc. Chalcopyrite dots are disseminated in secondary green-minerals in the area of intense alteration.

The rock (Qd) is estimated to have intruded into the Macuchi Formation in late-Creataceous through early Paleogene of Tertiary, included blocks and breccias of the Macuchi Formation near the contact of the both rock bodies and contact-metamorphosed it.

The microscopic characteristics are as follows:

Hornblende-biotite quartzdiorite (Ad) (C3020)

Location: About 2 km northeast of Ashuaca, on the ridge extending NE-SW direction

texture: Holocrystalline

Constituent minerals: Plageoclase biotite, Hornblende, quartz apatite, zircon, and opaque minerals

Alteration minerals: chlorite albite, epidote

2) Melanocratic quartzdiorite (Di)

a) Distribution

Melanocratic quartzdiorite (Di) crops out in the southern part of the surveyed area, extending about 2,500 m long and 100 m wide.

The rock (Di) also crops out at about 2,200 m north of Ashuaca as a small intrusive body of 150 m wide and 500 m long in the NE-SW direction.

Five more small-bodies are recognized in the survey area.

b) Lithology

The rock (Di) shows dark gray to dark green in color, massive, and medium to fine

grain size of rock forming minerals. Color index of the rock is 30 % to 40 %.

Following rock forming minerals are recognized in naked eyes:
Plageoclase quartz as feltic minerals and hornblende biotite as mafic minerals. As the result of microscopic observation, ratio of hornblende and biotite varies, and these mafic minerals have been altered to chlorite and epidote from one place to another.

The microscopic characteristics of the rock (Di) is as follows:
Melanocratic quartzdiorite (Di) (C3032)

Location: 1 km south southeast of Ashuaca, along a branch river flowing to northwest

Texture: Holocrystalline, equigranular

Constituent minerals: Plageoclase biotite quartz hornblende, apatite, and opaque minerals

Alteration minerals: Chlorite epidote actinolite, albite, leucoxene, smectite

3) Hornblende quartzdiorite (HQd)

a) Distribution

Hornblende quartzdiorite (HQd) distributes in the west and south of Ashuaca, the central part of the surveyed area, as two small stocks and a dike. This stocks intruded into Macuchi Formation (An and Tf), Hornblende-biotite quartzdiorite (Qd) and Melanocratic quartzdiorite (Di).

b) Lithology

Hornblende quartzdiorite (HQd) shows massive, gray to greenish gray in color and medium grain. Color index of the rock is between 20 % and 30 %. The rock body contains a number of blocks, breccias and fragments of Macuchi Formation (An and Tf), hornblende-biotite quartzdiorite (Qd) and Melanocratic quartzdiorite (Di).

Chalcopyrite, pyrite and molibdenite are recognized in forms of dissemination, films, patches or veinlets in the stocks. Following minerals are also recognized as rock forming minerals, in makid eyes: Plageoclase qurtz and hornblende biotite. Mafic minerals are partly altered to chlorite or other green minerals.

The microscopic characteristics of the rock (HQd) are as follows:
Hornblend quartzdiorite (HQd) (C3001)

Location: 0.5 km southwest of Ashuaca, at the junction of Q. Ugshacocha river and Q. Ashuaca river.

Texture: Holocrystalline equi-granular

Constutuent minerals: Plageoclase biotite quartz honblende, apatite and opaque minerals

Alteration minerals: Chlorite epidote actinolite, albite, leucoxene, and