REPUBLIC OF HONDURAS

REPORT ON GEOLOGICAL SURVEY OF THE WESTERN AREA

VOLUME 3

FEBRUARY, 1979

METAL MINING AGENCY

JAPAN INTERNATIONAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

PREFACE

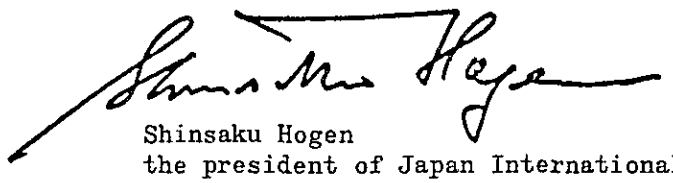
The Government of Japan, in response to a request by the Government of the Republic of Honduras, decided to investigate the potentiality of mineral resources in the western area of the Republic of Honduras and entrusted the geological and other survey works to Japan International Cooperation Agency. The Agency, considering the nature of the works to belong to special field of the investigation of geology and mineral resources, sought the cooperation of the Metal Mining Agency of Japan to accomplish the task.

The survey works are programmed to be carried out over a period of three years, this year's survey comprising the second phase. As a part of the survey works, Metal Mining Agency organized a 11-men survey team headed by Mr. Tadashi Sakuma of MESCO, Inc. and sent the team to the Republic from May 15th to October 6th of 1978. During this period, the team, with the help of the Government of the Republic of Honduras and its various agencies, was able to complete survey works on schedule for the current year.

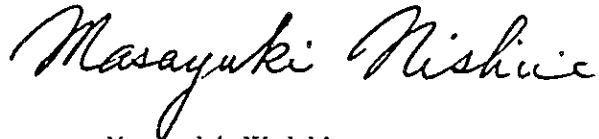
This report summarises the results of the survey of the second phase and will form a portion of the final survey reports obtained in the first and the third phases of this survey.

We wish to take this opportunity to express our heartful gratitude to the officials of the Government of the Republic of Honduras and its various agencies, as well as to the Ministry of International Trade and Industry, the Ministry of Foreign Affairs and cooperating companies, for the cooperation and support extended to the Japanese survey team.

February, 1979

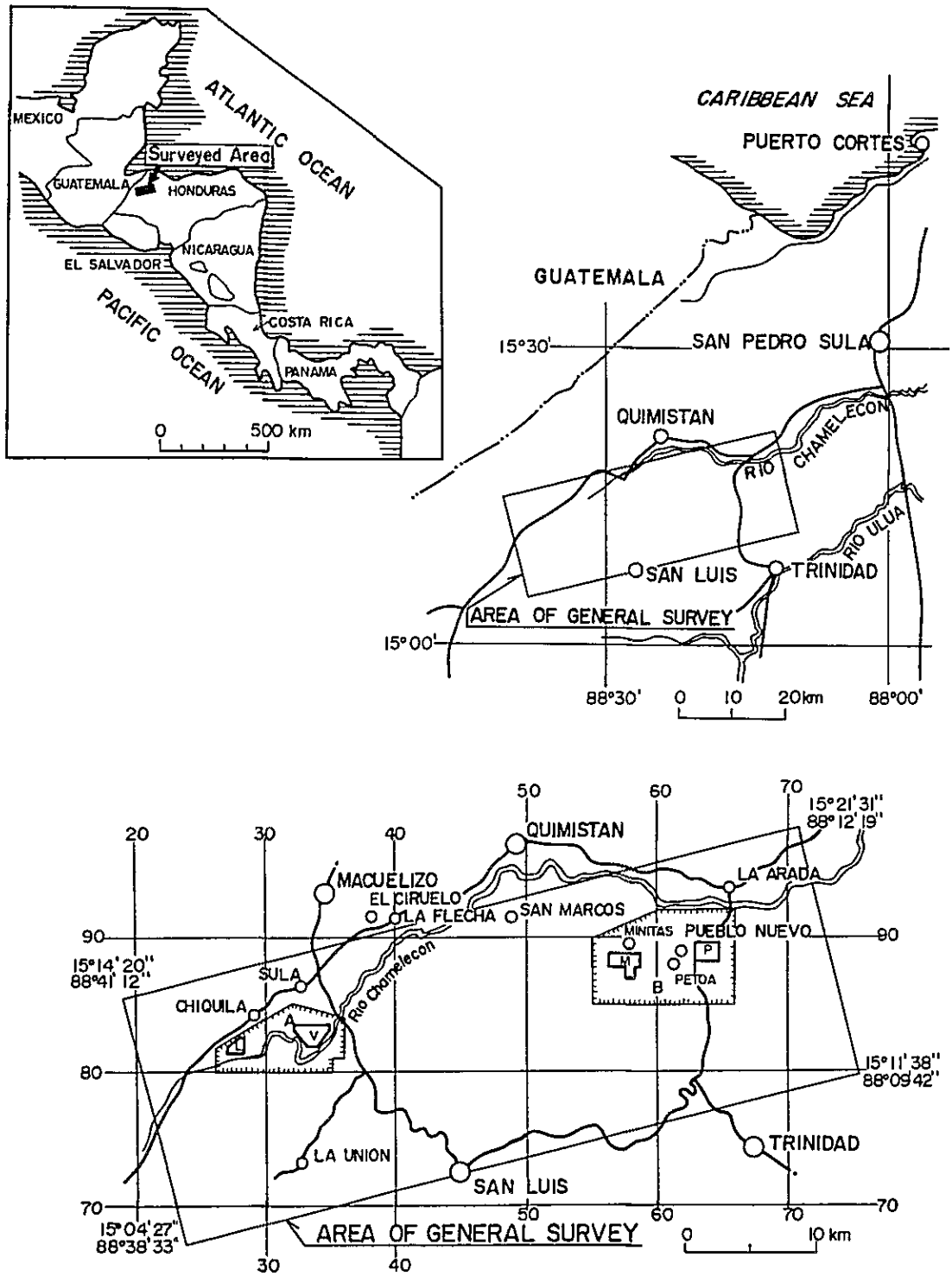


Shinsaku Hogen
the president of Japan International Cooperation Agency



Masayuki Nishiie
the president of Metal Mining Agency of Japan

Fig.1 LOCATION MAP OF THE SURVEYED AREA



INTEGRATED CONTENTS

ABSTRACT

(1) As the second phase of the Basic Geological Survey for the Development of Mineral Resources, detailed geological survey and diamond drilling were completed in the 4 sectors selected from the first phase survey area, for the purpose to investigate more concrete potentiality of the emplacement of mineral resources.

The selected four sectors are two sectors in the western part --- Vueltas del Rio sector and Laguna Seca sector, and another two sectors in the estern part --- Minitas sector and Pueblo Nuevo sector.

(2) The survey area is situated about 75 km south of the town of San Pedro Sula in the northwestern part of the Republic of Honduras. It lies in the low mountainous land of the hight of 200 to 650 meters above sea level, and geologically the survey area belongs to the geo-structural unit of the Sierra of Northern Central America.

As for the geology of the survey area, Paleozoic mica schist formation lines in the northernmost part, and to its south, sedimentary beds of Vueltas del Rio Formation or Minitas Formation are distributed, followed in the order to the south by Atima massive limestone Formation, Guare alternated Formation of limestone and shale, while southern part of the survey area is covered by Tertiary volcanic rocks of Matagalpa Formation.

The boundary between Paleozoic sediments and other formations is represented by east-west-trending Pueblo Nuevo overthrust. Dykes and stock-like igneous rocks composed of quartz diorite, andesite, diabase, liparite are found in the zone extending east-west within approximately 5 km from the overthrust. Some of them intruded into the Paleozoic and Mesozoic sedimentary rocks, and influence by such intrusion is observed as alteration and structural distrurbance. The distribution of the indications of mineralization

in the subject survey area is confined to the area along Pueblo Nuevo overthrust, which comprises various types such as disseminated copper type, copper-lead-zinc-iron contact replacement type and gold-copper-lead-zinc vein type, related to some of the above-mentioned intrusive igneous rocks. Most of the known indications of the mineralization are distributed in the above four selected sectors.

(3) In the Vueltas del Rio sector, the following geological features have been confirmed, through particular subdivision of the Vueltas del Rio Formation, by the detailed geological survey accompanied by trenching and by the diamond drilling of the 5 holes totalling 2,004.1 m in length.

That is, the Vueltas del Rio Formation is composed of sedimentary rocks mainly of metamorphosed volcanic pyroclastics such as tuff, tuff breccia, welded tuff, tuffaceous sandstone and shale, andesite, basic tuff, diabase etc. They have been remarkably altered by sericitization, silicification, argillization and others, which makes it often hard to recognize original rocks. In the northern part, schistosity develops well, and it is thought that a synclinorium exists there with the axis in east and west direction, as a whole.

In the diamond drilling carried out in the survey of the present phase, parts of vein type mineralization with the grade of Cu over 1% have been recognized in the drill holes No. 53-1, No. 53-2 and No. 53-4. Especially, in the cores of the drill hole No. 53-3, veinlets and dissemination of copper have been recognized in addition to gold-bearing vein with Zn grade of 1.7%, over 22 meters downward from the depth of 104 m. Furthermore, the parts where abundant gold is contained have been found in the drill holes No. 53-2 and No. 53-3, which reveals the area to be most favorable for the emplacement of vein type and dissemination type ore deposits of gold, copper and zinc.

In rather southern side of the present survey sector, east-west trending fracture zone has been presumed to exist, represented by the old workings of

gold and by the high anomaly zone of the geochemical survey. In this zone, remarkable iron dissemination has been observed extensively, too.

Detailed geological survey with trenching and investigation by diamond drilling will be necessary for the research of the features of gold distribution in the shallow part of the fracture zone and for the exploration of the mineralization in the deep part of it.

(4) Detailed geological survey with trenching was carried out in the Laguna Seca sector. In the northern part of the sector, Paleozoic mica schist formation is distributed with some inserted lenses of limestone, and the Vueltas del Rio Formation lines in its south, separated by the fault, accompanying the Atima limestone beds in its southern side. Geochemical high anomalies are found in a zone along the boundary between the Vueltas del Rio Formation and the Atima Formation. This zone is corresponded to the zone where strong silicification has been observed, containing remarkable iron dissemination partly, although no conspicuous indication of mineralization has been found in this zone and it would not be thought to be so favorable as to appraise the potentiality of this zone would be high. The future program for the exploration in this sector should be arranged after giving consideration to the program in the Vueltas del Rio sector.

(5) In the Minitas sector, detailed geological survey with trenching and diamond drilling of three holes totalling 901.8 m in length were carried out and the following points have been confirmed.

Classification has been attempted to subdivide diorites, which used to be grouped as one unit, into Minitas Formation, granodiorite and porphyries. The Minitas Formation is composed of metamorphosed andesite and metamorphosed andesitic pyroclastic rocks. Generally the rocks of this formation has been influenced by alteration such as silicification and chloritization, which makes it hard to confirm lithology. The metamorphosed andesites are thought

to be belonging to the older rocks prior to Permian system, as they have been intruded by the granodiorite, the age of which has been obtained to be 224 ± 17 m.y. by the isotopic age determination.

Overing them, the Atima limestone beds are distributed along the hillside and in the mountainous land. Also, dykes of granodioritic porphyry, diorite porphyry and granite porphyry are found here and there to have intruded them in northwest-southeast direction. At the southern end, Tertiary Matagalpa Formation overlies them.

In this sector, faults and dykes of the trends of eastwest and northwest-southeast are well developed. The existence of the mineralized part carrying copper-lead-zinc-iron associated with skarn minerals of garnet and actinolite has been confirmed along the margin of the dykes of granite porphyry and diorite porphyry, in the area from Minitas to Macutalo. Low mineralized Skarn minerals of chlorite and epidote have been caught over 7 meters of the core of the drill hole No. 53-6. Also, by the cores of the drill hole No. 53-7, remarkable mineralization of copper associated with skarn minerals of garnet and actinolite with limestone insertions has been found to be emplaced intermittently from the surface to the depth of 93 meters. On the surface, copper-zinc mineralization has been confirmed along the dykes in the Minitas valley. Further investigation will be required on the forms and features of granite porphyries and on the distribution of the associated sulphide minerals.

(6) In the Pueblo Nuevo sector, where thick vegetation coverings are remarkable, detailed geological survey with trenching was carried out and the followings have been confirmed.

In the southern side of the sector, the Minitas Formation composed of metamorphosed andesites is distributed, and in the northern part the rocks of the formation are seen intruded by liparites, which are again intruded by

the dykes of granite porphyries. From the central to southern part of the sector, the limestone beds of the Atima Formation form hilly land. Prominent are the tectonic lines and the faults of the directions of east-west and northeast-southwest. In a zone along the boundary between limestone and liparites, the indications of copper-lead-zinc mineralizations are found at Santa Ines and at Santo Domingo, which are though to be formed under the control of the combination of geo-tectonic lines, igneous rocks and the existence of limestone bottoms.

(7) As mentioned above, the geology, the structure and the mineralization of the Vueltas del Rio Formation and the Minitas Formation have been clarified by the survey works carried out in the selected four sectors. It is especially noted that many indications of gold-copper-zinc mineralization have been discovered through the investigation by the diamond drillings in the Vueltas del Rio sector and inthe Minitas sector.

Further detailed geological survey and diamond drilling are recommended in the Vueltas del Rio sector inthe first place, followed by the Minitas sector, for the purpose to ascertain the actual relation of mineralized area, kind of mineralization and related igeous rocks and structure in the above indications of mineralization.

CONTENTS

APPENDICES

General

List of Figures

Geology

List of Figures

List of Tables

List of Plates

List of Figures

List of Tables

List of Plates

GENERALS

Chapter 1 Introduction

1-1 Particulars and Purpose of the Survey

The government of the Republic of Honduras, with the cooperation of UNDP, conducted, for five years from 1969 to 1974, regional geological survey and geochemical exploration in the total area of 10,800 km^2 of the northwestern part of the Republic, and also performed systematic exploration works, in the selected areas, through the combination of the methods such as geological survey, detailed geochemical exploration, geophysical exploration, pitting, trenching and diamond drilling. Based on the results of the works, several favorable areas bearing indications of mineralization of dissemination-type and skarn-type associated with metal minerals of copper, gold, lead and zinc were recommended, and the government of the Republic of Honduras requested the government of Japan for Basic Geological Survey for the Development of Mineral Resources in October of 1975.

The government of Japan despatched the mission for the project selection three times and selected the area including Chamelecon area and Petoa area. The Basic Geological Survey was commenced in May, 1977. The survey was performed to confirm geology and structure of the selected areas by geological survey and geochemical survey, to select two favorable areas of Chamelecon and Petoa as the high potentiality areas for mineral resources. Conducting geological survey with trenching, geophysical prospecting by IP method, geochemical survey and diamond drilling, as well as examining the reported data in the past and UNDP survey results, it has been ascertained, after confirmation of the distribution and the alteration of the rocks at depth and the characteristics of the mineralization, that these areas are favorable for the mineral resources of various types as disseminated copper type, vein type, contact replacement type and weathered residual type.

In the present year, the works of detailed geological survey and diamond drilling have been conducted, for the confirmation in detail as for geology, structure and mineralization, in the four areas of Vueltas del Rio, Minitas, Laguna Seca and Pueblo Nuevo, selected as the favorable areas for the mineral resources where further investigations were thought to be required to make clear of the igneous rocks related to the mineralization and of the geological features concerning alteration and mineralization.

1-2 Outline of the Survey Works

1-2-1 Area of the Survey (Refer to Fig. 1)

The survey area is located about 75 km southwest of the town of San Pedro Sula and includes 4 areas totalling 15 km^2, two of which are Vueltas del Rio and Laguna Seca, situated in the western part of the survey area of the first phase, and another two of which are Minitas and Pueblo Nuevo in the eastern part of it.

1-2-2 Detailed Geological Survey

Outline of the geology and the structure and the outline of the mineral indications of the selected four areas had been comprehensively grasped by the first phase surveys comprising detailed geological survey, geophysical prospecting (IP method) and diamond drilling carried out in the last year, in addition to the results of the UNDP surveys. As the areas are covered with thick vegetation and rock exposures are poor due to remarkable alteration on the surface, trenching was carried out in each area using bulldozers, total length of which reaches 11 km. The areas were mapped geologically with small compasses and measuring tapes in a scale of 1 to 5,000, while detailed geological mappings of the scale over 1 to 2,000 were employed in such special areas as around the indications of metal mineralization and around the old workings. In the areas containing remarkable

indications of mineralization, systematic sampling was done and the samples were forwarded to the chemical analysis and to the research of the mineral paragenesis and the alteration by X-ray analysis and under microscope. Special efforts were paid in this year's survey to the confirmation of the extention of stratigraphical units and of their roles for the mineralization, after precise stratigraphical subdivision and persuit of each bed as much as possible, though it was hard to distinguish each bed lithologically due to heavy weathering and remarkable alteration.

These fieldworks were performed by Japanese 3 members with geologists of the Dirección General de Minas e Hidrocarburos of the Republic of Honduras, for about 4 months.

1-2-3 Diamond Drilling

Based on the information obtained through the geological survey and others up to last year, consideration was given for the determination of the locations of the drill holes, and diamond drillings with total length of 2,905.9 m of 8 holes were completed as follows;

5 holes, total length 2,004.1 m in Vueltas del Rio Sector and

3 holes, total length 901.8 m in Minitas sector.

The term for the drill-works was 124 days from June 5th to October 6th in 1978.

A survey member in charge of the drilling was sent in advance to the field of La Flecha on 15th of May, 1978, and did the inspection of the drill machines, and the observation of the actual locations for the drilling. Drill-sites were arranged. Another 6 drill-members and 1 geologist arrived on 5th of June, according to the schedule of the delivery, at the port, of the materials and supplemental parts and tools as well as mud-materials. Thus construction works were commenced. Construction of the access roads and the drill sites by bulldozer and preparation of water necessary to the

drilling were required in both areas. Two drill machines of TGM-5A were used. (Its capacity of drilling is 510 m in final NQ size and 660 m final BQ size) The machines were operated by wire-line method, through three shifts per day, each shift comprising 8 hours. Bentonite-mud water was used for the drilling. Transportation of water was done by tank truck. The top part near surface was drilled with metal bits without consuming water, and the attempt to recover as much cores as possible was successful. The total core recovery was 92.1 %.

After completion of the drilling for four months, the cores and the machines were stocked in the warehouse in the sites at La Flecha, as done before, and all the members returned to Japan on 6th of October.

All the cores were logged as for lithology, alternation and mineralization, and the data were recorded on the core-logging charts of the scale of 1 to 500. Systematic sampling was carried out with the drill cores to confirm the grade of mineralization. The samples were analysed in Japan and also at the Direccion General de Minas e Hidrocarburos of the Republic of Honduras.

1-3 Members of the Survey Team

Members of the survey team are as follows.

Japan side;

Leader	Tadashi Sakuma	MESCO, Inc
General Affairs	Sadayuki Nagahata	JICA
	Takeo Kuroko	MMAJ
	Hisamitsu Moriwaki	MMAJ
	Yukio Harada	MMAJ
Survey Member	Junnosuke Oikawa	MESCO, Inc.
	Jinichi Nakamura	MESCO, Inc.

Liaison representative	Kiyohisa Shibata	MESCO, Inc.
in the field	Harukichi Shimode	MESCO, Inc.
Survey member	Kaneo Shitagaki	MESCO, Inc.
	Hisashi Shimizu	MESCO, Inc.
	Yoshio Obara	MESCO, Inc.
	Tsugio Kita	MESCO, Inc.
	Munenori Ohnuki	MESCO, Inc.
	Shigeo Sekiguchi	MESCO, Inc.

Honduras side;

Ing.	Sergio I. Vicencio	Departamento de Geologia	(DGMH)
Ing.	Jose M. Gutierrez	Departamento de Geologia	(DGMH)
	Danilo Vasquez	Departamento de Geologia	(DGMH)
	Francisco Galeano	Departamento de Geologia	(DGMH)
	Porfirio Zuniga F.	Departamento de Geologia	(DGMH)

Honduras counterpart changed members at times for the partnership of the whole survey works.

JICA: Japan International Cooperation Agency

MMAJ: Metal Mining Agency of Japan

DGMH: Direccion General de Minas e Hidrocarburos

Chapter 2 General Consideration

2-1 General Geology of the Survey Area

The survey area is located near the border to the Republic of Guatemala, in the northwestern part of the Republic of Honduras, and is amid the mountainous land in the middle-stream of the Chamelecon River flowing north to the Carribian Sea.

The area surveyed in this year is situated in the hilly highland of the altitude of 200 to 650 m above sea level, the southern part of which forms steeply undulating mountainous land.

The survey area belongs to geostructural unit of Sierra of Northern Central America and is underlain by Paleozoic metamorphic rocks, Mesozoic sedimentary rocks and igneous rocks intruding them, although they are covered by Tertiary volcanic rocks in the southern part.

The area surveyed in this year comprises 4 sectors -- Laguna Seca, Vueltas del Rio, Minitas and Pueblo Nuevo.

Paleozoic metamorphic rocks, which are distributed in the northern part of each survey sector generally with the trend of east-west, are composed of such metamorphic rocks originated from pelitic sediments as mica schists and black schists. Along the north side of these schists, more highly metamorphosed green schists are there, while in the eastern side metamorphic rocks including gneisses partly are distributed.

Along the southern side of the aforesaid 4 sectors, limestone beds of Atima Formation, which belongs to the Mesozoic Cretaceous Yojoa Group, are well developed, and in the area between the Atima limestone beds and the Paleozoic metamorphic rocks, metamorphosed sedimentary rocks composed mainly of pyroclastic rocks, belonging to the Vueltas del Rio Formation and Minitas Formation, are distributed.

The Vueltas del Rio Formation is composed mainly of volcanic rocks and pyroclastic rocks of acidic to basic character, and is developed in the Vueltas del Rio area and partly in the Laguna Seca area. The rocks belonging to this Formation are weakly metamorphosed and the development of schistosity is observed. They are complicatedly folded with the axis of east and west, and bounded with fault to the Paleozoic metamorphic rocks.

The Minitas Formation is composed of metamorphosed andesite and its pyroclastic rocks of medium composition, in addition to partly found dioritic porphyries, and is distributed in the Minitas sector and Pueblo Nuevo sector. Granodiorite intruding them is observed in the Minitas area, while the distribution of liparite is seen with the covering by the Atima limestone beds in the northern side of the Pueblo Nuevo sector.

Intruding the Vueltas del Rio Formation, dykes and stocks of diabase, andesitic porphyrites, quartz porphyry and dacitic porphyry are observed. The areas with abundant dykes and stocks are seen accompanying remarkable alteration as sericitization, silicification etc., which makes it hard to estimate original rocks.

In the Minitas sector, there are mineral indications of iron-copper-lead-zinc with skarn minerals, along the contact zone of limestones with dykes of granite porphyries intruding in the direction of south east to northwest.

In the Pueble Nuevo sector, copper-lead-zinc mineral indications are found in the contact zone of limestone beds with igneous rocks.

Meanwhile, in the Vueltas del Rio area, mineral indication of copper-gold and partly of lead-zinc minerals have been found in the metamorphosed tuff breccia and metamorphosed tuff. It is thought that these mineralizations would have occurred in the same period as the activities of parts of the aforesaid dykes.

2-2 Geological Survey

In this year, detailed geological survey was carried out in the selected four areas --- Vueltas del Rio sector, Minitas sector, Pueblo Nuevo sector and Laguna Seca sector, and the survey was extended to investigation of the geology in the surrounding areas and of the mutual geological relation of these four areas. It is especially noted that subdivision of the Vueltas del Rio Formation was attempted successfully in addition to the survey results obtained up to last year's survey, in spite of the estimation of the original rocks due to remarkable alteration, and that igneous rocks were classified as precisely as possible with the Minitas Formation.

2-2-1 Vueltas del Rio Sector

In this sector, the Vueltas del Rio Formation is distributed predominantly, with small amount of the Atima limestone beds inthe southern part.

(1) The Vueltas del Rio Formation is the formation mainly of volcanic rocks and pyroclastic rocks composed of the beds of metamorphosed tuff breccia, tuff, welded tuff, andesite, conglomerate, shale and schalstein. According to the fact that this formation is weakly metamorphosed, it has been clarified that the formation would possibly be correlated to Paleozoic group rather than El Plan Formation (Jurassic), which is composed of sedimentary rocks without accompanying volcanic activities. In another words, each layer of these metamorphosed tuff breccia, tuff and andesite has several cycles of alteration and the total thickness reaches over 700 m, with the insertions of conglomerate and shale layers, and therefore it is thought that there would have been geohistory in which several igneous activities were included. Cantarranas Formation, Atima Formation and Guare Formation are composed of Jurassic to Cretaceous sedimentary rocks mainly of limestones, distributed in this area, and are not accompanied with igneous activities. Therefore, the Vueltas del Rio Formation is thought to have been formed by

the accumulation of volcanic rocks and pyroclastic rocks which were brought about by several cycles of basic to acidic igneous activities, after the formation of the mica schists distributed near the Chiquila village and of the black schists with limestone insertions, and the metamorphism to the Formation would have taken place at the end of Paleozoic Era.

(2) It has been ascertained that the Vueltas del Rio Formation reveals synclinorium with the axis of east and west trend. Schistosity develops well and remarkable foldings are seen with the strike of steep dipping beds to extend east-west or northeasteast-southwestwest. Prominent directions of faults and fissures are NE-SW and ENE-WSW though those of EW trend are often observed along the stratigraphical orientation. The directions of the dykes are also as above, and fracture zones of east-west trending are developed in some places.

(3) As for alteration, though in the northern part chloritization and silicification are recognized only indistinctly, such alterations as sericitization, silicification and argillization are extensively observed in addition to the strong tropic weathering shown by carbonatization, argillization and limonitization.

(4) Dykes and stocks of diabase, andesitic porphyrite, quartz porphyry and dacitic porphyry are seen in the direction of east-west and northeast-southwest. They are altered by chloritization and silicification. However, the distribution pattern is not likely to be related particularly to the mineralization or to the geological structure.

(5) Remarkable mineralization as for copper, gold, lead and zinc has been found associated with quartz, calcite,clay minerals etc., along the fracture zone and fissures developed inthe metamorphosed tuff breccia and tuff. In a zone extending east-west in the central part of the area, old working and remains of trenches for gold are seen scattered, and by the UNDP geochemical

survey results, a special zone containing Au 1 g/t to 3.0 g/t has been detected in an area of the width of 300 m with the extension of 1200 m, which shows extensive oxidation zone or secondary enrichment zone as for gold.

2-2-2 Minitas Sector

(1) The Minitas Formation, forming the basement in this area, is composed of fine to medium grained metamorphosed andesite and andesitic pyroclastic rocks with granodiorite intruding them. The metamorphic andesite has various lithofacies from microdiorite to porphyritic rocks, accompanying pyroclastic rocks as metamorphosed tuff, tuff brecia and so on. They were grouped as diorite in the survey reports up to last year's, because of the difficulties of the determination concerning the lithofacies of these rocks including the dykes of the later stage. In the present year, the subdivision of the rocks has been attempted as precisely as possible, and by the results of such subdivision, the following geohistory of the igneous activities has been ascertained. Extrusion of andesitic rocks and their pyroclastic rocks --- Intrusion of granodiorite (Extrusion of liparite) --- Metamorphism --- Sedimentation of the limestone bed of the Atima Formation --- Intrusion of the dykes of granite porphyries --- Mineralization.

(2) To say about structure, the metamorphosed andesitic rocks and the granodiorites are developed fundamentarily in the east-west trending, though they are covered unconformably by the Atima limestone beds. The directions of faults and dykes are basically northwest-southeast, which is represented by the results of geochemical survey and geophysical prospecting.

(3) The dykes of the granite porphyries are seen in the directions of east-west and northwest-southeast, giving remarkable skarnization in the surrounding rocks. Along the contact zone between the limestone and the metamophosed andesitic rocks as the basement in this area, mineralization of hematite, chlorite and epidote is sometimes found with the width of

several meters though no conspicuous mineralization has been recognized. As for the mineralization in this area, there are many indications of mineralization of copper iron, lead and zinc associated with skarn minerals mainly of garnet along the contact zone between limestone and the dykes of granite porphyry, of which the existence of the remarkable mineralizations have been recognized in the Macutalo area and in the Minitas area.

2-2-3 Pueblo Nuevo Sector

(1) The anomaly of a little high intensity caught in the north side of this area by the IP survey coincides with the area where liparite body occupies, and there is no direct relation of the anomaly with the mineralization. This liparite is seen intruding the metamorphosed andesitic rocks and covered with the limestones. Therefore the formation of this liparite is thought to have been at the similar period as the formation of the granodiorite intruding the metamorphosed andesitic rocks in this Minitas sector.

(2) As the mineralization in this area, indications of copper, lead and zinc are recognized in veins or as layers in the limestones along the boundary between such limestones and liparite or base rock, at the points of Santa Ines, Santo Domingo, Esperanza and so on. These indications are likely to be related to the faults and fissures of the trends of east-west and northeast-southwest. It is notable that they are found stratigraphically at the base of the limestones. No indications of mineralization have been found to be related directly to the dykes of granodiorites and andesites trending north-south or northeast-southwest.

2-2-4 Laguna Seca Sector

(1) The area is situated at the western end of the area occupied by the Vueltas del Rio Formation. In the southern side, metamorphosed andesitic rocks are distributed, while diabase, rather weakly metamorphosed tuff breccia, tuff are well developed in the northern side. As this metamor-

phosed andesite is lithologically similar to the metamorphosed andesites of the Minitas Formation, it is inferred that the Vueltas del Rio Formation and the Minitas Formation would have been the accumulation of the products caused by the igneous activity of the same period.

(2) The Paleozoic strata in this area are composed of mica schists, black schists and limestone beds, and are bounded with the Vueltas del Rio Formation by the faults of the trends of eastnortheast-westsoutheast or east-west, and therefore no direct stratigraphical relation of them has been confirmed.

(3) Along the abovesaid fault, the intrusion of liparite and the dykes of the andesite which intruded the metamorphosed andesite and the overlying Atima limestone beds are found. Their intrusions are thought to have been after the sedimentation of the Atima Formation. The faults of the trends of east-west and eastnortheast-westsouthwest are developed well in this area, which are seen confining the distribution of the Atima limestone beds as seen in the southern extension, limited by such fault.

(4) There is no remarkable indication of mineralization in this area, although pockets of the alteration composed of quartz and hematite are found in several localities along the margin of the dioritic porphyry.

2-3 Diamond Drilling

2-3-1 Vueltas del Rio Sector

By the fresh rock brought about by the drilling, the lithological determination of the rocks, which used to be very difficult about the rocks found on the surface, has become possible to a certain degree, and also the information on the lithofacies, the alteration and the distribution of ore grade at the depth has been obtained.

(1) Oxidation and secondary enrichment are observed to reach the depth of 140 to 200 m below the surface. Especially alteration such as carbonatization,

argillization and sericitization is remarkable in this oxidized zone. At the depth, chloritization, silicification and partly sericitization are found, and so it is thought that there is difference of alteration according to the depth.

(2) By the lithological classification of the rocks at the depth, tendency of the distribution of the metamorphosed tuff and metamorphosed tuff breccia has been confirmed. Especially, by the result of the attempt of the structure analysis taking the metamorphosed andesite to be a key bed, it has been inferred that the Vueltas del Rio Formation forms a synclinorium with the axis trending east and west. Through the diamond drilling carried out in the last year's survey, it was thought that the copper grade would rise higher at the depth. However, by the result of the diamond drilling in the present year down to more than 300 meters, it has been confirmed that copper grade would not necessarily have tendency to rise at the depth, though a zone containing high grade of zinc has been caught.

(4) By the diamond drilling completed in the present year's survey, remarkable indications of copper, gold and zinc mineralization have been confirmed in the drill holes No. 53-1, No. 53-2, No. 53-3 and No. 53-4. They are several indications of vein type mineralization containing more than 1% of copper along the width of 2 meters and in addition to the veinlet and dissemination part of the copper grade of 0.122% in average over 22 meters. Also, indication of gold mineralization has been caught in veins contained in the metamorphosed tuff breccia and tuff, as is the case of copper. There, gold is contained as electrum composed of gold and silver, associated with copper, lead and zinc.

Indications of predominant mineralizations caught in the drill holes completed in this year are as follows;

Hole No.	Depth(m)	Length(m)	Assay results Cu(%)	Zn(%)	Au(g/t)	Ag(g/t)
53-1	96-98	2	1.28	0.12	-	-
53-2	6-8	2	-	-	44	-
53-2	173-174	1	5.94	-	97	80
53-2	6-38	32	-	0.11	-	-
53-3	104-126	22	0.122	-	-	-
53-3	46-48	2	-	1.85	3.3	-
53-3	68-70	2	-	0.48	3.72	-
53-3	146-150	4	-	1.78	1.3	-
53-3	40-84	44	-	0.22	-	-
53-4	108-110	2	1.59	-	-	-
53-4	90-92	2	-	1.84	0.76	-
53-4	436-486	50	-	0.11	-	-

(5) These mineral indications are mostly emplaced in the metamorphosed tuff breccia and partly tuff in the shallow part less than 200 meters below surface, corresponded with the oxidization zone or secondary enrichment zone, where sericitization and argillization are remarkable. Ore minerals are chalcopyrite, sphalerite, galena, tetrahedrite and electrum with pyrite. Gangue minerals are quartz and calcite with occasional white clay.

2-3-2 Minitas Sector

(1) The metamorphosed andesitic rocks have been subdivided, by the fresh rocks at the depth caught by the drilling, into metamorphosed andesite, andesitic tuff breccia, welded tuff and granodiorite, granite porphyry, diroite porphyrite etc. of the later stage. Of the skarnization, the skarnization associated with dykes of the later stage as granite porphyry and granodioritic prophyry rather than metamorphosed andesitic rocks is

remarkable. Along the contact zone of the limestones with the older metamorphosed andesitic rock, nothing more than aggregates of hematite, chlorite and epidote have been formed, as seen in the drill hole No. 53-6. No mineralization has been recognized in this case.

(2) The mineralization found along the length of 90 meters from the depth of 6 meters to 96 meters has been confirmed to be the skarnized zone containing quartz, calcite, dolomite and chlorite in addition to garnet, actinolite and epidote, with the insertions of limestone and granite porphyries. Ore minerals are chalcopyrite, sphalerite, galena, magnetite and copper-oxide minerals. Mineralized parts containing marked grade of copper are as follows;

Hole No.	Depth(m)	Length(m)	Skarn mineral	Assay results	
				Cu(%)	Zn(%)
53-7	68-70	2	andradite	0.35	-
53-7	80-82	2	andradite	0.09	0.68
53-7	86-88	2	actinolite	0.68	-
53-7	90-92	2	actinolite	1.21	-

(3) Although the metamorphosed andesitic rocks have been subdivided lithologically into welded tuff, tuff breccia, andesite, microdiorite and dykes intruding them, it has been impossible to presume the geological structure of the basement rocks because the number of the drill holes is not sufficient. However, it has been inferred that the area where remarkable mineralization can be seen is underlain by the basement of complicated structure accompanying abundant dykes, while the geology of the other areas poor in mineralization is structurally and lithologically simple.

(4) The limestone found along the length of 3 meters from the depth of 288.7 m of the drill hole No. 53-7 is seen overlying the grey granular tuff, as a member of the basement metamorphosed andesitic rocks, and is in contact with

diorite porphyry on its top, although it has been impossible to determine its age due to heavy alteration. On this limestone, the following three cases are considered; (1) the limestone is a part of the Atima limestone beds, which appeared in the lower position by the fault movement, because there are many fracture zones in the surrounding areas; (2) the limestone is a part of the limestone beds contained in the older metamorphic rocks which has been brought to this point by dykes; (3) the limestone is a part of the limestone beds probably contained in the black schists distributed right below this limestone. Be it may any case, it is difficult to determine the geological position of this limestone with only one drill hole. Further study will be expected.

Chapter 3 Conclusion and View to Future Program

3-1 Conclusion

The present survey has been carried out as the third stage of the Basic Geological Survey for the Development of Mineral Resources in the western part of the Republic of Honduras. As the first stage, the geological survey and the geochemical survey in the total area of 1,000 km^2 in addition to the detailed geological survey and geochemical survey in the selected two areas of Chamelecon area and Petoa area were performed. In the second stage of the survey, the geophysical prospecting (IP method) and the diamond drilling were carried out both in the Chamelecon area and in the Petoa area, and the geological distribution of rocks, geological structure and features of the mineralized parts were comprehensively grasped, as the result of which a contact zone of the Paleozoic crystalline schists with the Mesozoic sedimentary rocks and Atima limestone beds was selected as the remarkably mineralized part. Finally, the four areas included in this zone were extracted as the areas of high potentiality for the emplacement of ore deposits. The four areas are Vueltas del Rio sector, Laguna seca Sector, Minitas sector and Pueblo Nuevo sector. As the third stage of the survey, the detailed geological survey accompanied with trenching was carried out, and also diamond drilling was performed in the Vueltas del Rio sector and in the Minitas sector. The results obtained by such surveys are as follows;

(1) Southward from the northern part of the Vueltas del Rio sector and of the Laguna Seca sector in the western part of the whole survey area, the Paleozoic crystalline schist formation, the Vueltas del Rio Formation and the Atima limestone beds are distributed. The Vueltas del Rio Formation is composed of sedimentary rocks mainly of metamorphosed andesitic volcanic

rocks and pyroclastic rocks belonging to the igneous activities at the end of Paleozoic Era.

Meanwhile, in the eastern two areas of the Minitas sector and the Pueblo Nuevo sector, the metamorphosed andesite and andesitic pyroclastic rocks with granodiorite and liparite intruding them are distributed as the basement, and the Atima limestone beds are overlying them. In the southern part of the Minitas sector, Tertiary Matagalpa Formation covers them.

(2) The geological structure in every area is fundamentarily based on the trend of east and west. In the Vueltas del Rio sector, a synclinorium with the axis trending east and west can be seen and dykes, faults and fracture zones are well developed in the two directions of northeast-southwest and east-west. In the Laguna Seca sector the Paleozoic formation is bounded with the Vueltas del Rio Formation by the faults of the trends of east-west and eastnortheast-westsouthwest, and also the dykes and the faults are developed predominantly in the same two directions as above. In the Minitas sector, the structure of the basement rocks and the limestone in addition to the faults are predominantly trending east and west, with the dykes and faults remarkably developed inthe direction of northwest-southeast. Furthermore, in the Pueblo Nuevo sector, dykes and faults of the trends of northeast-southwest as well as of east and west are recognized.

(3) As for alteration, heavy weathering including carbonatization and argillization has made the identification of the lithfacies on the surface extremely difficult. Through the results of the attempt to subdivide the rocks by the fresh rocks caught at the depth by the diamond drilling, it has been confirmed that, in the Vueltas del Rio sector, the development of schistosity is remarkable with the hydrothermal alteration such as sericitization, silicification and argillization, while in the northern part and at the depth chloritization and silicification have been recognized, though

obscure. Also in the other sectors, carbonatization, silicification and in parts sericitization have been recognized.

(4) As for dykes, the following points are noted;

In the Vueltas del Rio sector, diabase, andesitic porphyrite, quartz-porphyry and dacitic porphyry are seen intruding the Vueltas del Rio Formation. They have been altered by chloritization and silicification. It is thought that their intrusion would have been associated with the igneous activities at the end of the Cretaceous Period, though some of them might have been at the end of the Paleozoic Era.

In the Laguna Seca sector, there are dykes of liparite and andesite, the intrusion of which are thought to have been at the end of the Cretaceous Period.

In the Minitas sector, the dykes of granodioritic porphyry, granite porphyry, diorite porphyrite and andesite are seen predominantly in the direction of northwest-southeast, intruding mainly the layers prior to the Atima limestone beds. They have a great role to the skarnization found in this area. As the skarnization is observed in the Atima limestone beds, their intrusion is thought to have been at the end of the Cretaceous Period.

(5) To summarize the geohistory of the present survey area, the followings are noted.

Sedimentation of psammitic sedimentary rocks and pelitic rock origin
↓
sedimentary rocks
↓
Metamorphism; Folding (Formation of the Paleozoic metamorphic rocks)
↓
Extrusion of volcanic rocks; Accumulation of shallow water sediments
↓
Metamorphism; Block movement containing folding and faulting (Formation of the Vueltas del Rio Formation and the Minitas Formation)
↓
Sedimentation of the shallow water carbonate rocks (Formation of the Atima Formation etc.)
↓

Intrusion of granite prophyry and other dykes (Mineralization)

↓

Upheaval block movement along the Chamelecon fault

↓

Extrusion of the Tertiary volcanic rocks

(6) Mineralization

The following remarkable indications of mineralization have been detected in the present year's survey.

a) Indications of veinlets and dissemination type copper-gold-zinc mineralization, contained in the metamorphosed tuff breccia and tuff of the Vueltas del Rio Formation;

. The old workings for gold found on the surface

. The indication of copper mineralization in the hole No. 53-1

. Three indications of gold, copper and zinc mineralization in the hole No. 53-2

. Five indications of copper, gold and zinc mineralization in the hole No. 53-3

. Two indications of copper and zinc mineralization in the hole No. 53-4

b) Indications of skarnized copper mineralization in the Atima limestone bed in contact with granite porphyries, in the Minitas sector;

. Four indications of copper mineralization in the hole No. 53-7

. A surface exposure of copper and zinc mineralization in the Minitas valley (skarnization has not been confirmed yet)

. Exploration area at Macutalo of copper, lead, zinc and iron mineralization

. An indication at Petoa I of iron mineralization (skarnization not confirmed yet.)

c) In the Pueblo Nuevo sector, indications of veinlet and layered copper, lead and zinc mineralization along the base of the Atima limestone beds;

Four indications of the old workings and the surface exposures.

d) In the Laguna Seca sector, masses of alteration and silicification have been confirmed at several localities in the diorite porphyrites, but no real mineralization has been discovered yet.

7) It can be said from the above-mentioned evidences that the nost favorable mineralization for the emplacement of ore deposits in the present survey area is the veinlet and dissemination type mineralization found in the Vueltas del Rio sector. The indications of this type of mineralization have been found mainly in the fracture zone in the shallow part less then 200 m below surface, contained in the rocks altered by sericitization etc., with poor schistosity.

In the Minitas sector, the favorable skarnization would be expected in the contact zone between the limestone beds and dykes as granite porphyries trending northwest-southeast and east-west.

3-2 View to Future Program

The survey area is the area where it is very difficult to establish concrete relation among the lithological facies and layers and to find out indications of mineralization by the surveys on the surface only because of the poor exposure due to thick vegetation and heavy weathering. Therefore, trenching with bulldozers and diamond drilling were quite appropriate and effective as the methods of exploration in the area. Through the surveys carried out in the present year, the geology, the structure and the alteration of each extracted area have been ascertained, and many informations on the potentiality of the other areas and on the methods of exploration have been obtained in many points. Also, many favorable indications of gold, copper and zinc mineralization have been discovered by the diamond drilling and by the detailed geological survey in the Vueltas del Rio sector and in the Minitas sector. In future, it is desirable that the following methods of

exploration will be employed for further investigation of the mineral potentiality after extracting the most favorable areas for the emplacement of ore deposits.

a) Vueltas del Rio Sector

By the results of the investigation by the drill cores containing mineralization, of the drill holes No. 53-1, No. 53-2, No. 53-3 and No. 53-4, the followings are noted; that most of the indications of mineralization exist in secondary enrichment zone in the shallow part less than 200 m below surface while mineralization is rarely found at the depth more than 300 m below surface, that the mineralization is composed of veinlets and dissemination, that the area where the rocks with weak schistosity are distributed are favorable for the mineralization, that the areas with remarkable alteration and fractuation on the surface are favorable, and that the favorable areas are within anomalies detected by the geochemical survey.

Accordingly, a zone 600 m wide in east-west and 1200 m in extension, linking the drill holes No. 53-3 and No. 53-2 should be considered to be the most favorable zone as the particularities of this zone are coinciding the above-mentioned notes. It is recommended therefore that 5 to 8 holes of diamond drilling will be conducted in this zone to delineate the veinlet and dissemination type copper-gold mineralization and to confirm the ore reserves. Also, the exploration including detailed surveys on the surface by pitting and trenching is necessary to obtain informations on the behavior of gold near the surface and to appraise the potentiality for gold ore deposits economically. Furthermore, as the area to the east of the present detailed survey area is the plain where the Chamelecon River is meandering, diamond drilling of several holes will be necessary in this broad plain to the east of the area surveyed in the present year, in order to obtain informations how far the eastern extension of the Vueltas del Rio Formation

can be expected, how the features of alteration and mineralization are there, how the change of the anticlinorium goes and whether any igneous rock related to the mineralization exists. (Ref. Fig. 4)

b) Minitas Sector

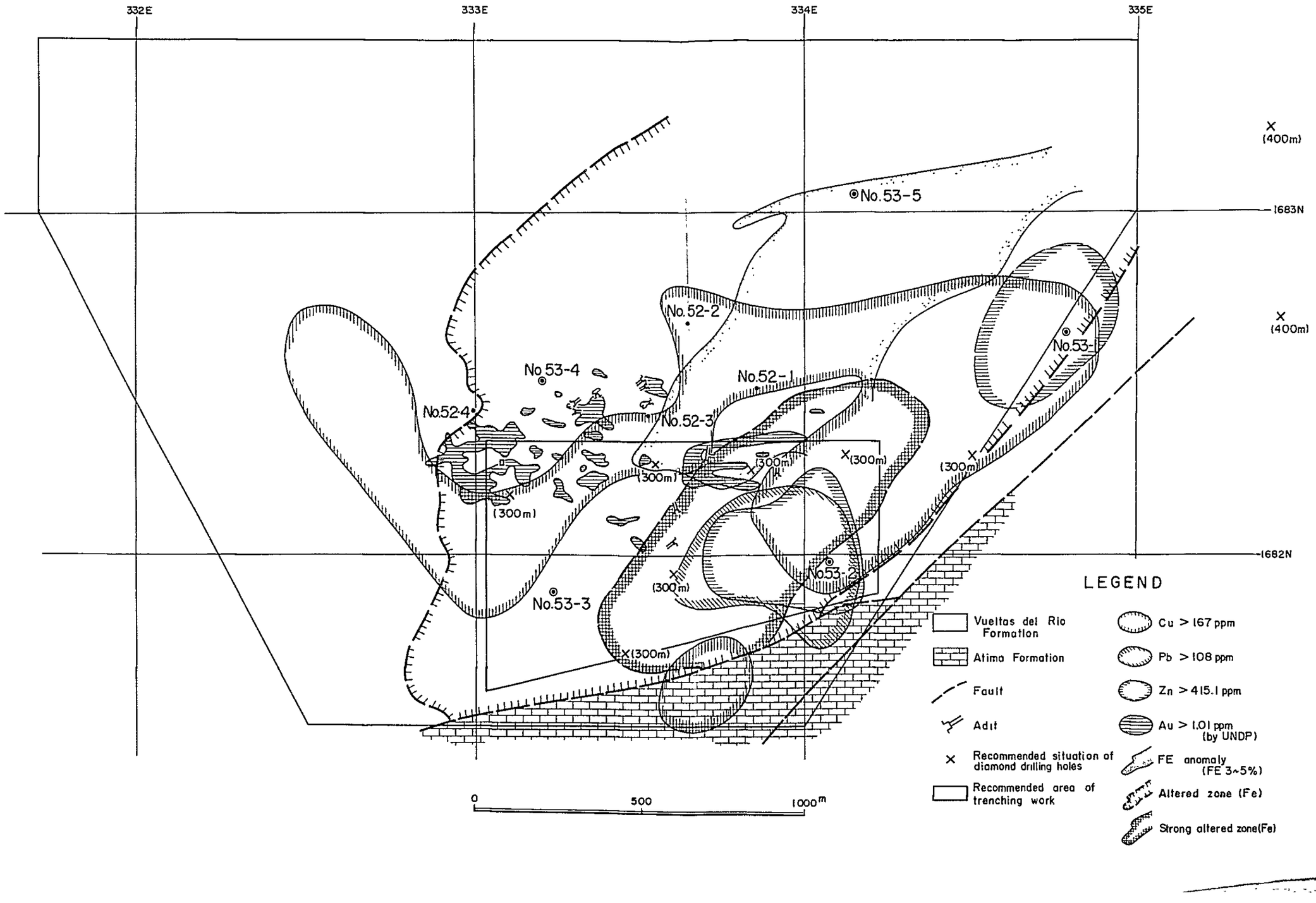
As it has become evident that the main mineralization is confined in the contact zone of the limestones and the dykes of granite porphyries, and as the concrete methods for the exploration of this type of mineralization are established in good order, the investigation by detailed trenching and detailed diamond drilling will be recommended to confirm the scale and the ore grade of the mineralization.

c) Other areas

In the Pueblo Nuevo sector, it is recommended to employ trenching and detailed geological survey around the known old workings and exposures of mineralization for the confirmation of scale and ore grade of the mineralization. However, consideration for the exploration in this area should be given according to the characteristics particular to the indications in this area, after seeing the results of the exploration to be carried out in the former two areas.

Fig. 4

Recommended exploration program for Vueltas del Rio Sector



PARTICULARS

PART I GEOLOGICAL SURVEY

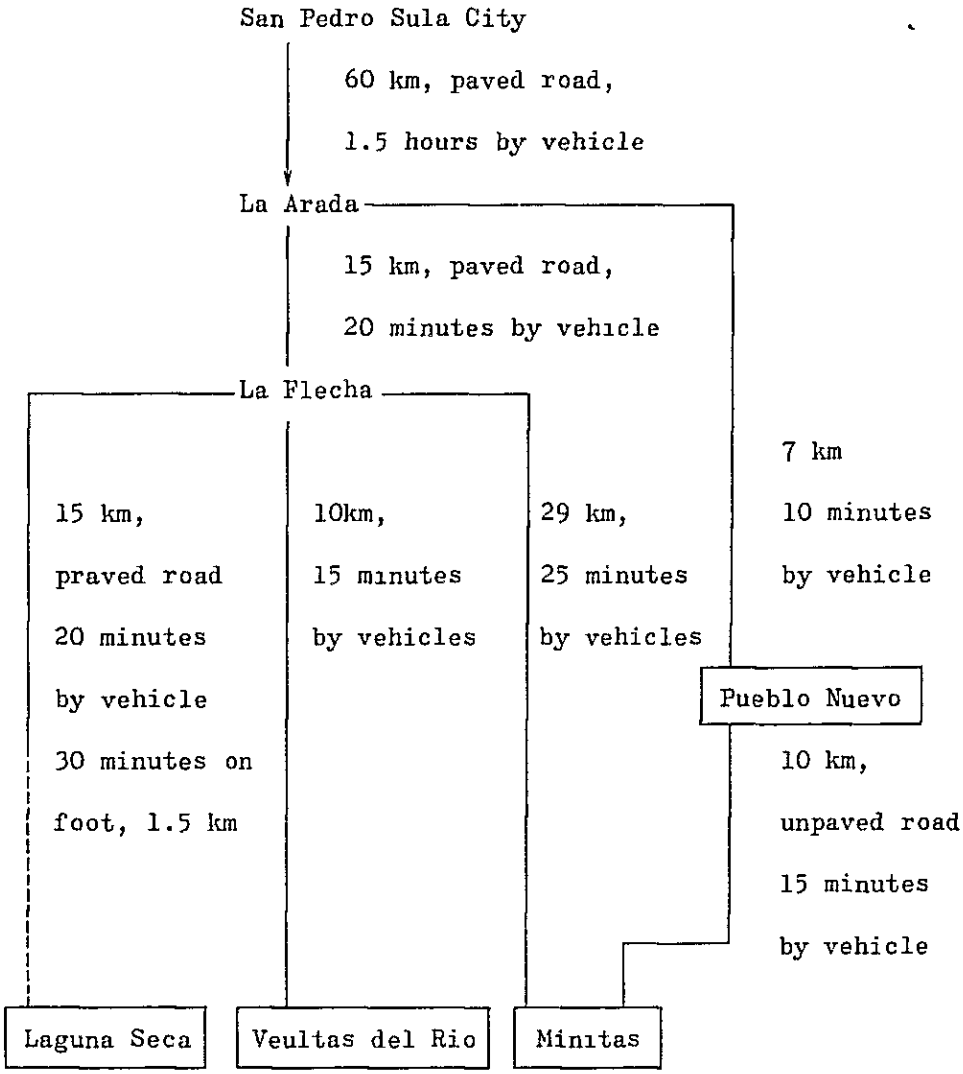
PART I GEOLOGICAL SURVEY

Chapter 1 Outline of the geology

1-1 Geography of the Survey area

The present survey area is located in the northwestern part of the Republic of Honduras, about 75 km southwest of the town of San Pedro Sula (the largest commercial and industrial town in the Republic of Honduras), from which about one and a half hours' drive by vehicles on the sealed road is necessary to get to the survey area. The survey area is hilly mountainous land of the altitude of 200 to 650 m above sea level, though the southern part of it forms steeply undulating mountainous land, with the covering of the Tertiary volcanic rocks. The area is covered with vegetation of pine trees and miscellaneous woods and is utilized as pasture. The lowland is also utilized as farm land, as well as pasture, for sugar cane, corns and fruits. The climate is tropical, as the area is situated in latitude about 15^{o} north. The rainy season is from June to October with the annual rainfall of about 1,000 mm in average.
It is very hot in the term from May to August, as the temperature is high as over $30^{o}C$. The average annual temperature is about $25^{o}C$.
There are dangerous creatures like venomous serpent, scorpion, tick in the survey area, but no malaria has been found in spite of dengue fever contagion.

To the four survey areas, access is as follows.

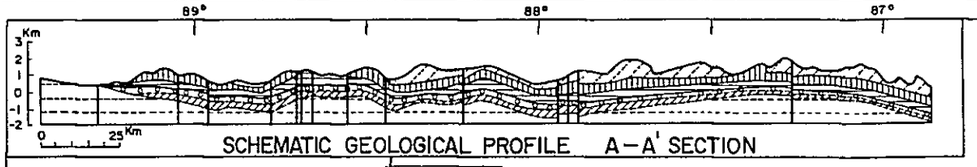


1-2 Geology and Stratigraphy (Ref. Fig 2, Fig 3)

The geology of the Republic of Honduras is composed of three tectonic blocks. Firstly, the block of Sierra of Northern Central America, extending to the territory of Guatemala, occupies most of the central and western part of the Republic. Secondly, along the coast of the Pacific Ocean, there is a Quaternary volcanic region extending northwest-southeast, forming the block of Pacific Volcanic Chain. The third tectonic block, Volcanic Range and Plateau, occupies the area between the first and the second tectonic blocks, where mainly Tertiary volcanic rocks are distributed.

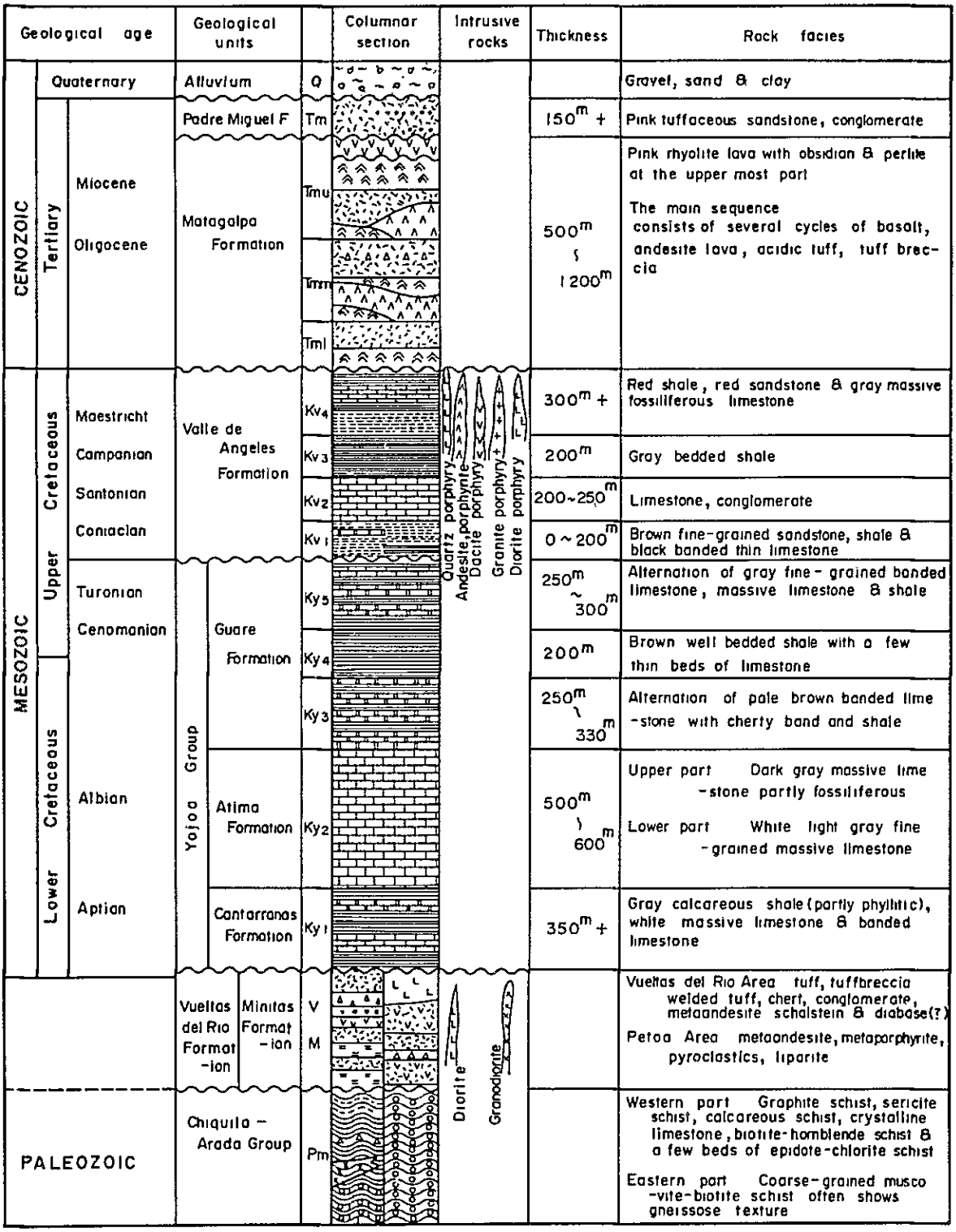
Fig. 2

GEOTECTONIC MAP OF REPUBLIC OF HONDURAS, C.A.



(Quated from MAPA GEOLOGICO DE LA REPUBLICA DE HONDURAS, 1:500,000, 1974.)

Fig. 3 SCHEMATIC GEOLOGICAL COLUMN OF THE SURVEYED AREA



The survey area belongs to the block of Sierra of Northern Central America, which is composed of Paleozoic metamorphic rocks, Mesozoic sedimentary rocks and igneous rocks intruding them, covered partly by the Tertiary volcanic rocks.

1-2-1 Paleozoic formations (Chiquila-Arada Group)

Concerning the present survey areas, distribution of the Paleozoic formations such as mica schists, black schists, limestone etc. has been observed in the Laguna Seca sector, while the Paleozoic formations including mica schists, gneisses, graphite schists, black schists and limestones are distributed in the neighbouring areas to the north of the other three sectors. The metamorphic grade is higher in the east and in the north.

Horne et al. (1976) stated as follows; "The Paleozoic formations found in the area(including the present survey areas)are composed of gneisses, mica schists, phyllites and submylonites, carrying wide ranges of minerals containing generally amphibole, calcium-plagioclase and epidote, which are indicative of almandine-amphibolite facies of the grade of regional metamorphism. On the other hand, the vicinity of Quimistan is underlain by the rocks of aluminous and arenaceous lithofacies showing low grade green schist facies of the regional metamorphism, which are comprising calcareous phyllites, sericite-chlorite schists, graphite schists, quartzites and crystalline limestones. In the area south of the town of Sula, there are quartz-feldspar-mica schists, and in the area further south, bedded schists of the low grade metamorphic psammitic and calcareous lithofacies such as calcareous phyllites, calcareous sericite schists and marble are distributed. Along the northern side, the rocks are of psammitic origin and highly metamorphosed while in the southern area the rocks are of pelitic origin and metamorphosed in rather lower grade."

The mica schists, black schists and marbles exposing in the Laguna

Seca sector are corresponded to the rocks of the pelitic origin metamorphosed in rather low grade. William et al.(1969) stated that the geological basement in the area consists of the Paleozoic mica schists, phyllites and quartzite, accompanying meta-volcanic rocks and ultramafic rocks in the northern part, which are thought to have been formed in or before the period of the Laramide orogeny. Horne et al.(1976) described that these basement rocks are composed of sedimentary rocks and volcanic rocks probably of pre-Pennsylvanian Epoch(before upper Carboniferous Period), which have been differently metamorphosed as for the grade, according to the locations, and that they were intruded by the plutonic rocks of the medium composition, overlain unconformably by the thick beds of muddy layers weakly metamorphosed before Jurassic Period.

The southern side of the Paleozoic basement rocks is limited by the fault bounding to the Vueltas del Rio Formation and no direct age relation can be obtained. As they are seen intruded by granite at a point of San Marcos, it is evident that they are older than the granite, the age of which has been determined to be 150 ± 13 m.y. by Rb-Sr isotopic method. Probably the formation of the pelitic origin weakly metamorphosed rocks, which Horne et al. described, would have been at the rather younger period of the Paleozoic Era as about Permian Period.

1-2-2 Vueltas del Rio Formation

This formation is exposed mainly in the Vueltas del Rio sector, as well as in a belt extending east and west with the width of 1 to 2.5 km in N-S, from Vueltas del Rio sector to Laguna Seca sector. The Vueltas del Rio Formation is composed mainly of basic to acidic andesitic or liparitic pyroclastic rocks with occasional insertions of shale, conglomerate and other volcanic rocks. They have been metamorphosed and schistosity develops well, with fine drag-foldings. Due to heavy alteration

by silicification, sericitization and argillization, it is extremely difficult to determine lithologically their original rocks on the surface. In this year's survey, emphasis has been laid to subdivide this Formation as precisely as possible to confirm the structure and the stratigraphy of this formation.

Although, in the last year's survey, fine grained rocks like tuff with well-developed schistosity in this formation was taken as phyllite while tuff breccia was treated as conglomerate and sandstone, it has been confirmed in this year's survey that the Vueltas del Rio Formation is composed of the sedimentary rocks such as volcanic rocks and pyroclastic rocks after classifying the rocks of the formation into metamorphosed tuff, tuff breccia, in addition to welded tuff, metamorphosed tuff containing quartzite layers, metamorphosed andesite, conglomerate, shale and schalstein. These beds have been intruded by the dykes of diabase, quartz porphyry, dacite porphyry and andesite and in the southern part they are in contact with the shallow water sediments of the Cantarranas Formation and the Atima limestone beds with unconformity or faults.

In the Laguna Seca sector, the distribution of the Vueltas del Rio Formation is small, and the development of schistosity as well as the alteration is rather weak. In the southern part, metamorphosed andesites and metamorphosed andesitic pyroclastic rocks are distributed and in the area further to the south there is the covering of the Atima limestone beds. These metamorphosed andesitic rocks are similar to the members of the Minitas Formation which forms the basement in the Minitas Sector, and therefore it is expected that the chronological relation of the Vueltas del Rio Formation to the Minitas Formation will be ascertained taking the metamorphosed andesites to be key beds.

The Vueltas del Rio Formation was, considering the component rocks to be mainly sedimentary rocks, correlated tentatively to the El Plan Formation in the last year's survey. However, viewing from the facts that it is composed of the sediments derived mainly from volcanic activities and that the development of schistosity is noted, it is thought that they would have been the products of the volcanic activity after the sedimentation of the crystalline schists, prior to the formation of the El Plan Formation, and therefore it would be thought that the period of the sedimentation and the metamorphism would have been around the Permian Period, but further study will be necessary for the chronological correlation of the formation.

1-2-3 Minitas Formation

The Minitas Formation is distributed as the basement over the area including the Minitas sector and the Pueblo Nuevo sector, and is composed of the metamorphosed andesites and their pyroclastic rocks with occasional dioritic porphyrite. In the Minitas sector, the formation is seen intruded extensively by granodiorite, while in the Pueblo Nuevo area liparite is observed to have intruded the formation.

They are overlain by the Atima limestone beds.

In the former reports, the volcanic rocks and the dykes were grouped together into one unit of "diorites", as the lithological determination of these rocks are extremely difficult due to heavy weathering on the surface, However, in the present year's survey, the subdivision of these rocks have been attempted.

The metamorphosed andesite is dark in color, showing porphyritic texture with the phenocrysts of feldspar and chloritized mafic minerals, and the andesites as well as their pyroclastic rocks are partly altered by epidotization, calcitization and argillization in addition to the regional metamorphism and the mylonitization such as chloritization.

Remarkable variation of the lithofacies is characteristic, from fine grained porphyritic facies to coarse grained dioritic facies. The granodiorite is distributed in irregular shape dominantly in the northern side of the Minitas sector, and is seen to have intruded the aforesaid andesite as dykes. As their forms are complicated and no reaction rim has been observed along the margin, the period of the intrusion is thought to have been not later than the formation of the metamorphosed andesites.

1-2-4 Yojoa Group

Cantarranas Formation; This formation is constituted by the alteration of grey limestone and schistose shale, distributed near Zapotal and near Chumbagua. The Formation is not developed in the present four survey areas.

Atima Formation; The formation comprises massive greyish white compact limestone beds, found in the four survey areas. By the fossils found in the beds of this formation, the age has been determined to be lower Cretaceous (Albian). In places, grey massive cherts with a few thin layers of sandstone and shale are inserted. The formation overlies unconformably the Vueltas del Rio Formation and the Minitas Formation and topographically it forms summits or sheer cliffs along hillsides. The formation show gentle dipping with the axis of east and west, and is in contact with the overlying Guare Formation with conformity.

Guare Formation; This formation is distributed in the southern area beyond the limit of the survey areas. Upwards from the lowest, the formation is composed of alternation of bedded limestone and quartzite, shale beds, alternation of bedded limestone and shale.

Valle de Angeles Formation; This formation is distributed in the southwestern area beyond the limit of the survey areas. The formation comprises shallow water sediments composed of alternation of sandstone and shale, limestone-

conglomerate beds, grey bedded shale, red beds of sandstone and shale. The age of the formation is said to be upper Cretaceous or early Tertiary.

1-2-5 Matagalpa Formation

This formation comprises great quantity of the Tertiary volcanic rocks broadly distributed in the southern side of the Minitas sector and in the area to the south of the other present survey areas.

Lower member; The member is composed of pyroclastic rocks found in the Minitas sector. Though there is variation of lithofacies at localities, basalt - andesite - tuff (rhyolitic, welded) are the main components in the area south of San Marcos.

Middle member; This member is composed of andesite, pyroclastic rocks, lapilli tuff, basalt lava flow and acidic tuff. Sometimes it is missing.

Upper member; This member is composed of basalt, tuff and rhyolite.

1-3 Igneous Activities

The igneous rocks found in this area are distributed in an area of 15 km in east-west by 5 km in north-south, roughly in the trend of east and west. They are found in and around the Vueltas del Rio Formation and the Minitas Formation, along the boundary zone of the Paleozoic metamorphic rocks and the Yojoa Group.

The Vueltas del Rio Formation comprises the sedimentary rocks composed mainly of pyroclastic rocks of tuff, tuff breccia, shale and metamorphosed andesites, and as they have been metamorphosed, the period of this igneous activity would possibly be Paleozoic. Dykes and stocks of diabase, andesitic porphyrite, quartz-porphyry and dacitic porphyry are seen to have intruded the Vueltas del Rio Formation.

The Minitas Formation has been confirmed to be composed of metamorphosed andesite and its pyroclastic rocks with granodiorite and liparite intruding them, after subdividing the rocks which had been grouped as a unit of diorites. Dykes of granite porphyry, diorite porphyry and andesite are found intruding the abovesaid rocks and the Atima limestone beds.

The isotopic age of the granodiorite (part of mica-hornblende-quartz diorite) in the Minitas Formation, determined by K-Ar method on the contained hornblende is 224 ±17 m.y., which reveals almost the same age of the northern mica schist's 222 ±8 m.y. As the metamorphosed andesites are older than the above, it is appropriate to place them to the formation in the Paleozoic Era. Viewing from the facts that the metamorphosed andesites in the Minitas Formation are similar to those of the Vueltas del Rio Formation lithologically, that no record of igneous activity can be found at the period of the formation of the El Plan Formation, and that the Vueltas del Rio Formation was metamorphosed, it would not be possible that the both formations were formed in the age of the sedimentation, the Mesozoic Era, but it is thought that the period of the formation would have been at the end of the Paleozoic Era, in which igneous activities were remarkable.

Diabase, quartz-porphyry, andesitic porphyrite and dacitic porphyry intruding the Vueltas del Rio Formation are the dykes of neutral to sub-acidic hypabyssal - plutonic rocks, similar to the quartz-diorite prophyry intruding the Cantarranas Formation in the area of Zapotal III to the west of the area, and the dykes intruding the Atima limestone beds is found to be andesite.

Meanwhile, the granite porphyry and the diorite porphyry, which brought about the skarnization in the area occupied by the Minitas Formation, are seen to have intruded the Atima limestone beds and the Minitas Formation,

and are thought to be the dykes of the age later than the Cretaceous Period, bearing the neutral to acidic composition. Such dykes are lithologically similar in the both areas.

Viewing from the facts that the Cantarranas Formation, the Atima Formation and the Guarre Formation comprise marine sediments mainly of calcareous compsition without accompanying igneous activity, that the Valle de Angeles Formation overlying them does not contain any kindof pebbles indicating igneous activity, and that the above dykes are not found in the Tertiary Matagalpa Formation, it is thought to be appropriate that the age of the intrusion of these dykes would be at the end of the Cretaceous Period, as mentioned in the reports of the last year's survey. Dykes of the andesites are seen to have intruded the Atima limestone beds in the Laguna Seca sector and in the Minitas sector, but in the Vueltas del Rio sector the period of their intrusion is thought to have been immediately after the metamorphism following the sedimentation of the Vueltas del Rio Formation. Especially, as the dykes of diabase are found in the northern side of the Vueltas del Rio Formation and are similar compositionally to the tuffs found in the surrounding areas, it is thought that there would have been little difference between the sedimentation of the Vueltas del Rio Formation and the period of the intrusion, which would be thought to have been immediately after the formation of it.

Although the mutual relations of the other dykes are not certain because of the poor availability of actual contact of them, it might be said that there would be some difference between the period of the intrusion of the porphyry dykes and that of the andesite, viewing from the fact that the dykes of the porphyries are found to have intruded mainly into the layer prior to the Atima Formation, though partly found in the Atima Formation, while the andesites are seen to have intruded into the upper part of the

Atima Formation.

Horne et al.(1976) said as follows; "The sedimentary rocks and volcanic rocks which were accumulated in the early to middle Paleozoic Era and regionally metamorphosed into almandine-amphibolite facies after deformed, are observed to have been intruded by the plutonic rock (Rb-Sr isotopic age: 305 ± 12 m.y.) of medium composition, partly metamorphosed. They are overlain unconformably by the thick beds of aluminous shale weakly metamorphosed before Jurassic Period. Another intrusion of plutonic rock (Rb-Sr isotopic age: 150 ± 13 m.y.) of neutral composition has been found to have occurred at San Marcos (northwest of Minitas) in the Jurassic Period. In Cretaceous Period, carbonate rocks were accumulated extensively. Plutonism mainly of granites occurred extensively in later Cretaceous to middle Tertiary Period, which accelerated the upheaval of the basement rock along the Chamelecon fault." Considering the above-mentioned items, it can be said that the volcanic rocks and the pyroclastic rocks of the Minitas Formation and the Vueltas del Rio Formation were extruded, formed and metamorphosed at or after the end of the Paleozoic Era but prior to the Jurassic Period, and that the activities of some dykes were at the period of the intrusion of the San Marcos plutonic rock. Also, it is thought that the intrusion of the dykes with the mineralization were there in the late Cretaceous to early Tertiary Period, after which extensive volcanic activity occurred to form the Matagalpa Formation.

The liparites found in the northern area to the Pueblo Nuevo sector are seen to have intruded the Minitas Formation, to have been intruded by acidic dykes and to have been covered with the Atima limestone beds. Viewing from the fact that the liparites are distributed in the area occupied by the metavolcanic rocks (quartz kelatophyre, lithic tuff, gabbro, anorthosite, etc.) appeared in the south of La Arada with the width of

about 15 km., as described by Williams (1969), it is thought that they were the products of the igneous activity corresponded to the period of the formation of the granodiorite found in the Minitas Formation.

1-4 Geological Structure

In the survey areas, the Paleozoic crystalline schists are distributed in the north, while the Mesozoic sedimentary rocks are found in the south, though the area further to the south is occupied by the Tertiary volcanic rocks. The distribution of these rocks from north to south is in the order of their age from the oldest to the younger. Through the areas, folds and faults are well developed with the predominant trend of east and west. The other structural lineations are ENE-WSW, NW-SE and N-S. The direction of east and west appears as the axis of the synclines and anticlines in the Paleozoic formations, as the axis of the synclinorium or as the trend of the dykes in the Vueltas del Rio Formation and as the main tectonic elements in the basement rocks in the Minitas sector. In many cases the trend of dykes are in this east-west direction. The boundaries of the Paleozoic schists --- the Minitas Formation --- the Atima Formation --- the Guare Formation --- the Valle de Angeles Formation are mainly in this east-west direction, and the foldings in these formations are with the axes of this direction. Meanwhile, in the Tertiary volcanic rocks of the Matagalpa Formation, which is mainly distributed in the area to the south of the survey areas, orientation of N-S or NNW-SSE are predominant. The lower part is found in the north and the upper part is in the south and in the east. Thus, the pattern of the tectonic direction and the distribution is considerably different from that found in the formations prior to the Valle de Angeles Formation.

As for the fault structure, the direction of east-west is predominant as above, and it is said that the most remarkable fault called Chamelecon fault bounding the Paleozoic formation to the Vueltas del Rio Formation is the thrust fault in the direction of east and west. There are many faults, fissures and dykes which are parallel to the beddings. However, there are many other faults and fissures trending other than east and west, in every area. In the Vueltas del Rio sector, there are many faults of the two directions of ENE-SWS and NE-SW against the synclinorium axis of east and west. In the Minitas sector, though the tectonism of the basement rocks and the distribution of the Atima limestones are controlled by the direction of east and west, the trend of the dykes are mostly NW-SE, which is more predominant than E-W. Viewing generally, dykes and faults are found concentrated along the southern marginal zone and the boundary zone, which indicate this zone would have been kept to be weak zone tectonically through the ages.

The geohistory of the structure in the survey areas is thought to be as follows;

- Accumulation of psammitic sedimentary rocks
- Intrusion of the plutonic rock of the neutral composition
- Metamorphism
- Accumulation of the pelitic origin sedimentary rocks
- Metamorphism
- Folding with the axes of the directions of E-W and ENE-SWS
- Extrusion and accumulation of volcanic rocks, accumulation of shallow water sediments (Original rocks of the Vueltas del Rio Formation)
- Metamorphism
- Folding, faulting, block movement (prior to Jurassic Period) Formation of geosynclinal structure with the axis of the direction of east and west

. Sedimentation of shallow water carbonate rocks (Yojoa Group)

. Folding

. Intrusion of granites and dykes (Period of the Laramide orogeny)

. Formation of faults

. Mineralization

. Upheaval of mass blocks along the Chamelecon fault

. Formation of the structure trending south and north

. Extrusion of volcanic rocks. (Tertiary)

. Block movement mainly of the direction of north and south*

* Development of the basin in north and south near Sula, associated with the Honduras depression. The basin structure developed extensively in this area in late Tertiary Period.

1-5 Mineralization

Information on the mineralization of the following types in this survey area has been obtained through the UNDP survey and the surveys up to the present year's.

A. Mineralization in the Paleozoic formations

--- Indication of gold mineralization associated with quartz vein in the chlorite schist, and indication of manganese mineralization in the black schist.

B. Mineralization in the Vueltas sel Rio Formation

--- Indications of veinlet and dissemination type copper, gold, lead and zinc mineralization, associated with dykes, metamorphosed tuff and tuff breccia etc.

C. Mineralization by the contact replacement between the porphyries and the limestone beds of Yojoa Group

--- Indications of copper, iron, gold, lead and zinc mineralization

associated with skarn minerals

D. Mineralization contained in quartz-diorite porphyry, diorite, liparite etc.

--- Indication of vein type copper, lead, zinc and gold mineralization

E. Vein type mineralization contained in the sedimentary rocks of limestones etc.

--- Indications of lead, copper, zinc and gold mineralization

F. Mineralization of residues on the surface

--- Placer gold

Occasionally secondary enrichment has been recognized in the above mineralizations but for F.

Among these various types of mineralizations, the indications found in the four areas through the present year's survey are shown in Table 1-9.

1-5-1 Mineralization in the Vueltas del Rio Formation

The mineralization in the Vueltas del Rio Formation is associated with the alteration by sericitization, silicification and calcitization, carrying quartz, calcite, clay etc., along many fissures and fracture zones of the directions of E-W and NE-SW, developed in tuff and tuff breccia. Main ore minerals are chalcopyrite, native gold, galena and sphalerite. Partly oxide minerals are associated.

The indications of the mineralization caught by the diamond drilling carried out in the present year's survey are as follows;

Hole No.	Depth(m)	Grade	Remarks
53-1	96 - 98	Cu 1.28%	quartz vein containing covellite and chalcopyrite
53-2	6 - 8	Au 44g/t	veinlets containing native gold
53-2	173 -174	Au 97g/t Ag 80g/t Cu 5.94%	vein

Hole No.	Depth(m)	Grade	Remarks
53-3	46 - 48	Au 3.34g/t	veinlets
		Zn 1.85%	
53-3	104 - 126	Cu 0.122% (in average)	chalcopyrite and pyrite of veinlets and dissemination type contained in tuff breccia
53-3	146 - 150	Au 1.3g/t	vein containing sphalerite, gold
		Zn 1.77%	and galena
53-4	90 - 92	Au 0.76g/t	vein
		Cu 0.15%	
		Zn 1.83%	
53-4	108 - 110	Au 0.24g/t	vein
		Cu 1.59%	

Moreover, many old workings and remains of trench exploration are scattered in a belt extending east and west in the central part of the Vueltas del Rio sector. By the results of the geochemical survey carried out by UNDP team, zone extending 1200 m with the width of 300 m containing Au 1 to 3.0g/t has been detected. (Refer to Plate 1-18) This mineralization is thought to be the results of the secondary enrichment in addition to the concentration of dissemination and veinlets in the area near the old workings. And therefore, further study on the distribution and the behavior of gold in the secondary enrichment zone is necessary.

1-5-2 Mineralization at Macutalo and at Minitas

As for the Macutalo indication, it has been confirmed by this survey up to the present year's and by the UNDP survey etc. that the mineralization at Macutalo occurs along the contact zone of limestone and granodioritic porphyries, composed of chalcopyrite, magnetite, sphalerite, galena and green copper minerals in association with skarn minerals such as garnet

(andradite), actinolite and epidote. That the width of the mineralized part reaches 60 m has been ascertained by the diamond drilling of 5 holes totalling 483.9 m of the drill length. The following assay results have been shown; DDH-3 Cu 0.54% along 22.1 m

DDH-6 Cu 0.31% along 3.4 m, and

DDH-5 Cu 0.24% along 13.1 m. (Refer to Plate 1-13)

Through the present survey in the Minitas sector, skarnization containing garnet and actinolite has been confirmed along the contact zone between limestone and granodioritic porphyry along the length of 93 m of the drill hole No. 53-7 located at Minitas. The mineralization is composed of parts of copper dissemination with some zinc impregnation with the assay result of Cu 0.3 to 1.2% between the depth of 68 m and 92 m. (Refer to Plate 2-8)

The extension of this mineralization has been turned out to occupy the area 500 m long and 90 m wide, by the investigation on the surface.

Meanwhile, indication of vein type mineralization containing magnetite and malachite of the extension of 5 m with the width of 1 m has been confirmed along the contact zone of limestone and granite porphyry at the old workings at Petoa I, the assay result of which is Cu 0.44%. Also, along the contact zone of limestone and granite porphyry in the Minitas valley, copper vein 1.75 m wide with the extension of over 5 m has been confirmed, showing the assay results of Cu 4.28% and Zn 0.77%.

The abovestated mineralizations are all found along the contact zone of the Atima limestone beds and granite porphyries. There is no more remarkable mineralization along the contact zone of limestone and the igneous rocks of the Minitas Formation than that containing chlorite and limonite.

1-5-3 Mineralization in the Limestone

In the Pueblo Nuevo sector, indications of vein-like or layer-like mineralizations have been found almost horizontally along the lowermost part of the limestone overlying the basement. At the old workings at Santa Ines, a vein 2 m wide with the extension of 150 m has been found containing malachite and chalcopyrite. Partly the assay result reaches Cu 1.99%. Also, at the remains of the old exploration at Esperanza, malachite and covellite are observed in an area 1 m wide with the extension of 5 m in limestone. They are, though scale is small, of vein type mineralization at the lowermost part of the limestone, carrying such grade to a certain extent.

1-5-4 Mineralization associated with dykes

In the Pueblo Nuevo sector, there is an old working, where vein 6 m wide and 50 m long has been found in the liparite, containing oxide copper minerals, galena and sphalerite, the assay results of which show the grade of Cu 0.31%, Pb 1.57% and Zn 2.04%. This is known to be Santo Domingo old working.

The abovestated are the main types of the mineralization and the importance of the mineralization is confined to these 4 types. The mineralization belonging to the type A associated with the crystalline schists is rare.

1-5-5 Period of Mineralization

The indications of the mineralization, except for that of the placer gold, are seen emplaced in various units of the Paleozoic formations, the Vueltas del Rio Formation, Minitas Formation, Yojoa Group and many dykes, and are not found in the Tertiary volcanic rocks. Remarkable skarnization has been observed along the contact zone of limestone and dykes of the granite porphyries. Considering the abovementioned evidences, it is thought

to be appropriate that the period of the main mineralization would have been the period of the intrusion of the above dykes. In another works, prior to the extrusion of the Tertiary volcanic rocks, the period of the intrusion of the dykes thought to be contemporaneous with the mineralization would have been at the end of the Cretaceous Period, as the mineralization is observed in the Cretaceous layers. Although the possibility still remains that the mineralization would have been associated with San Marcos plutonic activity in the Jurassic Period as for the mineralizations found in the metamorphic rocks and in the Vueltas del Rio Formation, main mineralization would not have been in relation to this plutonic activity as there are scarce indications of mineralization around the San Marcos granitic rocks. Furthermore, no remarkable mineralization has been found associated with the metamorphosed volcanic rocks of the Minitas Formation. Therefore, the period of the predominant mineralization is thought to have been at the end of the Cretaceous Period.

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Chapter 2 Details of the Geology

2-1 Vueltas del Rio Sector (Refer to PL. I-1, PL. I-5)

This survey area of the Vueltas del Rio sector occupies the area of 6 km^2, 2 km in north-south and 3 km in east-west, comprising hilly land of the altitude of 210 m to 510 m above sea level, covered with vegetation of pine forest.

The area was considered to be most favorable for the emplacement of mineralization, by the results of the various surveys of geochemical survey, pitting survey, shallow drilling and geophysical prospecting, carried out by the UNDP team, in addition to the presence of many remains of gold explorations. In the last year's survey, the features of geology, mineralization and alteration were confirmed by detailed geological survey, geochemical survey, geophysical prospecting (IP method) and diamond 4 holes totalling length of 1,202.6 m. It is extremely difficult to determine the lithofacies of the rocks distributed in this area due to heavy alteration and weathering. In the present year, detailed geological survey with trenching and diamond drilling of 5 holes totalling length of 2,004.1 m were carried out.

2-1-1 Geology

Occupying most of the survey area, the Vueltas del Rio Formation is distributed, intruded by the dykes of quartz porphyry, dacitic porphyry and andesite, while the Atima limestone beds are found developed in the southernmost part of the survey area.

(1) Vueltas del Rio Formation

This formation is composed mainly of andesitic, liparitic and dacitic pyroclastic rocks with inserted layers of shale, conglomerate and other volcanic rocks. They are metamorphosed and schistose usually. The rocks

of the formation are altered through the diagenesis by chloritization and silicification and by the hydrothermal alteration such as sericitization, silicification and argillization as well as by the heavy tropical weathering as carbonatization, argillization and limonitization. The determination of the lithofacies of these rocks is extremely hard on the surface due to these effects, but the following apparent differences have been recognized;

A) The part where schistosity develops well

--- mainly tuffaceous part with strong sericitization

The part where schistosity poorly develops

--- strongly silicified part or weakly altered or metamorphosed part, which are thought to be corresponded to the volcanic rocks or welded tuff.

B) The parts carrying abundant breccias, small amount of breccias and no breccia.

C) The part with poor variation of fabric textures, which is presumed to be volcanic rock composed of micritic groundmass and phenocrysts of feldspars, and the part with intense variation of fabric textures, which is thought to be tuff or welded tuff carrying fragments and phenocrysts of feldspar etc. with repetition of grain size variation of groundmass, several cm to several ten cm from fine grains to coarse grains.

D) The leucocratic part, representing sericitization, carbonatization and argillization and the dark greenish part, representing chloritization.

By the differences stated above, the attempt to subdivide the rocks of this formation has been done to obtain the following classification of rocks.

a) Metamorphosed tuff: Usually leucocratic and schistosity develops well. Repetition of coarse grained --- medium grained --- fine grained parts has been recognized.

b) Metamorphosed tuff: The size of breccias are under hen's egg usually. This tuff is grey to white and consolidated much harder than the tuff of the similar composition. Breccias are mainly of volcanic rocks.

c) Metamorphosed tuff and welded tuff: Porphyritic texture is remarkable, and schistosity poorly develops. Pattern like welded tuff develops well.

d) Metamorphosed tuff containing quartzite: Alternation of medium grained tuff and compact silicified part several mm to several cm in thickness. Bedding planes are distinct.

e) Conglomerate: Containing pebbles of volcanic rocks in the muddy part. Distribution is only local. Bedding planes are distinct.

f) Metamorphosed andesite and welded tuff: Porphyritic texture is observed with penocrysts and groundmass, Metamorphic grade is weaker than other rocks.

g) Schalstein and diabase: Distributed in the northern part of the present survey area, these rocks are occupying the apparent lowermost part of the formation. Dark green in color by intense chloritization Sericitization and silicification are rather weak. Phenocrysts comprise various minerals as feldspar, quartz and granular minerals.

h) Shale (fine grained tuff): Dark grey to black in color, and micrograined Fissility of every several cm develops. Partly sandy.

Stratigraphical relations of the abovestated rocks are from the lowest to the upper, schalstein, alternation of metamorphosed tuff and tuff breccia, metamorphosed andesite, alternation of metamorphosed tuff and tuff breccia and alternation of welded tuff and the metamorphosed tuff and tuff breccia. Extension of each bed can not be observed well.

Metamorphosed andesite lies in rather lower part and welded tuff is seen more in the middle to upper part.

(2) Atima limestone bed

The Atima Formation is composed of fine grained greyish white massive limestones distributed in the southern part of the area, bounded to the Vueltas del Rio Formation by faults. The Atima Formation is extensively distributed in the south beyond the limit of the survey area, composed of poorly bedded limestones, which should be correlated to the Yojoa Group. It has been approved that the Formation belongs to the lower Cretaceous Period, by the fossils such as Turrilitaceae Ammonite and stromatoporellina sp. found in the limestone at Piletas to the north of Potrerillos during the last year's survey.

2-1-2 Igneous activity

The following igneous rocks are distributed, intruding the Vueltas del Rio Formation, in this area.

(1) Dacitic porphyry: Medium to coarse grained, leucocratic and massive, the rocks has been intensely altered by silicification and sericitization.

This porphyry is exposed on the surface as dykes near the drill hole No. 53-5. Also, it is observed in the cores of the drill hole No. 53-5. Small exposure has been found in the west of the drill hole No. 53-5.

(2) Quartz porphyry: Massive greyish green to dark colored rock, exposing along the banks of the Chamelecon River. Intruding into the tuff breccia. Limonitized pyrite-quartz veins are developed concentratedly in a part on the surface.

Alteration is weak but the rock is observed to have been silicified, carbonatized and sericitized. It shows porphyritic texture.

(3) Andesite: Distributed as dykes 2 to 20 m wide of the trends of east-west and northeast-southwest in the southwestern part of this survey area.

Also several dykes of this andesite are seen in the central part of the area. Showing porphyritic texture, the rock contains phenocrysts of feldspar etc., and is observed to have been altered by chloritization and carbonatization.

The period of the activities of the above-mentioned igneous rocks is thought to have been after the sedimentation of the Vueltas del Rio Formation and before the Tertiary Period.

2-1-3 Alteration

The rocks distributed in the survey area have been metamorphosed regionally and such are well observed as the development of schistosity, the drag foldings, mylonitized parts and the parts where constituent minerals have been crushed and elongated. In addition, chloritization and silicification are found well in the northern area as well in the northern area as well as at the depth, especially in the andesitic rocks. Hydrothermal alteration such as sericitization, silicification and argillization has been extensively found, intensely in the central part and rather weakly in the surrounding areas. Oxidation is seen down to the depth several ten meters below surface, here intense limonitization and argillization are observed. The leached zone, white in color, by argillization, carbonatization and sericitization reaches down to the depth of 150 m below surface, which is thought to be supergene alteration zone.

2-1-4 Geological structure

The distribution of each stratigraphical unit is mainly in the direction of east and west, though partly in the western part the direction of ENE-WSW can be seen. Structure is complicated with small drag folds,

but as a whole a synclinorium bearing two synclines and an anticline with east-west trending axes is developed, plunging gently to the east. In the northern area beyond the limit of the survey area there are tectonic overthrusts (Chamelecon fault and Peublo Nuevo fault) with the trends of ENE-WSW and E-W, separating the Paleozoic crystalline schists and the Vueltas del Rio Formation. In this survey area, there are faults and fissures parallel to the above two faults. The existence of the synclinorium structure stated above has been presumed by the consideration and the analysis from the evidences that the strata show north dipping in the souuthern part of the survey area while they show south dipping in the northern part, and that shales are distributed forming a syncline with the axis of east-west in the western part of the survey area.

Dykes of andesite are found predominantly in the central and western part of the survey area with the trends of east-west and northeast-southwest. Schalsteins are distributed in east and west along the northern side of the Vueltas del Rio Formation, occupying the apparent lowermost position stratigraphically, and are in contact with the Paleozoic formations.

The eastern part of the survey area forms a plain and along the boundary between this plain and the hilly part developing its west a fault trending northeast-southwest is inferred. In the east beyond this fault, the distribution of the Vueltas del Rio Formation has not been known.

2-1-5 Geological history

The Vueltas del Rio Formation is composed mainly of the metamorphosed pyroclastic rocks. Schistosity develops well and the schistosity of this formation is in good harmony with that found in the Paleozoic crystalline shists. Therefore, it is thought that the period of the metamorphism of the Vueltas del Rio Formation would possibly have been related to the period of the metamorphism of the Paleozoic crystalline schists. In the

report of the last year's survey this formation was thought to be correlated to the El Plan Formation of the Jurassic Period tentatively, as this formation was thought to be composed of shallow water sediments such as phyllite and shale which were slightly metamorphosed. However, through the results of microscopy and of course, by the results of the detailed geological survey in the field, it has been confirmed that this formation comprises the sedimentary rocks composed mainly of pyroclastic rocks. Therefore, it has been turned out that it is not appropriate to correlate this formation to the El Plan Formation, which does not contain any trace of igenous activity.

The Paleozoic formations distributed in the northern part of the survey area are composed of the crystalline schists originated from pelitic, partly psammitic sedimentary rocks, the crystalline schists originated from basic igenous rocks and the crystalline schists originated from calcareous rocks. The ages of these rocks are not certain, but as the volcanic rocks are regarded as the constituent members of the Paleozoic basement rocks in the description of the geological history by Horne al. (1976), it is thought to be appropriate to enter them into the Paleozoic member. The geological history of this area, considering the facts as stated above, is summarized as follows;

- Formation of pelitic, partly psammitic sedimentary rocks
- Extrusion of igenous rock of medium to basic composition
- Formation of calcareous rock origin pelitic sedimentary rocks
- Formation of green and black shists by metamorphism
- Extrusion and sedimentation of volcanic and pyroclastic rocks, and the formation of shallow water sedimentary rocks
- Metamorphism --- Vueltas del Rio Formation
- Folding and Faulting

· Intrusion of dykes

· Formation of calcareous and argillaceous sedimentary rocks

--- Cantarranas Formation

· Folding and Faulting

· Formation of shallow water sediments of carbonate rocks

--- Atima Formation, early Cretaceous Period

· Formation of shallow water sediments

--- Guare Formation, later Cretaceous Period

· Formation of shallow water sediments

--- Valle de Angeles Formation

· Intrusion of granites and dykes

--- Formation of ore deposits

· Upheaval movement of mass blocks along the Chamelecon fault

· Extrusion of the Tertiary volcanic rocks, formation of N-S faults

2-1-6 Ore Deposits

In this survey area, old gold workings operated in the past at more than 8 localities are known in a belt extending east and west, about 600 m wide with the extension over 1,200 m, where many fracture zones and altered zones are found. Alos, by the detailed geochemical survey carried out by the UNDP team, an anomalous zone, about 300 m wide with the east-west extension of 1,000 m, containing 1.0 to 3.0 ppm of gold in soil has been detected. This anomalous zone is corresponded to the abovesaid gold bearing fracture zones. By the diamond drilling completed in this year's survey, veins containing copper of more than 1.0% have been caught in the drill holes No. 53-1, No. 53-2 and No. 53-4, and also veinlets and dissemination of Cu grade of 0.122% in average have been found from the depth of 104 m to 126 m of the drill hole No. 53-3. Furthermore, as for gold, high grade gold have been caught in veins such as the part containing

44 g/t Au along the core length of 2 m down from the depth of 6 m of the drill hole No. 53-2 and the part containing 97 g/t Au with 5.94% Cu along the core length of 1 m down from the depth of 173 m of the same drill hole. Also, as for zinc, parts containing veinlets of the Zn grade of more than 1.0% have been caught respectively in the drill holes No. 53-3 and No. 53-4. (Refer to Table 1-9)

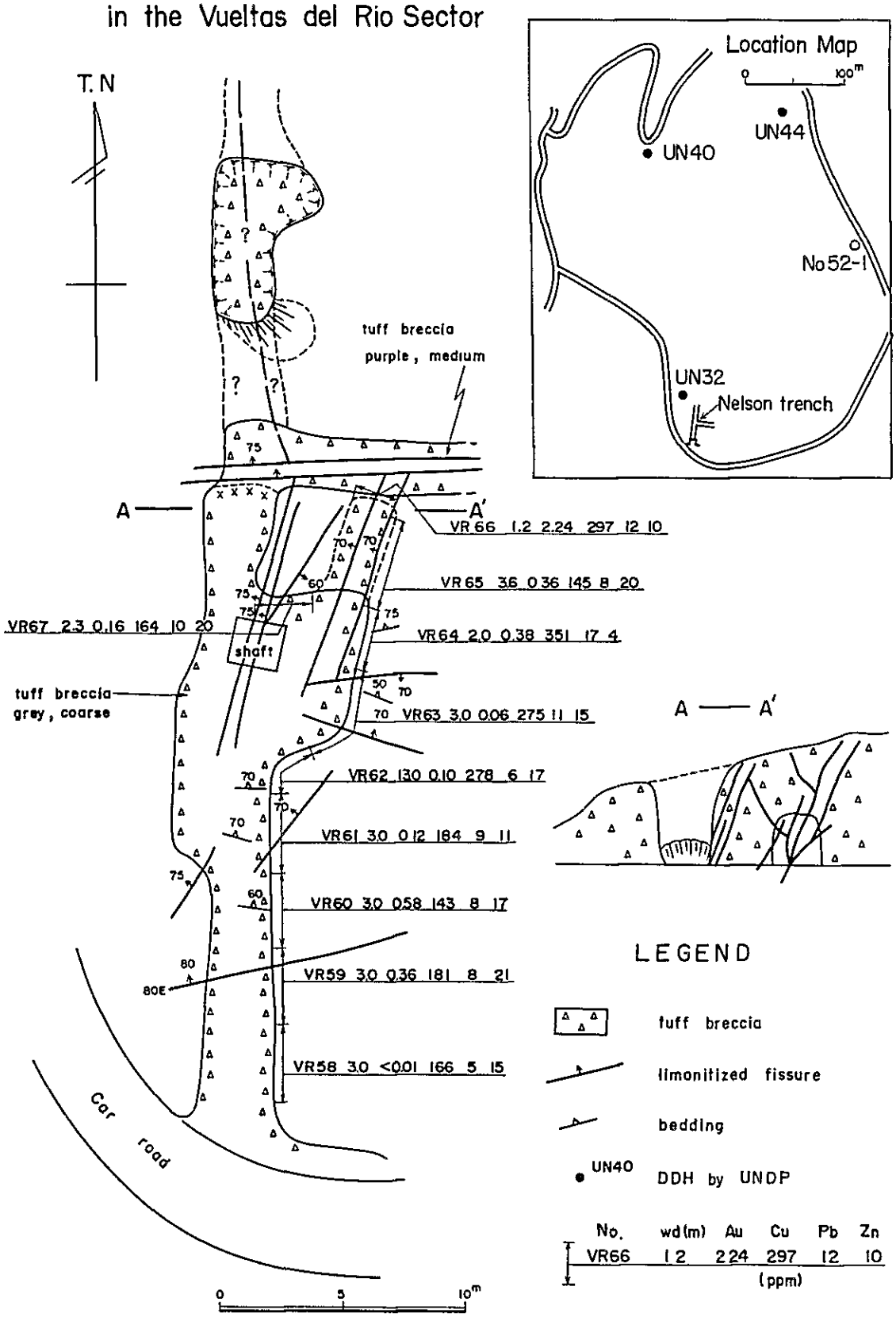
In this area, the dykes of the dacitic porphyry distributed near the drill hole No. 53-5 are intensely silicified and there is a zone much sericitized to the south of it. Therefore, the Existence of porphyry copper type ore deposits would have been expected, but 4 drill holes completed in 1977 and the hole No. 53-5 revealed only low grade mineralization. However, through the present survey, indications of veinlets and dissemination type copper mineralization have been confirmed, and also indications of vein type gold, copper, lead and zinc mineralization have been found at several localities. It is known that the gold distribution on the surface is dependant upon fissures of the directions of east-west and north-south in the aforestated gold bearing fracture zone (Nelson trench, Fig.I-1), but it is impossible to detect orientation of gold distribution in the drill holes. To mention about the alteration, remarkable argillization in addition to the limonitization partly occurred has been recognized, and it is thought to be necessary to study the form of the gold, copper, lead and zinc mineralization on the surface and at the depth in and around the abovesaid gold-bearing fracture zone.

2-2 Laguna Seca Sector (Refer to PL. I-2, PL. I-6)

This sector occupies an area of about 4 km^2, 2 km in north and south and 2.5 km in east and west, and comprises sheer hilly land of the altitude of 300 m to 550 m above sea level. The land is utilized as pasture, with

Fig. 1 - 1

Geological sketch of the Nelson trench in the Vueltas del Rio Sector



with the vegetation of pine trees and other miscellaneous trees. In this area, as the high anomalies of copper, lead and zinc were detected by the geochemical survey along the Chamelecon fault, detailed geological survey accompanied by trenching has been carried out in the present year to confirm the features of mineralization in relation to the geology.

2-2-1 Geology

In the northern part of this area, there is a fault called the Chamelecon fault trending ENE-WSW, which separates the Paleozoic crystalline schists distributed in the northern side of the fault, from the Vueltas del Rio Formation, metamorphosed igneous rocks and the Atima limestone beds developed in the southern side of the fault. Along the Chamelecon fault, dykes of liparite are found to have intruded the Vueltas del Rio Formation and in the southern part dykes of the younger andesite are found.

(1) Crystalline schists

The crystalline schists comprise mica schist, limestone and black schist. The mica schists are bluish black to grey well-bedded medium to fine grained rock, containing mainly biotite but occasionally sericite. The limestone is compact fine grained grey massive rock and often shows bedding plane by the layers like white stripe composed of micrograined quartz. Partly it contains veinlets of calcite. The limestone occurs in lenticular layers in the mica schists. The black schist is grey black in color. Schistosity develops well and the rock has tendency to be foliated easily. Fine drag folds are observed and weathering is recognized by the argillization.

(2) Vueltas del Rio Formation

The Vueltas del Rio Formation in this area is thought to be the extension of the beds of this formation found in the Vueltas del Rio

sector, and lithologically similar rock beds are seen in this area. The metamorphosed tuff and schalstein are distributed in the northern side while mainly tuff breccia develops in the southern side of this survey area. They are all trending east and west, dipping to the south. It is noted that less amount of welding is seen and the schistority develops rather weak in this area than those found in the Vueltas del Rio sector. In the central part of the area, there is a distribution of metamorphosed dioritic porphyrite about 300 m wide, extending east and west. This dioritic porphyrite is dark green to grey in color, bearing pehnocrysts of white feldspar and green minerals. The relation to the other rock units has not been confirmed due to topographical restriction and heavy alteration. Further to the south, andesite (dark colored or dark green medium grained massive rock) is distributed with the tuff breccia between the above dioritic porphyrite and the andesite.

(3) Atima Limestone beds

The Atima limestones are dark grey massive compact limestones rarely bedded and almost without insertions, except for occasional lenticular thin layers of quartz 0.2 to 2 mm in thickness. The relation of this limestone to the metamorphosed andesite has not been confirmed at exposures, though it can be said that the limestone is found on the higher level topographically than the andesite.

(4) Liparite

The liparite is grey compact dyke rock with the width of approximately 100 meters developed along the Chamelecon fault. Sometimes it is dark green in color and phenocrysts of mica can be observed, but phenocrysts of feldspar are very rare in this rock.

(5) Andesite

The andesite is black colored compact basaltic pyroxene andesite.

Five dykes have been observed intruding the Atima Formation and the metamorphosed andesites, in the direction of northeast and southwest.

2-2-2 Geological Structure

The Chamelecon fault runs in ENE-WSW and dips steeply in the west while the direction of the fault is almost east and west in the east. In this area, faults and fracture zones of the above two directions are abundant. The northern limit of the Atima Formation is bounded by a fault in east and west, running through the Laguna Seca village, and there are many faults and dykes of the trends of northeast-southwest. The boundary between the crystalline schists and the schalsteins belonging to the Vueltas del Rio Formation is represented by an overthrust running east and west, with the dip to the north.

2-2-3 Mineralization

Along the marginal part of the dioritic porphyry distributed in the central part of this area, altered parts by silicification have been recognized at several localities. They form white or translucent quartz mass bearing hematite and are distributed spottedly over 300 m along a line in east and west. Sometimes green copper minerals are associated. Also, at several points in the dioritic porphyrite, remarkable silicification and argillization can be recognized, but no notable indication of mineralization has been found in such locations.

After all, the geochemical high anomalies are corresponded to the contact zone of the Vueltas del Rio Formation with the dioritic porphyrite and to a zone along the Chamelecon fault including the marginal part of the Vueltas del Rio Formation. The alteration zone by silicification associated with the dioritic porphyrite found in the other rocks on the surface would be the cause of the geochemical anomalies. As no remarkable indication of mineralization has been found and also alteration is rather

weak, this sector is thought to be rather unfaborable for the mineralization.

2-3 Minitas Sector (Refer to PL. I-3, PL. I-7)

The Minitas sector occupies an area of about 5 km^2, 3 km in east-west and 1 to 2 km in north-south, of the altitude of 350 to 650 m above sea level, and comprises rather steep mountainous features, utilized as pasture, covered with thick vegetation of pine trees and other miscellaneous trees.

In this area, UNDP team performed geochemical survey, geological survey, geophysical prospecting (Turam method) and diamond drilling and confirmed the skarnization at Minitas and at Macutalo, where further exploration was warranted.

Last year, the potentiality of the emplacement of contact replacement ore deposit and vein type ore deposit was ascertained through detailed geological survey, geochemical survey, geophysical prospecting (IP method) and 2 holes of diamond drilling totalling length of 623.3 m. Therefore, in the present year, detailed geological survey accompanied by trenching and 3 holes of diamond drilling totalling 901.8 m were conducted in this sector, for the confirmation of the geological structure of the ore horizons and for the comprehension about the relation of the mineralization to the geological structure confirmed as above.

2-3-1 Geology

By the thick covering of the vegetation and the poor exposure due to heavy weathering, it was extremely difficult to determine lithofacies of the rocks on the surface in this area. However, in this year, attempt has been done to subdivide as precisely as possible the igneous rocks which used to be grouped into one unit of diorites, and detailed observation and analysis were conducted.

The rocks distributed in this area are, upwards from the lowermost, the Minitas Formation composed of metamorphosed igneous rocks, Atima limestone beds, dykes of granite porphyry, diorite porphyry, and andesite intruding them, and the basalts belonging to the Tertiary Matagalpa Formation.

(1) Minitas Formation

The Minitas Formation is distributed in the topographically lower part in the northern and eastern part of the area. The Formation is composed mainly of fine to medium grained metamorphosed andesite, metamorphosed andesitic pyroclastic rocks and granodiorite intruding them.

a) Metamorphosed andesite and andesitic pyroclastic rocks: Dark to greenish black, brownish black and greyish purple in color, the rocks are hard and with phenocrysts of feldspar and mafic minerals replaced by chlorite. The size of the phenocrysts varies from as coarse as several mm to fine grained, and the texture is porphyritic. The pyroclastic rocks have fragments or phenocrysts of feldspar, and irregular variation of the sizes of the constituent minerals is remarkable from fine grain to coarse grain. Sometimes the rocks contain essential breccias 1 to 5 cm in diameter. Generally, they are silicified and chloritized by regional metamorphism and by mylonitization. Also, partly they are epidotized and calcitized and on the surface they are argillized by weathering. Due to these alterations, the determination of lithofacies of the rocks on the surface is extremely difficult.

b) Granodiorite: Distributed in the northern part of the survey area, the granodiorite is observed to have intruded the above-mentioned metamorphosed andesites, but is overlain unconformably

by the Atima limestone beds. The granodiorite shows very complicated shape and form. The rock is grey to greenish grey, coarse grained and hollocrystalline. Reaction rim has not been found, but occurrence of some epidote has been recognized in places along the margin of the intrusive body. Along the marginal part, the rock constitutes abundant dykes. Partly schistosity develops. On the surface, it is recognized that the weathering decompose this rock to produce sands. Under microscope, granular texture is observed (Refer to Table I-2, Sample No. 0401), which is composed of quartz, potash-feldspar and plagioclase, though chloritized epidotized.

(2) Atima limestone beds

The Atima limestone beds are composed of greyish white massive limestone without bedding, over 250 m in thickness. They are distributed in the higher places of hilly land or along mountain sides, of the altitude of 400 to 650 m above sea level, in the survey area. The limestone is compact and micritic. Altered part is white in color. Occasionally it contains muddy part.

(3) Matagalpa Formation

Part of the volcanic rocks and pyroclastic rocks developed over the highland area in the southern part of this sector has been found to cover the Atima Formation etc. The period of their extrusion is thought to have been Tertiary Oligocene to Miocene Epoch. Upwards from the lowermost, basalt, andesite and tuffs are developed. The basalt is dark grey to black hard cryptocrystalline rock showing porphyritic texture, bearing plagioclase, olivine, magnetite and pyroxene. The andesite is dark green, brown and reddish purple in color and has structure of autobrecciation. The tuffs are composed mainly of andesitic breccias, lappilli tuff and acidic tuff, but in places with welded tuff.

2-3-2 Igneous Activity

The following igneous rocks have been caught in this area, intruding Minitas Formation and the Atima limestone beds.

a) Granite porphyry and granodioritic porphyry: A dyke of this rock is distributed near the Minitas valley with the width of about 70 m and another dyke of the rock about 70 m wide have been found at a point of Macutalo, both trending in northwest-soth-west. The rocks are medium grained leucocratic hollocrystalline and kataclastic. Intensely silicified, the rock looks apparently like aplitic rock. There are some places where green copper minerals are recognized to be disseminated along the fracture zones in the rocks, and also garnet bearing green skarn masses are found associated with copper, iron, lead and zinc minerals in the feature of dissemination, by the replacement of parts of the limestone of the Atima Formation. This rock is thought to be closely related to the mineralization found in this area.

b) Diorite porphyry: As a dyke, trending northwest-southeast, this diorite porphyry has been found to be distributed in the central part of this survey area.

This rock is composed of phenocrysts of feldspar and micro-crystalline groundmass. The intrusion of this rock into the Atima limestones has been observed. The rock is altered heavily by weathering.

c) Andesite: As dykes of the width of several ten meters, in the direction of northwest-southeast, the andesite is distributed in the eastern part of this survey area. It is dark green to dark brown compact rock.

2-3-3 Geological Structure

This survey area occupies the contact zone of the Paleozoic crystalline schists distributed in the north to the non-metamorphosed sedimentary rocks of the Atima Formation and also non-metamorphosed volcanic rocks of the Matagalpa Formation developed in the southern part. The metamorphosed andesites and granodiorites, comprising basement, are distributed almost in east and west, but partly in the direction of northwest-southeast. The Atima limestones are developed in the topographically higher part as hillside or top parts of the hilly land, and their distribution is almost in the direction of east-west and northwest-southeast. The dykes intruding the Atima Formation and others are mostly trending northwest and southeast. Indications of mineralization are observed to be associated with fissures and dykes of the direction of east-west and northwest-southeast. The same two directions are remarkable about the faults, which are seen to have given transition to the basement and the Tertiary volcanic rocks.

2-3-4 Geological History

The rocks, which were grouped into one unit of "diorite" in the report up to last year's, have been subdivided into the following units. That is, they are, in the order from the oldest, metamorphosed andesites, granodiorites intruding the former, Atima limestone beds, dykes of granite porphyry, dykes of diorite porphyry, dykes of andesite and Matagalpa Formation.

As for granodiorite, the result of the age determination (by K-Ar isotopic method on the hornblende contained in the mica-hornblende-quartz diorite), performed in the last year's survey, gives 224 $\pm$ 17 m.y., indicating Permian to Triassic Period, which is corresponded to the period of metamorphism of the crystalline schists distributed in the northern area beyond the limit of this survey area. Accordingly, the metamorphosed

andesites intruded by this granodiorite are thought to be older than the latter or prior to the Permian Period. Therefore, this granodiorite is thought to have been the product of the igneous activity at the period of the orogeny represented by the formation of such schists. Also, it is thought that the formation of the dykes of granite porphyry which are presumed to be related to the skarnization would have been in Cretaceous to early Tertiary Period.

2-3-5 Mineralization

It is known that there is a remarkable skarn-type ore deposit of Macutalo in this area. Through the present year's survey, a skarnized alteration zone 90 m wide with the extension of over 500 m has been confirmed around the drill hole No. 53-7. This zone is tentatively called Minitas skarn zone, hereunder in this report. Furthermore, in the Minitas valley to the southwest of the Minitas skarn zone, an indication of copper and zinc bearing vein has been found along the dyke of granite porphyry.

Macutalo ore deposit: This ore deposit is located in the far upstream of the Minitas valley, at the altitude of 560 m above sea level. It is massive skarn type ore deposit formed along the boundary between limestone and medium grained granodiorite porphyry. Skarn minerals are garnet (andradite), epidote, actinolite and chlorite, and ore minerals are magnetite, hematite, native gold, chalcopyrite, chalcocite, pyrite etc. The garnet zone is as wide as over 7 m and is associated much of magnetite, while the actnolite zone is as wide as over 4 m and is associated with copper minerals.

Minitas skarn zone: This skarnized zone containing garnet, epidote and actinolite has been confirmed to be extended continuously to the depth of 93 m by the diamond drilling. It has been ascertained that there is a part containing 0.3 to 0.5% Cu and 0.2% Zn in this zone.

It is necessary to confirm the features of the mineralization through the further exploration by detailed trenching and diamond drilling.

Outcrop of mineralization in the Minitas valley: This outcrop is located on the right bank in roughly the middle-stream of the Minitas valley, where vain-like mineralization, 1.75 m wide and over 5 m long, has been found to be exposed extending northwest-southeast along the boundary zone between granite porphyry and limestone. Ore minerals are pyrite, chalcopyrite, as well as covellite and malachite. The latter two ore minerals are observed to have filled the space amidst the grains of gangue mineral of quartz irregularly. Under microscope, corroded goethite is observed to be formed along the margin of malachite, and the ore contains tenorite and gold grains as well. (Refer to Table I-2(3), Sample No. 72807)

As stated above, in the Minitas area, remarkable skarnization zone has been confirmed and favorable mineralized area has been extracted through the present year's survey.

Further detailed exploration by trenching and diamond drilling will be recommended to delineate the actual mineralized part preferentially on the above-stated three mineralized zones.

2-4 Pueblo Nuevo Sector (Refer to PL. I-4, PL. I-8)

The Pueblo Nuevo sector occupies an area of 4 km^2, 2 km in north-south and 2 km in east-west, at the altitude of 180 to 400 meters above sea level. The area comprises hilly land covered with vegetation of miscellaneous trees, but partly utilized as pasture. In this area geochemical survey, geological survey and geophysical prospecting were performed by the UN team, and also, as a part of this series of surveys, detailed geological survey, geochemical survey and geophysical prospecting (IP method) were carried out in the last year, through which indications of

copper, lead and zinc mineralization were confirmed at Santa Ines and at Santo Domingo, while the information of the IP high anomaly was obtained to be extening widely to the north of the survey area. In this year, trenching by bulldozers and detailed geological survey were carried out to confirm precisely the geological structure, which had been uncertain in many points due to thick vegetation and thick soil cover, and to clarify the character of the geophysical anomaly.

2-4-1 Geology

In this area, it is difficult to determine lithofacies of the rocks because of the poor exposures due to heavy weathering, but as completed in the Minitas sector, subdivision of igneous rocks was attempted, the result of which was then analysed. Upwards from the lowermost, the stratigraphical succession is Minitas Formation composed of metamorphosed andesite and diorite porphyrite, liparite unit distributed in the north, the limestone beds of the Atima Formation covering them, dykes of andesite and porphyrite intruding them, and granodiorite.

(1) Minitas Formation

The Minitas Formation is distributed in the topographically lower portion in the central to southern part of this area. It is composed mainly of fine to medium grained metamorphosed andesite and andesitic pyroclastic rocks, in addition to liparite intruding them and distributed in the northern part of this survey area.

a) Metamorphosed andesite and andesitic pyroclastic rocks: Being dark to greenish black, brownish black hard rock, it has various phases as for grain size from that of andesitic rock to dioritic rock. Quantity and grain size of the phenocrysts of feldspar and mafic minerals are also variable. Lithofacies and alteration are almost similar to those found in the Minitas sector.

b) Liparite: The liparite is grey to yellowish grey, brownish grey in color and is hard compact rock, containing grains of quartz and occasionally small fragments of mica. Partly development of joints is observed but comparatively massive parts are also seen. When weathered, this rock is easily to be crushed to small pieces. Generally it has homogeneous lithofacies, though in places silicification and argillization are found in this rock.

c) Atima limestone beds: This limestone is grey to greyish white fine grained massive limestone, poorly bedded with rare insertions. It occupies topographically high portion or hillside and forms steep cliffs.

2-4-2 Igneous Activity

In this survey area, there are granodiorite and dykes of andesite and porphyrite, all of which are found to have intruded the liparite belonging to the Minitas Formation. The relation of this liparite to the metamorphosed andesites of the Minitas Formation is not certain in this area, as no exposure showing such relation has been found, but they seem to be in contact with each other bounded by fault. In the Minitas sector, the exposure in which liparite dykes are observed to have intruded the metamorphosed andesites has been found near La Hacienda. The period of the activity of this liparite is not certain --- though it is thought the activity might be at the same period as the intrusion of the granodiorite or at the end of Cretaceous Period when the intrusion of many dykes has been confirmed, viewing from the facts that Williams et al. (1969) grouped the area of the distribution of this liparite into the area of the metamorphosed igneous rocks, and that the liparite is seen to have been intruded by the dykes belonging to the activity at the end of Cretaceous

Period. Meanwhile, the dyke of the granodiorite, though it has been confirmed that this dyke intruded the liparite, is seen to have been caught as xenolith-like pieces in the liparite. It is certain that the granodiorite has not intruded the Atima Formation. Therefore, little chronological difference might be there between the activities of the granodiorite and the liparite.

2-4-3 Geological Structure

In the lower portion along valleys and streams, the metamorphosed andesites of the Minitas Formation are distributed, while the limestone overlie them unconformably in the topographically higher portion. Near the boundary plane, the limestone is rather coarse grained and the andesite side is rather hardened with much epidote seen in places.

As remarkable faults, a northeast-southwest trending fault has been found accompanying ore vein at Santo Domingo, and another fault parallel to this can be presumed to run through Agua Caliente. An east-west trending fault is seen in the southern side of the old workings at Esperanza.

No notable fracture zone or tectonic zone can be found in the area occupied by the liparite, but the valleys are tend to run in north-south and in east-west.

2-4-4 Mineralization

Santa Ines:

The mineralization is seen of a vein, almost horizontal, carrying green copper minerals and chalcopyrite, 2 m thick with the extension of 150 m, which is seen emplaced in the limestone close to the unconformity plane between the liparite and the overlying limestone. The assay results of the samples collected across the vein of the width of 2 m have shown the ore grade of Cu 0.7 to 4% and Zn 0.5 to 0.8%. The limestone is partly pebbly, porous, silicified and

dolomitized, and remarkable silicification and limonitization have been found along this indication of the mineralization. More than 5 remains of old pitting are known.

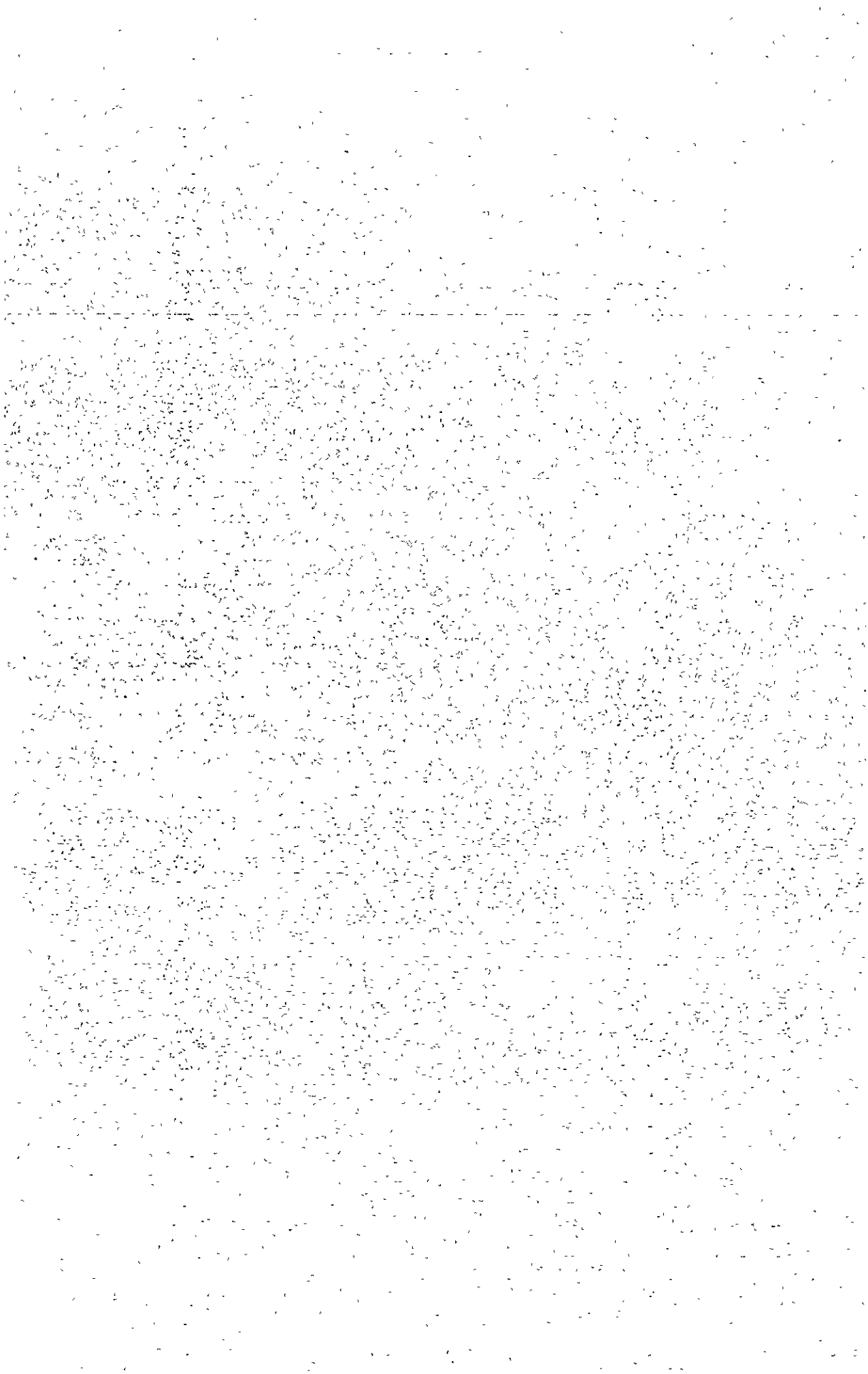
Indication at Santo Domingo:

The ancient pits located near about 200 m east from Santa Ines have been correlated the extended part of the Santa Ines indications, and have scattered cupper oxide ores. This is the indication of mineralization located along the valley south of the Santo Domingo village. It is a northeast-southwest trending ore vein 6 m wide with the extension over 50 m as far as traced, which is found to have been emplaced around the contact zone between limestone and liparite. The assay result of the sample, collected in channel of 0.9 m in length across the vein, reveals the ore grade of Pb 1.57% and Zn 2.04%. The ore minerals are chalcopyrite, hematite, galena, pyrite, sphalerite and goethite. Hematite is most abundant.

Old working at Esperanza:

This old working has been found on the cutting wall along the east side of the road near the junction of the road running between Santa Barbara and La Arada and the road to the Pueblo Nuevo village. The working is 2 m in width, 1.2 m in height and 7 m in length.
The mineralization found there is that of the dissemination of green copper minerals and iron-oxide minerals in the limestone, along the contact of limestone and medium grained hornblende dioritic rock.
As above-mentioned, it has been confirmed through the surveyes by trenching and others that the moderately high anomaly in the northern part, shown by IP method of the geophysical prospecting is corresponded to the distribution area of the liparite body developed in the northern part.

After all, no other favorable indication has been found than the mineralizations at Santo Domingo, at Santa Ines and at Esperanza.



PARTICULARS

PART II DIAMOND DRILLING

PART II DIAMOND DRILLING

Chapter 1 Introduction

1-1 Purpose of the Survey

As a part of the second phase surveys of the Basic Geological Survey for the Development of Mineral Resources in the western part of the Republic of Honduras, an investigation by diamond drilling was carried out to ascertain the relation between geological structure and mineralization in the Vueltas del Rio sector and in the Minitas sector, which had been extracted as the areas where geological environment is favorable for the emplacement of ore deposits.

In the Vueltas del Rio area, features of the alteration and mineralization in the central part of the area had been confirmed by the 4 holes of diamond drilling performed in the previous year, and the investigation to the depth and in the surrounding area had been recommended to be necessary. Accordingly, for the exploration of the extension of mineralization to the east, to the south and to the north, and for the confirmation of the variation of the mineralization down to the depth more than 300 m below surface, diamond drilling to the depth of 500 m was programmed.

In the Minitas area, in order to confirm the features of the mineralization along the boundary between limestone and igneous rocks, diamond drilling was programmed respectively in the limestone zone, in the igneous rock zone and in the mineralized zone.

1-2 Outline of the Survey

A survey member in charge of the drilling was sent in advance to the field of La Flecha on 15th of May, 1978, and did the inspection of the drill machines, and the observation of the actual location for the drilling.

By receiving materials and supplemental parts and tools as well as mud-materials at the port from the vessel, preparation works were performed. Another 6 drill-members and 1 geologist arrived on 5th of June, and the construction works were commenced. All the drill sites are located in the pine forests in the Vueltas del Rio area, and construction of access roads and the drill-sites by bulldozers and preparation of water necessary to the drilling were completed. In the Minitas area, construction of access roads and preparation of water necessary to the drilling for the three drill sites were completed, but repair works by 6 workers were required all through the time because of the extremely muddy condition caused by heavy rains.

Two drill machines of TGM-5A were used (The capacity of drilling is 510 m in final NQ size and 650 m in final BQ size) to drill 8 holes of total length of 2905.9 m, by wireline method through three shifts per day, each shift comprising 8 hours. Six crews, each of which is composed of 1 driller and 4 workers, were prepared for the drilling in addition to the 2 members for water carriers. Bentonite-mud was used for the drilling and the part near surface was drilled with metal bits without consuming water. Thus, the attempt to recover as much cores as possible was sucessful, and the total core recovery was 92.13%. The area for the drilling and the amount of performance are as follows;

Area	Hole No.	Number of Holes	Drilled Length (m)	Core Recovery (%)
Vueltas del Rio	53-1	1	401.0	95.8
	53-2	1	301.0	97.3
	53-3	1	400 8	96.3
	53-4	1	500.5	94.5
	53-5	1	400.8	85.3
	Total	5	2004.1	93.7

Area	Hole No.	Number of Holes	Drilled Length (m)	Core Recovery (%)
Minitas	53-6	1	300.3	94.7
	53-7	1	300.5	80.5
	53-8	1	301.0	90.7
	Total	3	901.8	88.3
Grand Total		8	2905.9	92.13

The term of the investigation by diamond drilling was 124 days from 5th of June to 6th of October, 1978. After completion of the drilling for four months, the cores and the machines were stocked in the warehouse in the sites at La Flecha, as done before, and all the members returned to Japan on 6th of October.

1-3 Core logging and Analysis Works

All the cores obtained through the diamond drilling carried out in the present year were logged as for lithology, alteration and mineralization by the geologist stationed there, and the data were recorded on the core-logging cherts of the scale of 1 to 500. Also, the analysis of geology in the field was performed by the correlation of the results of the core-logging to the surface geology and to the results of the core logging completed in the last year. Cores were split into halves. As for the cores of the drill holes located in the Vueltas del Rio area, samples were collected over almost all the length. Chemical analysis of the core samples was performed preparing each sample from every 2 meters of the core length, although a sample comprises 10 meters of the core length in weakly mineralized parts. As for the cores of the drill holes located in the Minitas area, samples were collected from every 10 meters of the core length in addition to the continuous sampling from the mineralized and skarnized parts.

On the core logging, detailed observation was performed through the description of features of occurrence, fissures, fracture zones and alteration precisely, especially of the igneous rocks to be subdivided into many lithofacies, as well as of the sedimentary rocks. Necessary parts were described in large scaled illustration chert in order to confirm the relation of mineralization to the geological structure.

For the geological analysis, thin sections and polished sections of every rock and each mineralized part were prepared, and determination of lithological names of the rocks, classification of alteration of the country rocks and studies of mineral paragenesis were completed with the help of X-ray analysis, in addition to the correlation of the results to the geological features confirmed by the various surveys carried out in the past.

Chapter 2 Diamand Drilling Works

2-1 Location of the Drill Holes

The each site where the holes of No. 53-1, 53-2, 53-3, 53-4 and 53-5 were drilled in Vueltas del Rio Sector is located about 23 km far from La Flecha via Chiquila Village and it takes about 40 min. by drive. La Flecha is located almost halfway from San Pedro Sula to Copan along the national road connecting both towns and the base camp of the prospecting team was stationed there in La Flecha.

Meanwhile, there are two routes to reach the sites in Minitas Sector where the holes of No.53-6, 53-7 and 53-8 were drilled. One is via San Francisco del Los Valles located 2 km south of the junction which is 20 km far from La Flecha on the road leading to San Pedro Sula. The other is via the Minitas farm and Pueblo Nuevo which is reached from La Arada on the Santa Barbara road. La Arada is 30 km far from La Flecha on the national road.

The distance from La Flecha to the sites in the former route is about 32 km and it takes one hour by drive.

The geographical location and elevation of the drilling holes are as follows.

No. of Holes	Longitudinal Distance	Latitudinal Distance	Elevation(m)
53-1	334.80 E	1682.65 N	216
53-2	334.07 E	1681.98 N	265
53-3	333.23 E	1681.90 N	342
53-4	333.20 E	1682.53 N	473
53-5	334.16 E	1683.05 N	449
53-6	357.98 E	1687.75 N	510
53-7	357.40 E	1687.93 N	595
53-8	356.96 E	1687.85 N	435

2-2 Preparatory Works

2-2-1 Road Construction and Maintenance

The chief prospector who arrived at the site on 20th, May. advancingly, made the ground survey at the drilling sites in Vueltas del Rio and Minitas to plan the new road construction and existing road maintenance, and the transportation scheme of materials and equipment. He also made an arrangement for labour mobilization and water supply.

The access road to the holes of No. 53-2, No. 53-3 and 53-4 in Vueltas del Rio was prepared, constructing a new road by using bulldozer by 1,120 m and mending the present road by 1,200 m.

Due to the ceaseless heavy rainfall, however, the road condition was so messy that the cumulated distance of the road which was mended by men during the drilling works mounted to 15 km. The access road to the holes of No. 53-6, 53-7 and 53-8 in Minitas was prepared by constructing a new road by using bulldozer by 1,700 m and by mending the present road by 6,000 m. But the road condition was also extremely bad as the other and the road repair job accumulated up to 10 km.

Even with the ceaseless repair job, however, traffic on both roads were extremely hazardous due to the muddy and slipperly surface when it rained heavily.

2-2-2 Transportation of Equipment and Material

The transportation of equipment and material to the drilling sites of No. 53-1 and No. 53-2 was started on 5th and 6th, June respectively by a 6t truck from the warehouse in the base camp in La Flecha via chiquila and Ojos de Agua.

The supplementally equipment and material shipped from Japan for the drilling works of 1978 were transported to La Flecha on 14th, June from the part of Amapala after the custum clearance.

2-2-3 Development of Drilling Bases

The drilling bases of No. 53-2, 53-3, 53-4 in Vueltas del Rio and No. 53-6, 53-7, 53-8 in Minitas were developed by a bulldozer in connection with the development of the access roads.

The drilling bases of No. 53-1 and No. 53-5 in Vueltas del Rio were developed by men hand in order that the present roads were not to be disturbed by the development works.

2-2-4 Drilling Water Supply

Drilling water for the drill holes of No.53-1 and 53-2 was supplyed by pumping water from Rio Chamelecon and the pipeline ran 240 m and 420 m respectively. Since there was no water source near to the holes of No. 53-3 and 53-5, water was delivered by a truck equipped with a steel tank of 1,000ℓ capacity.

To the No. 53-4 hole, water was pumped up from the water bag (3m x 4m x 1.4m) which had been constructed in 1978 and the pipe line was 550 m long.

Water for the No. 53-6 hole was pumped up from Quebrada Minitas and the pipeline was 700 m long.

Water for the No. 53-7 was transported 1,000 m by the track above stated from the swamp, located 800 m southwest to the hole base, where a water intake bag (3m x 4m x 0.8m) was provided.

To the No. 53-8 hole, water was supplied from the fountain located 350m south to the hole, where a water intake bag (3m x 4m x 1.2m) was provided. The water flow of the fountain was estimated to be 40 ℓ/min. and the pipeline to the hole base ran 500 m.

2-3 Drilling Works

Since there was a possibility that the surface soil contained gold minerals at the five drill holes in Veltas del Rio, drilled cores were tried

to be recovered in the surface layer at each hole. Accordingly, dry drilling was carried out with a metal bit of 116 mm dia. and the core recovery was 100%.

When the holes touched the rock face, drilling was continued with the HQ wireline method and the casing pipes were inserted followingly. And the final part of the holes was drilled with the BQ wireline method.

The drilling progress of each hole was as follows. The meterage in the following paragraphs corresponds the hole depth from the surface.

2-3-1 No. 53-1 hole

Total drilled length : 401.00 m

Drilled rock core length : 384.25 m

Rock core recovery : 95.8%

The hole was drilled down to 6 m in the layer of brown surface soil with a single metal bit of 116 mm dia. without feeding water to reach the rock face. Below this, drilling was continued with a long metal bit of the same diameter with feeding mud water to 6.70 m, where the rock appeared stable and HW casing pipes were securely inserted.

A HQ-WL bit was employed and the hole was chilled down to 45.00 m, where the rock facies tourned out to the fissureless tuff and NW casing pipes were securely inserted.

Drilling was continued with a NQ-WL bit.

From 52.00 m, clayey tuff appeared and, due to the pressure by increase of clay, the drill rods were jaunmed to cause the extreme deterioration of drilling works, so that the hole was reamed with a NW casing shoe bit and casing pipes were set to 60 m.

The hole was drilled with a NQ-WL bit thereafter to 201.00 m and BW casing pipes were securely inserted. While drilling was carried out with the same bit, mud water was completely lost around 73.00 m, where a mud ball

mixed with "Tel-stop" and "Bentonite" was thrown into the hole to prevent the water loss.

When core choking took place at 145.70 m and the inner tube was tried to be pull out, the rods (NQ-WL) were fall off to the hole bottom due to the trouble of the oil hydraulic rod holder.

Since slime sedimented at the hole bottom where the rods stuch in, they were jammed so badly that the winch and rod puller could not pull them off. Therefore, the rods and core tubes were hit up and down by a drive hammer to give them vibration and they were recorvered at last.

From 201.00 m, a BQ-WL bit was employed for drilling.

Core choking and caving were serious due to white clay contained in metaandesite and tuff breccia. Mud water of bentonite was replaced by that of rebonite to increase the sealing effect, with which measure the caving was recovered and the drilling was finished when the hole reached 401.00 m.

2-3-2 No. 53-2 hole

Total drilled length : 301.00 m

Drilled rode core length: 292.90 m

Rock core recovery : 97.3 %

Dry drilling was carried out to 4.00 m in the red brown soil with a single metal bit of 116 mm dia. where the hole touched the rode face.

Drilling was continued to 6.05 m with a long metal bit of the same diameter with feeding mud water and HW casing pipes were inserted to 6.00 m.

The bit was changed to that of the HQ-WL size with which drilling was continued to 51.10 m.

The rock facies was stable tuff and NW casing pipes were securely inserted to 51.00 m.

A NQ-WL bit was employed and the hole was drilled to 132.10 m. During this, the rock facies was so stable that drilling was performed without hitch. BW casing pipes were inserted to 132.00 m and a BW-WL bit was employed.

From 136.00 m the rock facies turned out to be tuff containing white clay and caving took place to cause the jamming of the BW-WL rods and then, drilling became impossible. The hole was reamed with a BW casing shoe bit and casing pipes were inserted to 138.00 m.

Between 177.00 m and 222.00 m, the complete loss of mud water took place mine times where the mixture of bentonite and Tel-stop was throun into the hole to prevent it.

However, caving did not occure at the above places and drilling was finished when the hole reached 301.00 m.

2-3-3 No. 5 3-3 hole

Total drilled length	: 400.80 m
Drilled rock core length	: 385.90 m
Rock core recovery	: 96.3 %

Dry drilling with a single metal bit of 116 mm dia. was carried out to 3.5 m where the hole reached the rock face and HW casing pipes were securely inserted. A HQ-WL bit was employed and the hole was drilled down to 29.00 m where the hole was reamed naturally due to the rock facies of clayey tuff and consequently, HW casing pipes fell off from 3.50 m to 27.00 m, so that HW casing pipes were extended to the same depth. The hole was drilled with a HQ-WL bit to 52.40 m and HW casing pipes were securely inserted.

Thereapon, a NQ-WL bit was employed and drilling was continued to 201.00 m.

The rock facies was stable tuff breccia and drilling was carried out without any hitch.

BW casing pipes were inserted to the same depth and the bit was alonged to BQ-WL one.

The rock facies was tuff breccia and tuff.

Between 235.00 m and 245.00 m, mud water was lost completely by three

times. But everytime, it was prevented by throwing ball mixed with Bentonite and Tel-Stop.

Generally, drilling was carried out more than saticefactorily without any hitch like caving and it was finished when the hole reached 400.80 m.

2-3-4 No. 53-4 hole

Total drilled length : 500.50 m

Drilled rock core length : 472.90 m

Rock core recovery : 94.50%

Dry drilling with a single metal bit of 116 mm dia. was carried out to 2.00 m where a long metal bit was employed and drilling was continued to 6.00 m with feeding mud water as rock appeared from the ground surface. Then HW casing pipes were inserted.

The hole was drilled to 102.10 m with a HQ-WL bit. The rock facies was clayey tuff but NW casing pipes were inserted inspite of soft rock.

Drilling was continued with a NQ-WL bit. NW casing pipes were shipped down to103.50 m because of vibration, so that they were extended to the same depth.

Drilling was continued to 245.95 m with a NQ-WL bit and BW casing pipes were inserted.

Thereafter, a BQ-WL bit was employed and drilling was finished when the hole reached 500.50 m. The general rock facies was brecciated clayey tuff and tuff breccia which caused frequent choking.

Therefore, the inner tubes were inevitably lowered and lifted more times than in the other holes, and the wear of diamond bits was extreme.

When the BW casing pipes were tried to be pulled out, the rod hoist could not manage it.

Even a drive hammer had no effect in giving them any movement.

Then, a casing cutter was used but it could not cut them completely

because it was a poor one.

When, the rod hoist was tried again, the casing pipes were moved incidentally. Then all the casing pipes were pull out successfully.

2-3-5 No. 53-5 hole

Total drilled length : 400.80 m

Drilled rock core length : 341.90 m

Rocks core recovery : 85.3 %

Dry drilling with a single metal bit of 116 mm dia. was carried out to 3.00 m and the hole was drilled down to 6.50 m in wet drilling with a long metal bit of the same diameter. And HW casing pipes wer inserted.

The hole was drilled down to 32.00 m with a HQ-WL bit.

The complete loss of mud water took place at 29.00 m, 30.00 m and 31.00 m.

A mud ball mixed with bentanite, Tel-Stop and saw dust was thrown into the hole to prevent the water loss. However fissures which caused it seemed large and deep ones, and the recovery of mud water was only 15%. Meanwhile, the hole was reamed with a HW casing shoe bit and casing pipes were extended to 32.00 m to prevent caving.

The weathered zone continued and water loss occured occasionally. Accordingly, above procedure, namely, drilling, reaming and casing, was repeated to 42.00 m. The hole was drilled to 74.90 m with a HQ-WL bit and NW casing pipes were inserted.

Then, drilling was continued to 201.00 m with a NQ-WL bit.

The rock facies was the alteration of tuff and tuff breccia. Because of this stable facies, drilling were performed without hindrance like choking.

When NQ-WL rods were tried to be pulled out at 201.00 m to change the bit into BQ-WL one, they were trapped in the coagulated mud water.

Accordingly, mud water circulation was continued for eleven hours to

replace the coagulated water with new water and they were pulled out eventually. Thereupon, BW casing pipes were inserted to 201.00 m and the bit was changed to BQ-WL one.

Below this, the rock facies changed to be brechered clayey tuff and tuff breccica which caused frequent choking and increase of the soil pressure. They were recovered by applying ribonite water instead of bentonite water and the drilling was continued.

When the hole reached 400.80 m , it was finished. Then, BW casing pipes were tried to be pulled out but in vein.

An additional timber trestle was mounted to double the hoist wire but this arrangement also made no effect in pulling them out even with the help of the hydraulic force of the drilling machine.

Two jack of 20t were tried but also in vein. Eventually, NW casing pipes were pulled out and the hole was reamed from 74.90 m to 201.00 m with a diamond casing shoe bit.

And all the pipes were successfully pulled out at last.

2-3-6 No. 53-6 hole

Total drilled length	: 300.30 m
Drilled rock core length	: 284.30 m
Rock core recovery	: 94.70 %

Dry drilling was carried out to 2.00 m with a single metal bit of 116 mm dia. and the hole was drilled down to 9.00 m by wet drilling with a long metal bit of the same diameter, where HW casing pipes were inserted.

The bit was substituted by a HQ-WL bit.

The rock facies was fissured limestone and the complete loss of mud water took place at several depths below 30.00 m which was tried to be prevented by throwring a mud ball of bentonite, Tel-Stop, sewdust and fallen leaves into the hole. It gave, however, no effect to prevent it because of

too many fissures, so that grease was applied on the rods to prevent their wear due to vibration. Thus, drilling was continued to 44.70 m and NW casing pipes were inserted to the same depth. The bit was substituted by a NQ-WL bit and mud water was completely lost when the hole reached 45.20 m. The same preventive measure as above was applied without much effect. Accordingly the hole was reamed to 45.50 m by a NW casing diamond shoe bit and NW casing pipes were inserted to the same depth.

Drilling was resumed and continuied to 119.80 m. During this drilling, complete water loss took place again but drilling was continued by applying the same preventive measure as above.

BW casing pipes were eventually inserted to the same depth.

Then, the bit was substituted by a BQ-WL bit and drilling was finished when the hole reached 300.30 m. During the drilling with the BQ-WL bit, mud water was completely lost at 152.00 m, 160.00 m, 190.00 m and 263.00 m, and the preventive measure as described above was applied to continue drilling.

The rock facies were limestone to 121.50, meta welded tuff between 121.50 to187.10 m and crushed metaandesite between 187.10 m to the bottom, which caused core choking and consequent deterioration of the drilling progress.

2-3-7 No. 53-7 hole

Total drilled length	: 300.50 m
Drilled rock core length	: 241.90 m
Rock core recovery	: 80.50 %

The hole was drilled to 3.00 m by dry drilling with a single metal bit of 116 mm dia. and extended to 11.30 m by wet drilling with a long metal bit of the same dia. to which depth HW casing pipes were subsequently inserted.

A HQ-WL bit was attached and the hole was drilled to 20.00 m. Since weathered soil and skarn caused caving of the hole, it was reamed to 18.00 m

by a HW casing metal shoe bit and HW casing pipes were inserted to the same depth.

Drilling was continued to 42.50 m and NW casing pipe were inserted down.

The bit was substituted by a NQ-WL bit.

Fissured limestone was encountered from 41.00 m which caused mud water loss. The mud ball as described above was made and thrown into the hole to prevnet it but all in vein.

Eventually, reaming by a NW casing diamond shoe bit and casing were carried out alternately.

Thus, NW casing pipes were inserted down to 74.00 m. Drilling was continued with the same sized bit to 122.90 m through crushed limestone, skarn and granite porphyry etc, and BW casing pipes were inserted.

The bit was substiluted by a BQ-WL bit and the hole was drilled to 153.00 m through crushed argilaceous welded tuff, where the BQ-WL rods wered jammed due to caving and the soil pressure increase. Then, the hole was reamed to 152.00 m with a BW casing diamond shoe bit and casing pipes were inserted.

Drilling was continued with the same sized bit through welded tuff, tuff breccia, diorite porphyry, etc, and it was finished when the hole reached 300.50 m. During this drilling, caving took place occasionally but was recovered by circulating ribonite solution in the hole.

Drilling water was taken in a bag, sized 3.0m x 4.0m x 0.8m, provided in a swamp which was 1 km far from the hole and delivered to the hole base in a tank of 1,000ℓ capacity equipped on a small truck. The road from the swamp to the hole was very bad in its condition particularly when it rained. Accordingly, when mud water loss was serious, drilling was suspended frequently since water delivery could not catch up with water consumption due to the bad condition of the road.

2-3-8 No. 53-8 hole

Total drilled length : 301.00 m

Drilled rock core length : 273.10 m

Rock core recovery : 90.7 %

The hole was drilled to 2.00 m by dry drilling with a single metal bit of 116 mm dia. and extended to 8.90 m by wet drilling with a long metal bit of the same diameter. HQ casing pipes were inserted to the same depth. The bit was subitiluted by a HQ-WL bit and the hole was drilled to 12.00 m where the HW casing pipes fell down to 10.50 m because of the rod vibration. Accordingly, HW casing pipes were extendend to the same depth. The bit was subitituted by a NQ-WL bit and the hole was drilled down to 119.70 m.

The drilling progress was selicefactorily good because no serious water loss and caving took place except for frequent choking.

Then, BW casing pipes were inserted to the same depth. The bit was substituted by a BQ-WL bit and drilling was continued.

When the hole reached 301.00 m, drilling was finished. The rock facies below 150.00 m was pyroclastic rock crushed by intrusive dykes which caused core choking and occassional caving but drilling was performed by protecting the hole with ribonite water circulation.

2-4 Mobilization and De-mobilization

No.1 drilling machine was transfered for operation from No. 53-1 to, No. 53-3, No. 53-5 and to No. 53-8. Meanwhile, No. 2 drilling machine was transfered from No. 53-2 to No. 53-4, No. 53-6 and then to No. 53-7. This transfering work was done without difficulty since the roads to the drilling sites were developed so that a 4-ton truck was trafficable.

Transfer and re-installation of the drilling machine at the drilling hole of No. 53-1 and No. 53-2 took 8 days as material transportation was

done simultaneously but the same work at No. 53-3, 53-4 and 53-5 took 3 to 4 days respectively, and respective 4 to 6 days at No. 53-6, 53-7 and 53-8 in Minitas.

After the accomplishment of drilling works, No. 1 and No. 2 drilling machines were dismantled and stored in the storage hut built in the yard of the base camp in La Flecha. The dismantiling work of No. 1 and No. 2 drilling machines were finished on 26th and 29th, September. respectively. And on the request of a counter part, the drilled cores were stored in the other storage hut built in the same place.

Chapter 3 Geology of the Drill Holes

3-1 Surface Geology around the Drill Holes

3-1-1 On the Hole No. 53-1

This hole is located along a roadside inthe La Vegona village at the eastern end of the hilly land in the Vueltas del Rio area. The surface around the point of this drill hole is composed of metamorphosed members of tuff, tuff breccia and welded tuff belonging to the Vueltas del Rio Formation, situated at the eastern end of the axis in east and west of a syncline. The area is corresponded with geochemical high anomaly of copper and zinc obtained through UNDP survey and by this series of the surveys carried out in the last year. Also, the area is close to the tectonic line trending northeast and southwest. The rocks distributed at and around the drill hole are rather intensely altered. The drill hole is situated in the moderate zone of the FE anomaly of IP survey, the center of which is located in the west.

3-1-2 On the Hole No. 53-2

This hole is located at the southeastern end of the hilly land in the Vueltas del Rio area. The surface around the drill hole is composed of metamorphosed member of tuff, tuff breccia and others belonging to the Vueltas del Rio Formation as is the case of the drill hole No. 53-1. The beds are trending almost east and west, and many joints are developed well. The point of the drilling is corresponded with the marginal zone of the high anomaly of copper and zinc obtained by the UNDP geochemical survey, and also is corresponded with the high anomaly of the geochemical survey carried out in the last year. On the surface, oxidation and limonitization are extensively found in the west of the drill hole, in addition to the other alteration.

3-1-3 On the Hole No. 53-3

The area around this hole is underlain by metamorphosed welded tuff, tuff, tuff breccia and andesite of the Vueltas del Rio Formation distributed in the southern part of the survey area. They are trending east and west, with the dip to the north. Fracture zones and fissures of the direction mainly of east-west are found in the surrounding area, which is corresponded to the peripheral zone of the high anomaly of copper and zinc, detected by the UNDP geochemical survey. The vicinity is in a depression topographically. Alterations such as argillization and sericitization are observed to be remarkable.

3-1-4 On the Hole No. 53-4

This hole is located in the midway between the drill holes No. 52-3 and No. 52-4, which is on a range topographically. The vicinity is composed of metamorphosed members of tuff breccia, tuff and welded tuff of the Vueltas del Rio Formation. The location of this hole is corresponded with the axial part of an anticline in the central part composing a part of the synclinorium with the axis running east and west. The position of the drill hole is included in the high anomaly of gold by the results of the UNDP geochemical survey, and also is within the fracture zone bearing gold with the east-west trending, in which drill holes No. 52-3 and No. 52-4 are located. Several old workings of the past exploration for gold have been found around the drill hole. The surrounding area of the drill hole is in a heavily altered zone by argillization and sericitization, with the development of schistosity. It is corresponded with the southwestern marginal part of the moderate FE anomaly of IP survey.

3-1-5 On the Hole No. 53-5

This drill hole is located on a range in the northeastern part of the highest land in the Vueltas del Rio area, and dykes of the dacitic

porphyry are distributed at the drillspot, intruding the Vueltas del Rio Formation. The surrounding area is composed of metamorphosed members of tuff, tuff breccia and andesite etc., altered by intense silicification, sericitization and argillization. Schistosity remarkably develops, mostly in the direction of northeast-southwest. The area is corresponded with the axial part of a syncline with the axis running east and west. No notable anomaly has been detected around area by the geochemical survey, although the area is situated in an area of strong FE effect by IP survey, with heavy dissemination of pyrite.

3-1-6 On the Hole No. 53-6

In the Minitas sector, the areas for drilling were selected along the contact zone of limestone and metamorphosed igneous rocks on the higher part of the hilly land.

This drill hole is located at the south of the Minitas village, of the height of 500 m above sea level, which is on a plateau composed of limestone. Skarnized zones are known on the surface in the northeast and along the southwest to northeast side. The limestone is fine grained compact whitish grey massive rock, belonging to the Atima Formation. Along the Minitas valley in the east side, metamorphosed andesite and pyroclastic rocks are found exposed. The area around this drill hole is situated in a high anomaly zone of copper, including high anomaly of zinc, which was detected by the geochemical survey. In the vicinity of the drill hole, fissures, dykes of granite porphyry and skarnized zones with the trend of northwest-southeast are distributed, though partly trend of east-west has been recognized.

3-1-7 On the Hole No. 53-7

The drill hole is located on a range of the altitude of 550 m above sea level, located 350 m north of the drill hole No. 52-6. The area is occupied by the skarnized Atima limestone, composed of skarn minerals of

garnet associated with dark brown iron-oxide minerals. In the surrounding area, limestone and metamorphosed andesites are found in the lower part. The area is in a high anomaly of copper detected by the geochemical survey. The anomaly of zinc is also seen in the surrounding area. Carbonatization and argillization in addition to skarnization are recognized partly. In the vicinity of the drillhole, fissures of the direction of NWW-SEE, skarnized zone extending northwest and southeast, limestones trending east-west or northwest-southeast and basement rocks in east and west are developed, and the variation of such directions has been recognized.

3-1-8 On the Hole No. 53-8

This drill hole, positioned along the boundary zone between limestone and metamorphosed andesites, is located on the slope of rather broadly distributed talus of the hight of 430 m above sea level. The vicinity is composed of talus covering, containing boulders of Tertiary volcanic rocks, the limestones, and the older rocks, which has rendered the relation between limestones andigneous rocks to be uncretain. By the results of the geophysical prospecting, moderate FE effect has been detected in this area, while, by the result of the geochemical survey, the area is corresponded with the marginal zone of the high anomaly of copper, lead and zinc, distributed in the southern side.

3-2 Geology of the Drill Cores (Refer to PL.II-3, PL.II-4, PL.II-5, PL.II-6, PL.II-7 and PL.II-8)

3-2-1 Hole No. 53-1 (400.00 m, vertical)

(1) Rocks

From the surface to the depth of 6.5 m, the core comprises river sediments. Between 6.5 m and the depth of 194 m, the rocks are metamorphosed welded tuff with the insertions of fine to medium grained tuff and metamor-

phosed andesite, and to the depth of 269 m the core is composed of fine grained metamorphosed andesite. The core below the depth of 269 m to the bottom is constituted by metamorphosed tuff breccia with two thin layers of tuff inserted at the depths of 350 m and 372 m. Schistosity develops in the tuff.

(2) Alteration

Intense sericitization is found in the core from 73 m to 194 m of the depth, mainly of welded tuff and in the core from 310 m to 350 m of the depth, mainly of metamorphosed tuff breccia. Carbonatization is seen partly and weakly. Silicification is observed in moderate to intense degree from 194 m to 350 m of the depth. Chloritization is seen in all through the cores except the part composed of metamorphosed andesites. The fracture zone with clay is found between 279.2 m and 288.4 m of the depth.

(3) Mineralization

Pyritization is weak but is found almot to the depth of 101 m, below which there is no pyritization.

Copper mineralization is found along the length of 2 m between 96 m and 98 m of the depth, which shows Cu 1.28% and Zn 0.12%, as well as along the length of 2 m from 98 m to 100 m of the depth, revealing Cu 0.18%. There are remarkable indications of mineralization in steeply dipping quartz veins 5 to 10 cm in width containing chalcopyrite and pyrite. Three veinlets-zones are found between 97.2 m and 98.6 m of the depth.

From the surface to the depth of 16 m, the assay of the core shows Zn 0.15% in average. It has not been confirmed yet whether this zinc indication is due to zinc-oxide or not. Content of gold is low.

3-2-2 Hole No. 53-2 (301.0 m, vertical)

(1) Rocks

Weathered soil is seen down to the depth of 6.25 m from the surface.

From there to the depth of 160.1 m, the core comprises light medium grained tuff carrying well developed lamelae structure with three inserted layers of tuff breccia. Down to the depth of 210.5m, tuff breccia develops and to the depth of 235.9 m there is fine grained tuff. To the bottom from there, metamorphosed andesite with thin layers of tuff breccia insertion is recognized. This andesite is fine to medium grained porphyritic rock. Schistosity develops in the tuff.

(2) Alteration

All through the core, sericitization, carbonatization and argillization are recognized to have been developed except for the part of the core below 210 m of the depth, where alteration is inferior. Especially, in the core between 150 m and 200 m of the depth, remarkable sericitization is recognized in the tuff breccia. As a fracture zone, white brecciated clay zone is seen at the depth between 210.5 m and 214.5 m.

(3) Mineralization

Weak pyritization is recognized from the surface to the depth of 210 m, below which pyritization is rare. The part where high gold grade of as much as 44 g/t is contained has been detected between 6 and 8 m of the depth. This part is composed of remarkable hematite association along weak fissilities in the tuff. Also, the part at the depth of 173 m and 174 m reveals the assay results of Au 97 g/t, Ag 80 g/t, Cu 5.94% and Zn 0.19%. This is corresponded with the part where calcite veins are contained in the tuff breccia. The part is composed of the mineralized veins of 5 cm in width in fracture zone. In the tuff from the depth of 6 m to 32 m, zinc is contained as much as 0.11%.

3-2-3 Hole No. 53-3 (400.8 m, vertical)

(1) Rocks

Weathered soil is there from the surface to the depth of 3.5 m.

From there to the depth of 64m, welded tuff is seen. Tuff breccia is recognized between 64 m and 228.1 m of the depth, in which metamorphosed andesite along the length of 20 m and partly tuff layers are inserted. From the depth of 228.1 m to 312 m, tuff is seen and from there to the bottom, the core is composed of tuff breccia with the insertion of metamorphosed andesite 5 m in length.

(2) Alteration

Weakly to moderately the cores are silicified from the surface to the bottom. Sericitization and carbonatization are recognized weakly down to the depth of 116 m, but intense argillization is found from the surface to the depth of 64 m. Chloritization is recognized moderately to intensely from the surface to the depth of 116 m.

(3) Mineralization

A zone of pyrite veinlets associated with sphalerite containing Au 3.34 g/t and Zn 1.85% has been recognized in the welded tuff at the depth from 46 m to 48 m. A group of galena-chalcopyrite-calcite veins containing Au 3.72 g/t, Zn 0.48% and Pb 0.15% has been found in the tuff breccia at the depth between 68 m and 70 m. Abundant calcite veins containing pyrite, chalcopyrite, sphalerite and galena are observed in fracture zones between the depth of 40 m and 84 m the Zn grade of which is 0.22% in average. Also, along the length of 22m, from the depth of 104 m to 126 m, network-like veinlets of calcite are seen gathered to form a mineralized zone showing Cu 0.122% in average. In this zone, chalcopyrite and minor amount of pyrite partly associated with sphalerite have been recognized. In the tuff breccia at the depth between 146 m and 150 m, four sphalerite-galena-chalcopyrite-pyrite ore veins are found at the steep dipping as much as 70^{o}, the average grade of which is Au 1.3 g/t, Zn 1.78% and Pb 0.19%. (Refer to Fig. I-2) Pyritization is recognized all through the cores but weak.