REPORT
ON
THE MINERAL EXPLORATION
IN
THE PACHAPIRIANA AREA
REPUBLIC OF PERU

CONSOLIDATED REPORT

MARCH 1992

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

Preface

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

The survey was carried out for four years from 1988 to 1991 by MMAJ in collaboration with Instituto Geologio Minero y Metalurgico (INGEMMET), Ministry of Energy and Mines, Government of the Republic of Peru.

This report summarize the results of the survey for four years. We hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

March, 1992

Kensuke YANAGIYA
President
Japan International Cooperation Agency

Gen-ichi FUKUHARA
President
Metal Mining Agency of Japan

CONTENTS

List of Figures

List of Tables

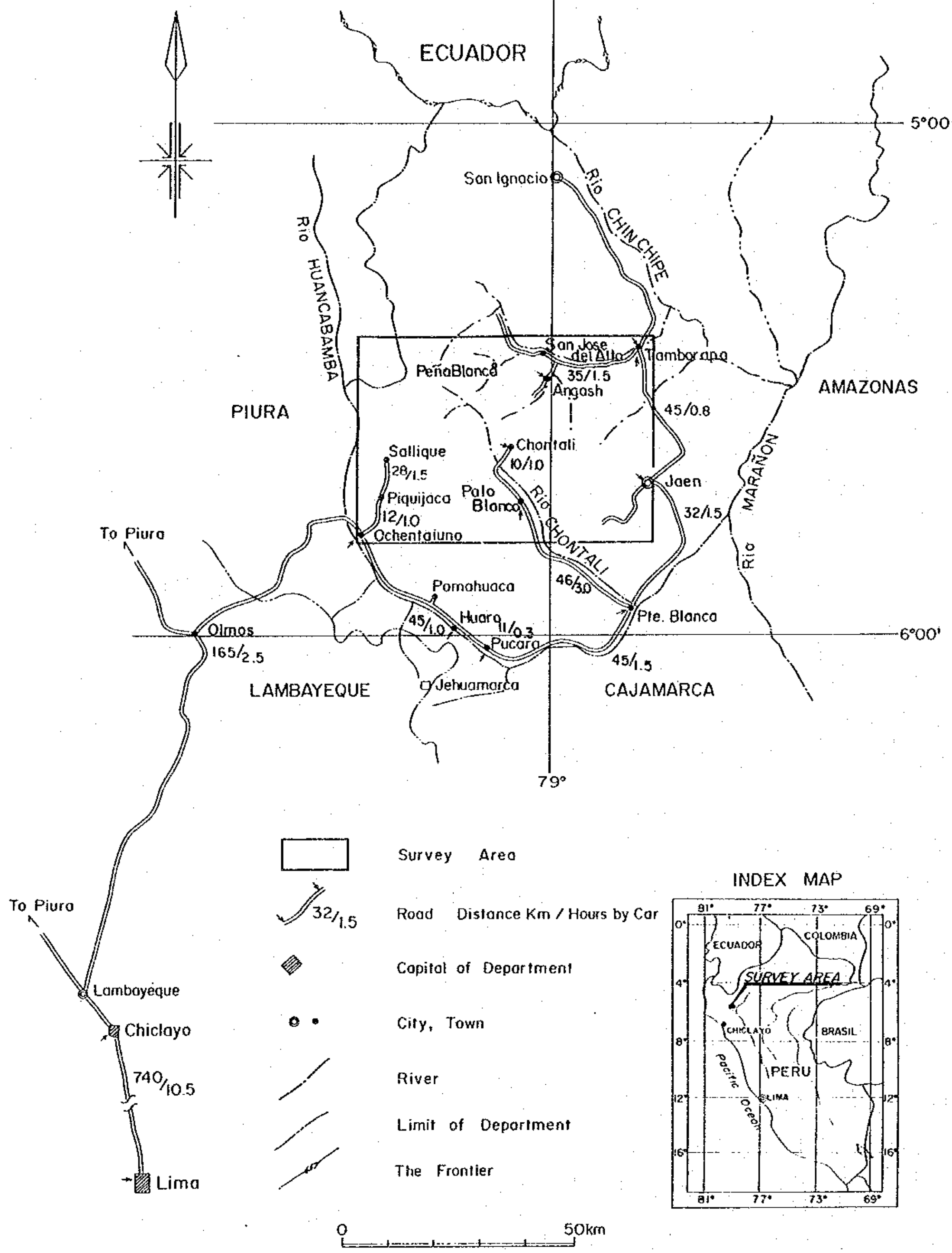


Fig.I−1 Location and Accessibility of the Survey Area

SUMMARY

This report summarize the results of the survey for mineral exploration and development in the Pachapiriana area, Republic of Peru, carried out for four years from 1988 to 1991. Purpose of the survey is to clarify the geological setting, characters of mineralization and their relationship, and to find the occurrence and potentiality of the mineral resources of the survey area.

The survey area is located at the border of Ecuador in northern Peru, occupying the east slope of West Andes cordillera, covering an area of 2,820km2 .

Geology of the area is composed of Cambrian Olmos Complex, pre-Silurian Salas Group, pre-Jurassic Leche Formation, Jurassic Oyotun Volcanics, Goyllarisquizga Group, Inca Formation, Chulec Formation, Pulluicana Formation of Cretaceous age, Llama Volcanics, Porculla Volcanics, Shimbe Volcanics of Tertiary age and Quarternary Tamborapa Formation.

Showings of minerlarization of the area can be classified into three types, skarn type, porphyry copper type and epithermal dissemination or vein type. Emplacement of the showings is confined to Leche Limestone, Oyotun Volcanics and Porculla Volcanics. The showings of skarn type mineralization occur within Oyotun Formation at Paramo of San Felipe area, Miraflores Sur of Palma area, and within Leche Limestone at Angash of Pena Blanca area. All showings of this type, however, appear to be too small and low grade to be a workable ore deposits.

The showings of porphyry copper type mineralization occur wihtin Oyotun Volcanics at La Huaca of San Felipe area and Zonanga of Palma area. The type of rock alteration and extent of geochemical anomalies of these showings indicate the existence of porphyry copper type deposits. Beside a wide spread low resistivity zone was found at La Huaca by electro-magnetic survey.

The showings of epithermal dissemination or vein type mineralization occur within Oyotun Volcanics at Pena Verde of San Felipe area, Hualatan of Chontali area, and within Porculla Volcanics of Jehuamarca area. Low resistivity anomalies by electro-magnetic survey were found on these showings.

A high resistivity body within a low resistivity anomaly which indicate a mineralized body was found and tested by diamond drilling in Jehuamarca. Diamond drilling has revealed an existence of copper-zinc-lead dissemination body associating with silicification zone. The grade of dissemination zone was too low to be economical at the present metal price. Thus this deposit is to be taken into account as a future resource.

In Hualatan of Chontali area, a gentle dome of high resistivity zone which suggest an intrusive body was detected in a zone of shallow gravity basement. Then auriferous quartz veins were found by diamond drilling. Taking the deflection of quartz veins and the distribution of the grade of outcrop into consideration, it can be assumed that the mineralization zone dips steeply southward. Gold content of the vein, which is very variable on the surface, can be improved in the depth of at least 200 meters below the surface, since the average of homogenization temperature of liquid inclusion of vein quartz shows 151℃ which is too low for gold deposition.

As a conclusion of the survey, the gold mineralization zone of Hualatan of

Chontali area is selected as the most potential target area for further exploration. On the other side, the showing of porphyry copper type mineralization which were remained without detailed survey are required to be carried out further geophysical exploration.

Part I GENERAL REMARKS

Table 1 Flow sheet of the Survey

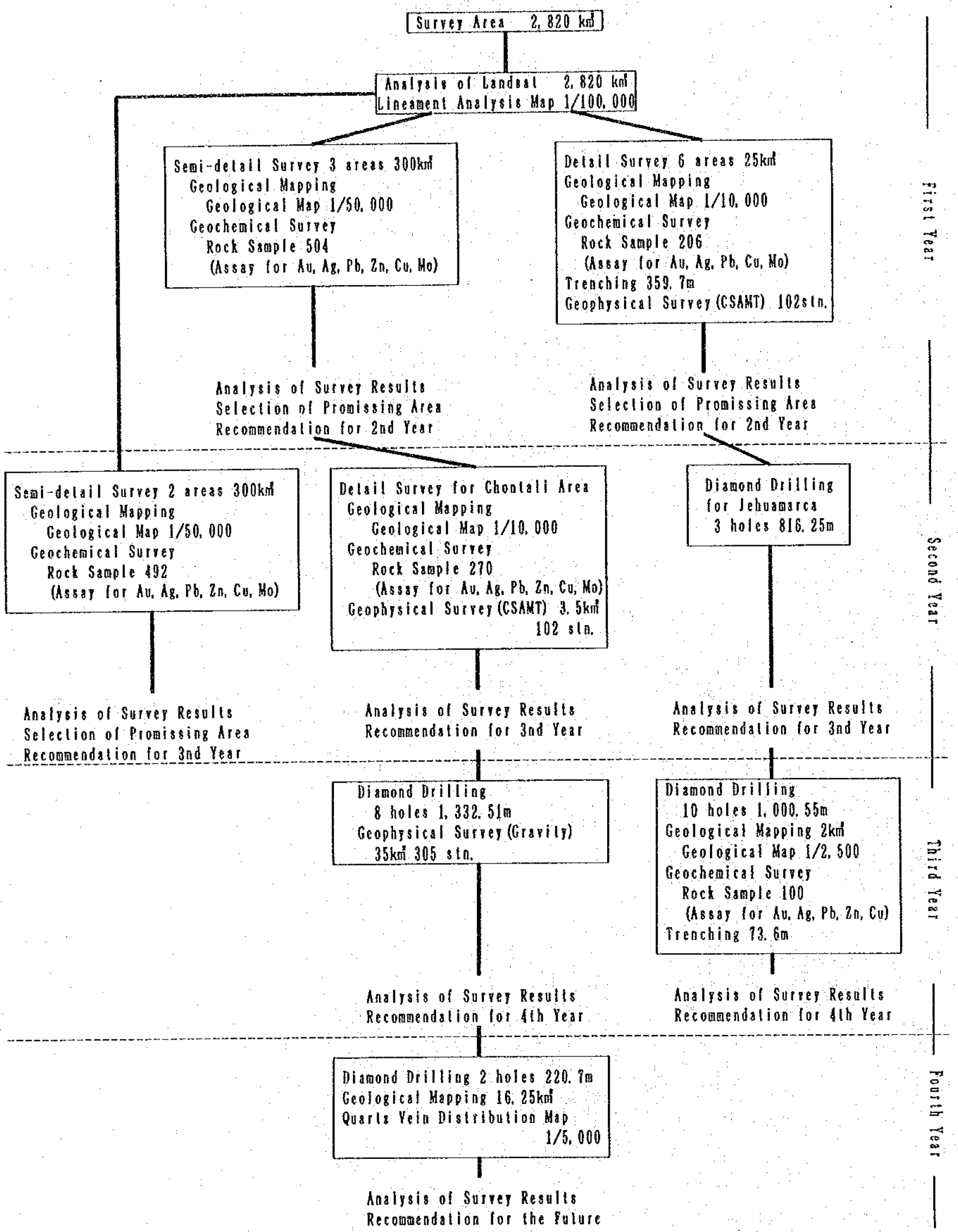
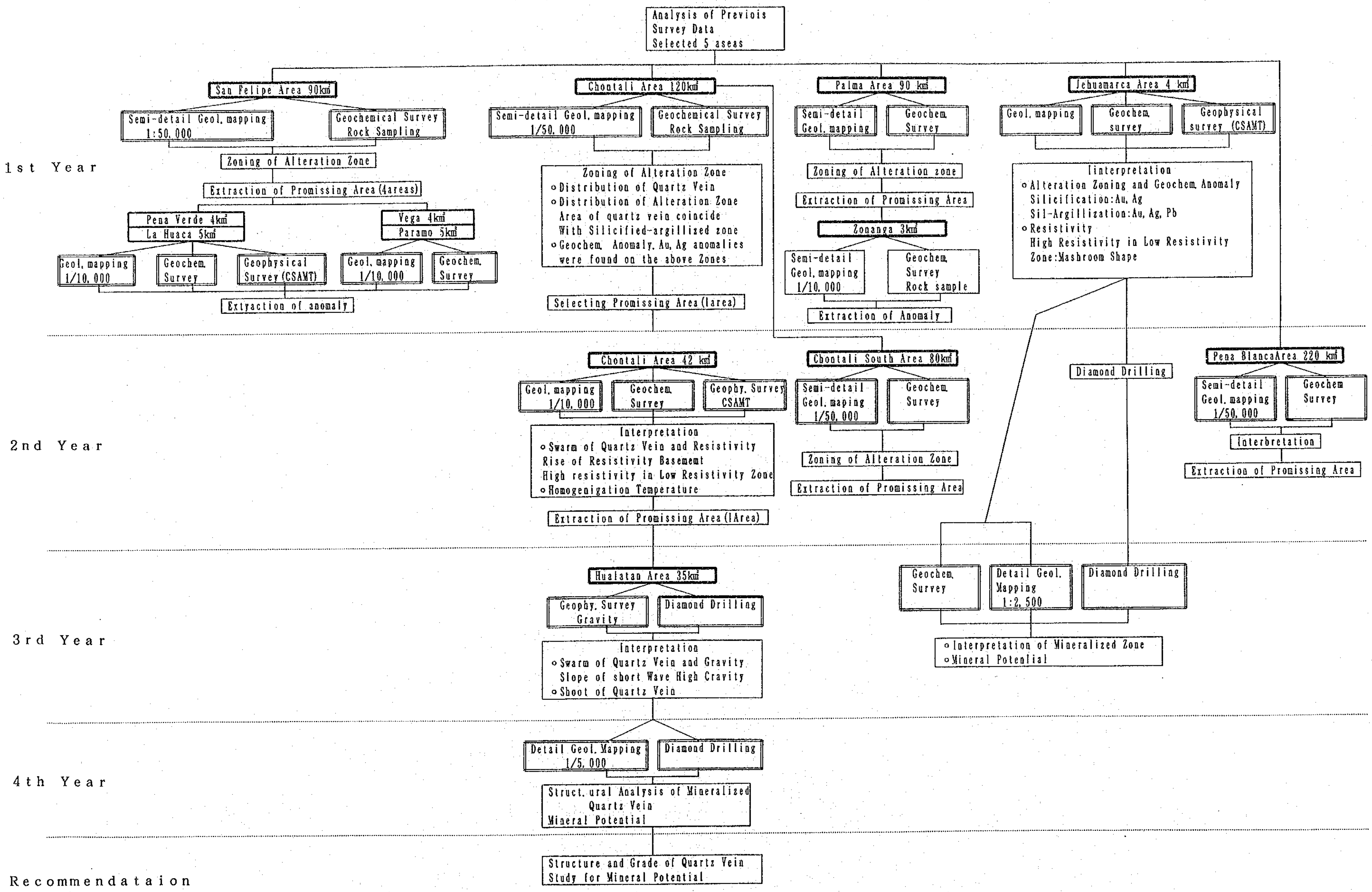


Table 2 Quantity of the Survey

	Phase I (1988)	Phase II (1989)	Phase III (1990)	Phase IV (1991)	Total
Geological Survey					
Semidetailed (km^2)	300	300	—	—	600
Detailed (km^2)	25	42	2.5	16.25	85.75
Trenching (m)	359.7	—	73.6	—	433.3
Geochemical Survey					
CSAMT (km^2, m.p.)	25, 102	35, 102	—	—	60, 234
Gravity (km^2, m.p.)	—	—	33, 305	—	33, 305
Drilling Survey					
Drilling hole	—	3	16	2	21
Total Length (m)	—	816.25	2334.06	220.70	3371.01
Laboratory Test(Sample)					
Chemical Analysis	26	236	327	54	643
Thin Section	20	24	25	5	74
Polished Section	15	9	22	—	46
X-ray Diffractive Analysis	20	28	48	15	111
Whole Rock Analysis	11	10	—	—	21
Homogenization Temperature	—	30	12	12	54
Absolute Age Determination	5	5	—	—	10
Resistivity measurement	20	23	—	—	43
Density Measurement	—	—	35	—	35

m.p. measured point

Table 3 Flow Chart of the Extraction of Promissing Area



Chapter 1. OUTLINE OF THE SURVEY

1-1 Survey Area and Purpose of the Survey

The survey area is located in the northern most of Peru, on the border zone with Equador, being situated in the east slope zones of the Western Andes mountains. That is, the area covers the ridge of the Western Andes on the west, and the Great Amazon Plains on the east.

In terms of administrative jurisdiction, the survey area covers three departments and four provinces. The major part of the area belongs to Jaen province, Cajamarca department, with its north-eastern part falling in San Ignacio province of the same department, and its north-western part in Huancabamba province, Piura department. Jehuamarca, the isolated portion of the survey area, is located in Ferrenafe province, Lambayeque department.

Geographically, according to the Universal Transverse Mercator Projection System, the survey area covers an area of 2,186km2 (44km x 64km) situated between 9,400,000N to 9,356,000N and 680,000E to 744,000E and another area of 4km2 (2km x 2 km) situated between 9,327,000N to 9,325,000N and 693,000E to 695,000E, thus being represented in a total area of 2,820km2.

The survey area is in a part of the area for which a geochemical survey using stream sediments was carried out under the Northern Geochemical Project (Proyecto Geoquemico del Norte) sponsored by the U.K. The detailed survey for the extracted geochemical anomalous zones was realized partially by INGEMMET itself, and partially by German and french organizations. However, the major part has remained pending due to shortage of funds.

Under these circumstances, INGEMMET requested, through the Ministry of Foreign Affairs of the Republic of Peru, technical cooperation from the Japanese Government for the follow-up survey in March 1988. In August 1988, a delegation for the preliminary survey and agreement negotiations for this purpose was organized among the Ministry of International Trade and Industry (MITI), Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ), and sent to Peru. On August 15, the scope of work to the Pachapiriana Area Project was signed between the parties.

The purpose of this survey was to verify the potential existence of mineral deposits expected in the survey area through various methods, including an analysis of existing data, lineament extraction based on the LANDSAT image analysis, geological, geochemical and geophysical surveys and diamond drilling.

1-2 Survey Method and Amount of the Work

The items and amount of the work carried out in the survey area are shown in the flow sheet of Table 1. Extraction of the promising area was done according to the flow chart of Table 3.

1-3 Survey Period and Member of Survey Team

Details of the survey period is summarized as follows;

Table 4 Survey Period

Year	Survey in Peru	Data Analysis in Japan
1st year	17. Oct.- 30. Dec. 1988	31. Dec. 1988 - 28. Feb. 1989
2nd year	10. Jul.- 29. Dec. 1989	30. Dec. 1989 - 28. Feb. 1990
3rd year	9. Jul.- 7. Dec. 1990	8. Dec. 1990 - 28. Feb. 1991
4th year	24. Jun.- 5. Aug. 1991	6. Aug. 1991 - 10. Jan. 1992

Members of the survey team for each years are as follows;

1) The first year

a) Preliminary Survey and Negotiation

From Japan:

Mr. Yoshio MATSUKAWA	MMAJ
Mr. Shotaro KISHIMOTO	MITI
Mr. Naotaka ADACHI	MMAJ
Mr. Hiroyasu KAINUMA	JICA

From Peru:

Mr. HERCILLA GONZALES. J.G.	INGEMMET
Mr. FLORES NANES, G.	INGEMMET
Mr. DYARLE GONZALES, L.	INGEMMET

b) Survey Group

From Japan:

Mr. Hiroshi HAMA	MINDECO
Mr. Minoru KAMEZAWA	MINDECO
Mr. Osamu MIZUYACHI	MINDECO
Mr. Fukujiro MIYOSHI	MINDECO
Mr. Takeshi YOSHIMOTO	MINDECO
Mr. Mitsuyoshi SAITO	MINDECO

From Peru:

Mr. VILCA NEIRA, C.	INGEMMET
Mr. ROJAS RIVERA, E.	INGEMMET
Mr. JIMENEZ VELASCO, C.	INGEMMET
Mr. GALLOSO CARRASCO, A.	INGEMMET
Mr. GAMARRA ROMERO, C.A.	INGEMMET
Mr. PARI PINTO, W.	INGEMMET

2) The Second Year

a) Planning of Survey

From Japan:

Mr. Hideya METSUGI	MMAJ

From Peru:

Mr. BALCAZAR RIOJA, G.	INGEMMET
Mr. FLORES NANES, G.	INGEMMET
Mr. DYRCE GONZALES, L.	INGEMMET

b) Survey Group

From Japan:

Mr. Hiroshi HAMA	MINDECO
Mr. Kazuhiro ADACHI	MINDECO
Mr. Kazuhiko YAMANAKA	MINDECO
Mr. Manabu KOBAYASHI	MINDECO
Mr. Takeshi YOSHIMOTO	MINDECO
Mr. Mitsuyoshi SAITO	MINDECO
Mr. Yuji KATABE	MINDECO

From Peru:

Mr. VILCA NEIRA, C.	INGEMMET
Mr. ROJAS RIVERA, E.	INGEMMET
Mr. QUISPE ARANDA, L.	INGEMMET
Mr. GAMARRA ROMERO, C.A.	INGEMMET
Mr. PARI PINTO, W.	INGEMMET
Mr. JIMENEZ VELASCO, C.	INGEMMET

3) The Third Year

a) Planning of Survey

From Japan:

Mr. Katsumi YOKOKAWA	MMAJ
Mr. Hideya METSUGI	MMAJ

From Peru:

Mr. BALCAZAR RIOJA, G.	INGEMMET
Mr. DEL CASTILLO, J.R.	INGEMMET
Mr. DEL AGUILA, R.	INGEMMET
Mr. FLOREZ NANES, G.	INGEMMET
Mr. CHACON ABAD, N.	INGEMMET

b) Survey Group

From Japan:

Mr. Hiroshi HAMA	MINDECO
Mr. Kazuhiko KINOSHITA	MINDECO
Mr. Mitsuyoshi SAITO	MINDECO
Mr. Haruo HARADA	MINDECO

From Peru:

Mr. JIMENEZ VELASCO, C.	INGEMMET
Mr. GAMARRA ROMERO, C.A.	INGEMMET

Mr. PARI PINTO, W.	INGEMMET
Mr. QUISPE ARANDA, L.	INGEMMET

4) The Fourth Year

a) Planning of Survey

From Japan:

Mr. Katsumi YOKOKAWA	MMAJ
Mr. Etsuo KOZAWA	MMAJ
Mr. Kenzo HAGIO	MITI
Mr. Tomoki SATO	MFA

From Peru:

Mr. DEL CASTILLO, J.R.	INGEMMET
Mr. CHACON ABAD, N.	INGEMMET
Mr. JIMENEZ BELASCO, C.	INGEMMET

b) Survey Group

From Japan:

Mr. Hiroshi HAMA	MINDECO
Mr. Akimitsu TAKEBE	MINDECO

From Peru:

Mr. JIMENEZ VELASCO, C.	INGEMMET
Mr. PALACIO, C.	INGEMMET

MMAJ : Metal Mining Agency of Japan
MITI : Ministry of International Trade and Industry
JICA : Japan International Cooperation Agency
MINDECO : Mitsui Mineral Development Engineering Co., Ltd.
MFA : Ministry of Foreign Affair
INGEMMET : Instituto Geologica Minero y Metalurgico

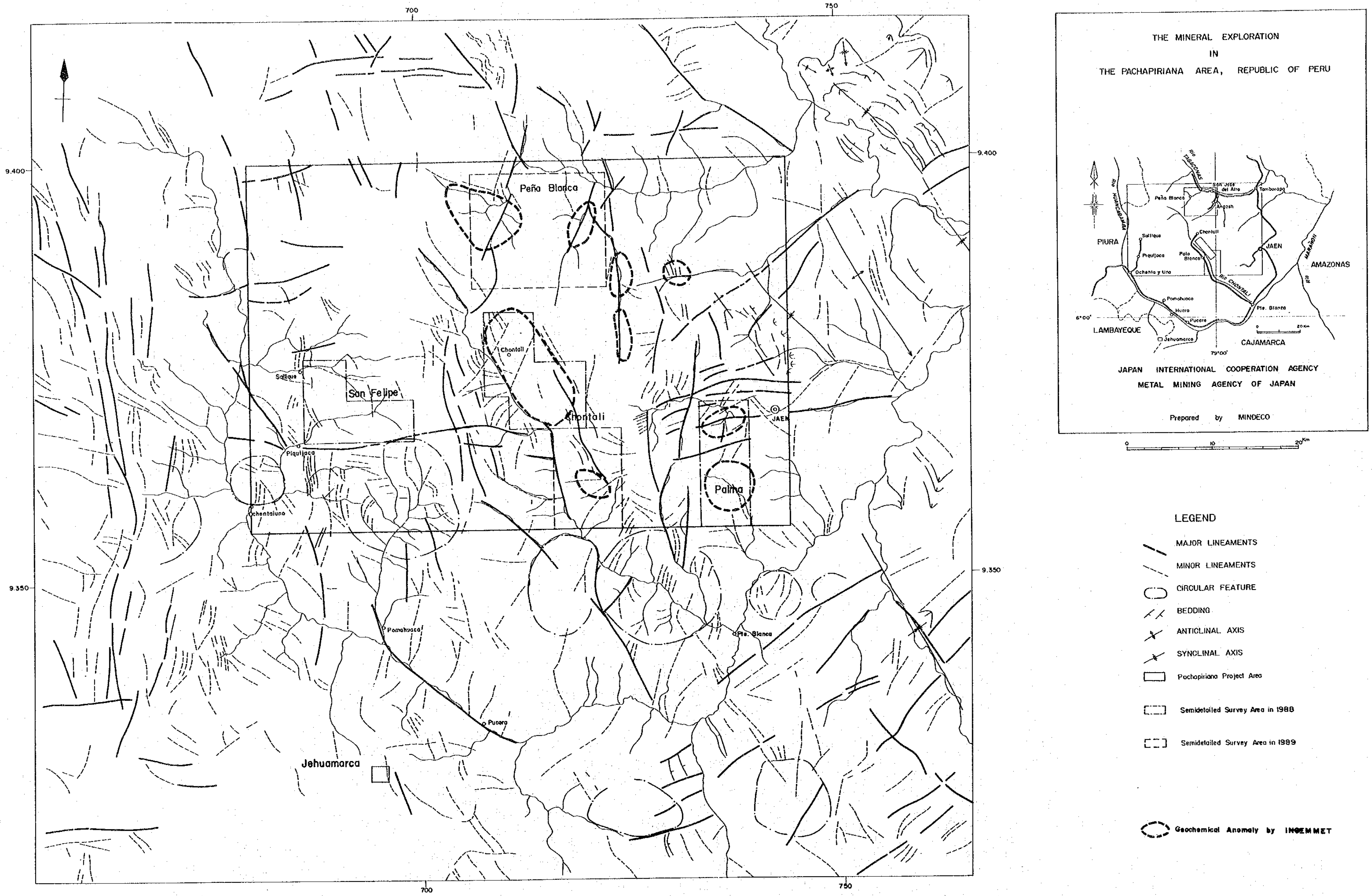


Fig. I - 2 Geochemical Anomary Extracted by INGEMMET

Chapter 2 AVAILABLE GEOLOGICAL DATA

Though in the past the survey area has been partially and/or locally surveyed from a geological viewpoint. Regional geological survey was conducted by INGEMMET in 1987. (Reyes. L. y Caldos. J., 1987).

With respect to the ore deposits, "Proyecto Geoquemico del Norte" was conducted during the period from 1968 through 1970 under the technical assistance of the U.K. government and its follow-up survey was performed by INGEMMET with technical assistance of West Germany and French governments from 1971 to 1975, and "Proyecto Integral Chinchipe" which was conducted through 1983 to 1986, are noted among others.

In the "Proyecto Geoquemico del Norte" mineralized indications were found out in Canariaco, La Huaca, La Granja, Jehuamarca, Pena Verde, Paramo and Vega, of which follow-up surveys have been carried out in Canariaco and Jehuamarca by INGEMMET, at La Huaca under the technical assistance of France, and at La Granja under the technical assistance of West Germany. Other mineralized indications were left without survey.

In the "Proyecto Integral Chinchipe", geochemical anomalies were extracted in Tomaque, Haquilla, Cerro Campaua, El Cedro, Las Pinas, Chontali, Jaen and Zonanga. Follow-up survey for the first four mineralized indications has been commenced in 1986 under the technical assistance of West Germany.

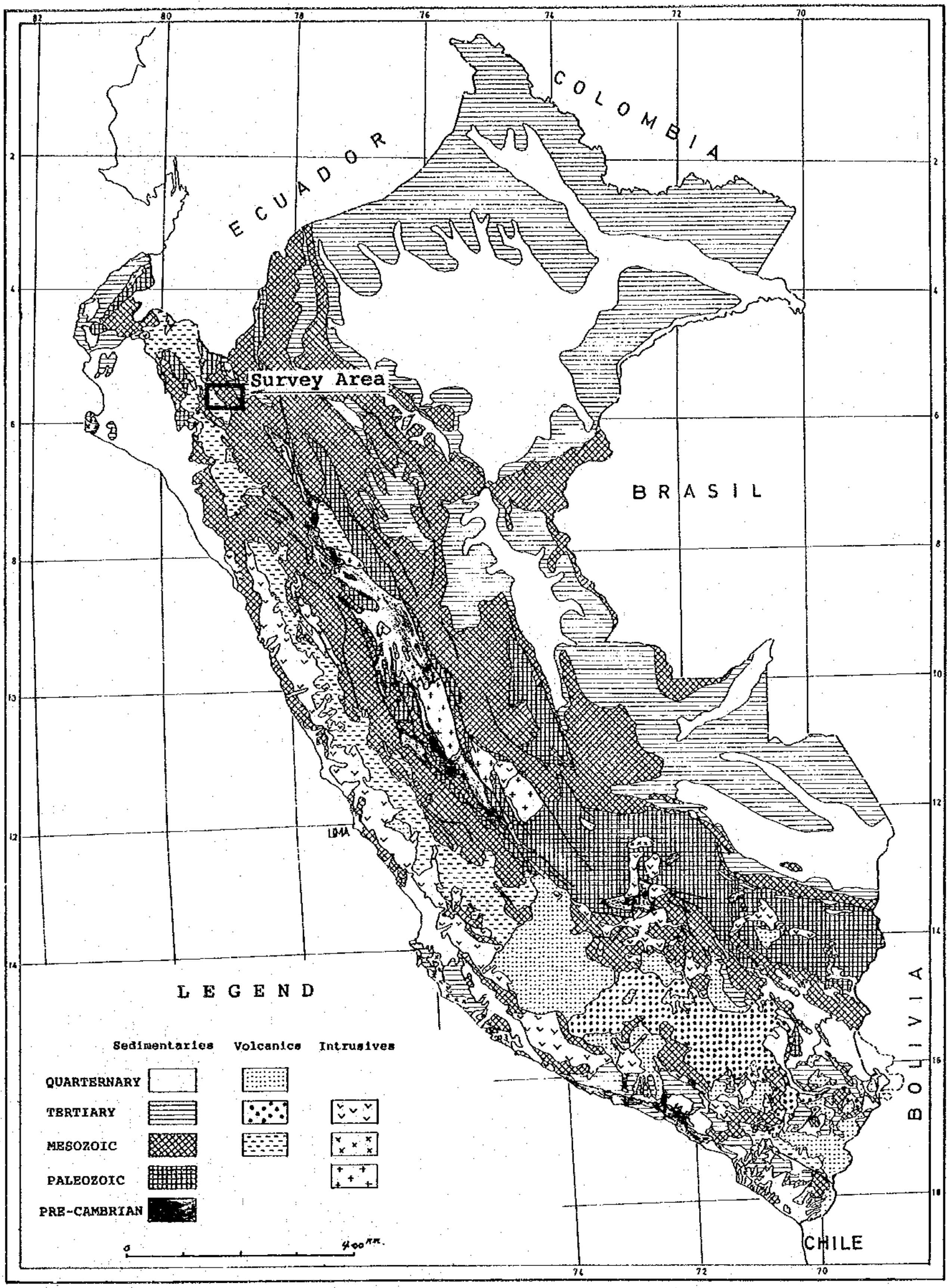
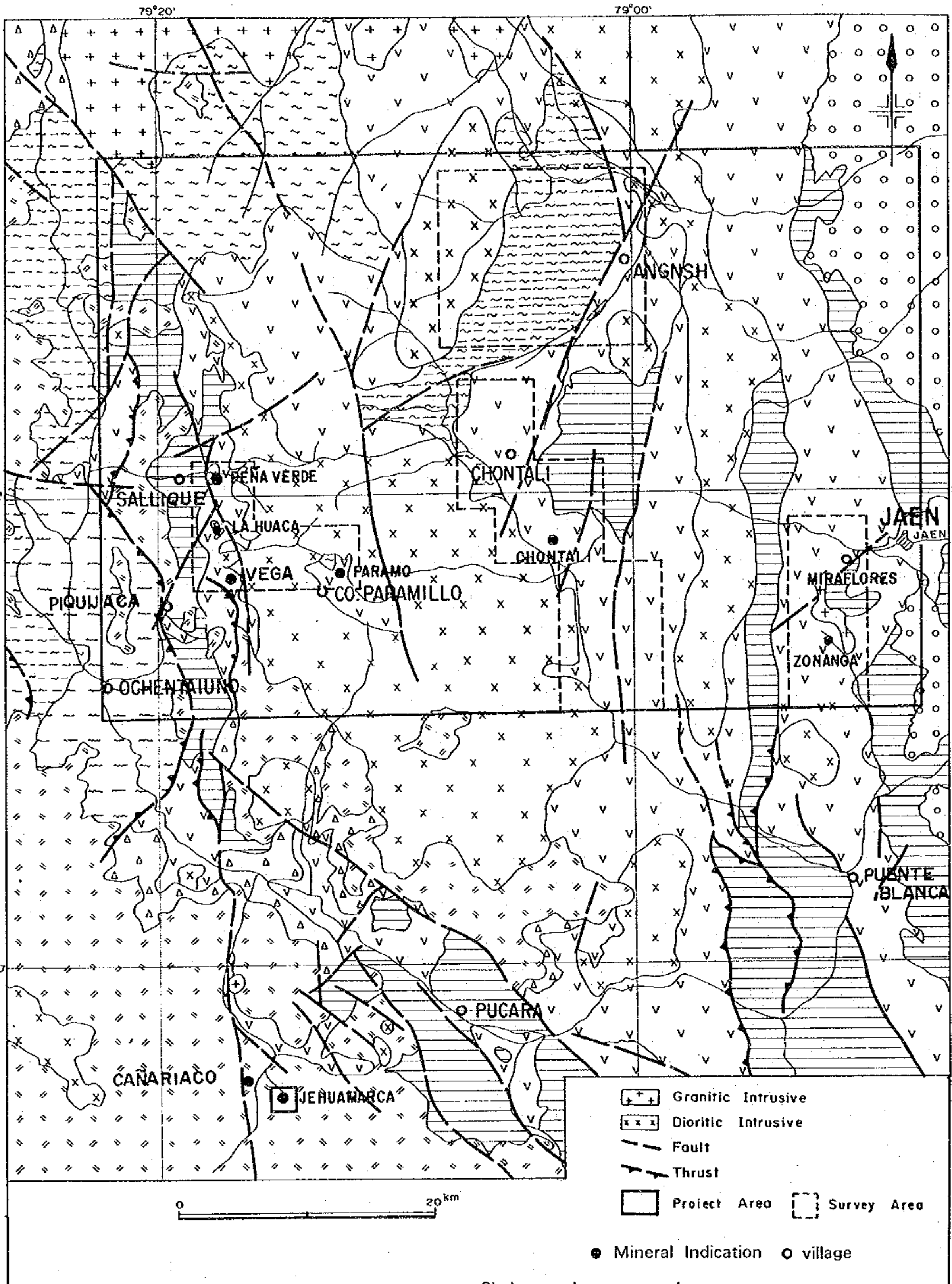


Fig. I - 3 Generalized Geological Map of Peru

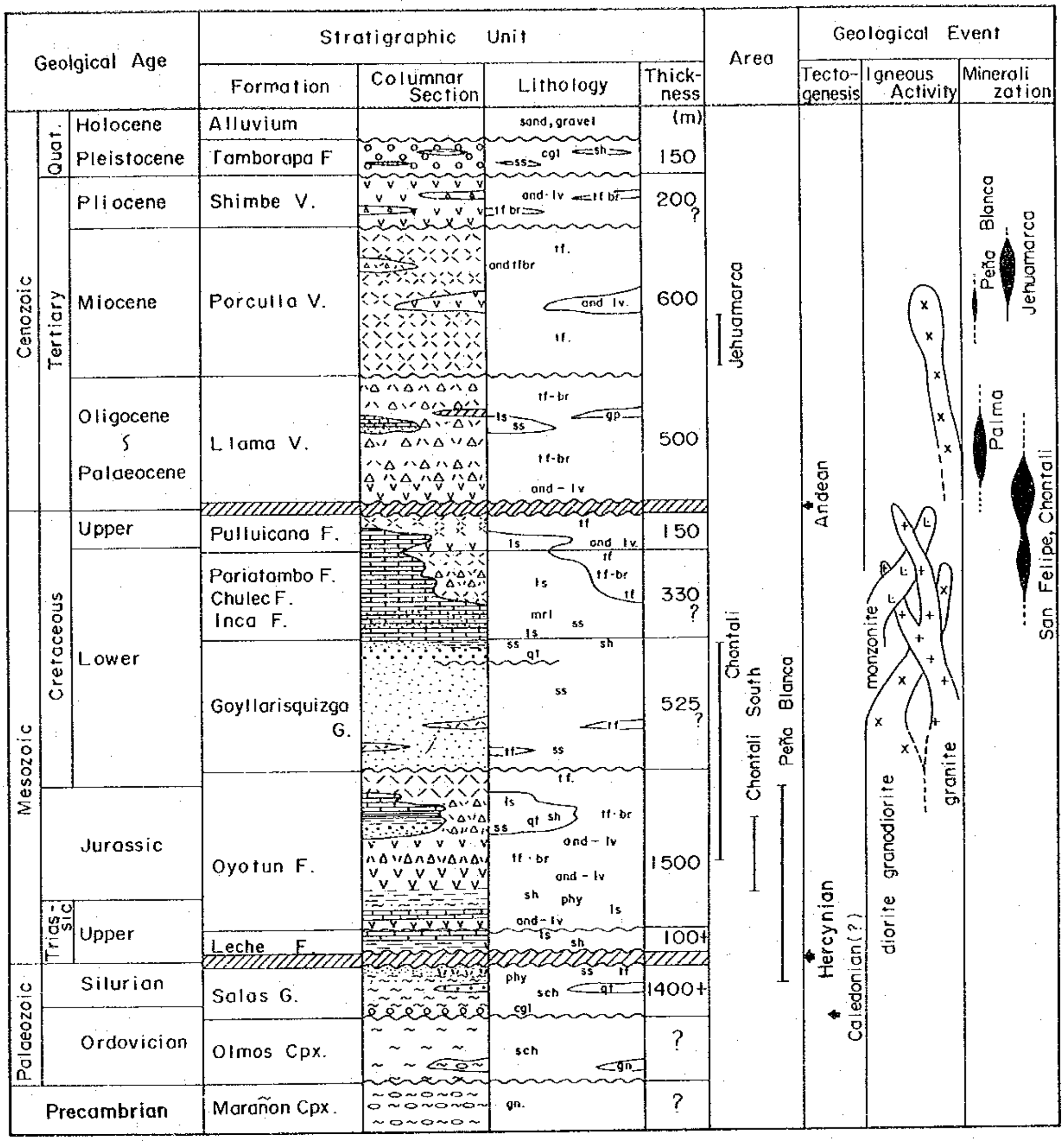
after Bellido (1969)



Quaternary	Tamborapa Formation		Shale, sandstone, conglomerate
Tertiary	Porculla Volcanics		Andesite, tuff, tuff breccia
	Llama Volcanics		Tuff breccia, sandstone, limestone, gypsum
Cretaceous	Goyllarisquizga Group		Quartzite, shale, sandstone, limestone
Jurassic Triassic	Oyotun Volcanics		Andesite, tuff, tuff breccia, shale, limestone
Silurian Ordovician	Salas Group		Phyllite, schist, quartzite, conglomerate
Cambrian	Olmos Complex		Schist, gneiss.
Proterozoic	Marañon Complex		Gneiss

Fig. 1 — 4 Generalized Geological Map of The Survey Area

modified from Wilson (1984), Reyes et al (1987) and Davila et al (unpubl)



Abbreviations.

and	andesite	gn	gneiss	md	mudstone	sch	schist
acd	acidic	gp	gypsum	mrl	marl	sh	shale
br	breccia	ls	limestone	phy	phyllite	ss	sandstone
cgl	conglomerate	lv	lava	qt	quartzite	tf	tuff
F.	Formation	V.	Volcanics	G.	Group.	Cpx.	Complex

Fig. I-5 Generalized Stratigraphic Column of the Survey Area

Chapter 3 GENERAL GEOLOGY

The survey area is situated in the southernmost of a tectonically disturbed zone, so called Huancabamba deflexion zone (Fig. I-3). At this zone general trends of geology turn from NNW-SSE so called Andean trend to NE-SW Ecuador-Columbian trend. This causes great variation of rock facies. In addition most of the survey area is uncivilized and the access of the survey routes is not easy, thus bringing some confusion to correlate geological formation and it requires further study.

Geological outline of the area is given below after Wilson (1984), Reyes y Caldas (1987) and Davila et al (unpublished), revised after the results of first and second years geological survey. A geological map and a stratigraphic column are generalized as shown in Figs. I-4 and I-5, respectively.

The survey area consists of metamorphic rocks correlative with Precambrian to Paleozoic, Mesozoic sedimentary and volcanic rocks and Cenozoic volcanic and intrusive rocks.

The metamorphic rocks, consist of the basement Maranon Complex, Ordovician Olmos Complex and Silurian Salas Group, show facies change from gneiss, schist to phyllite. They are distributed in the western half of the survey area.

Mesozoic rocks are the main constituent of geology of the survey area and consist of the following units in ascending order: Leche Formation (mainly calcareous rocks), Oyotun Volcanics, Tinajones Formation (arenaceous rocks intercalated with tuffaceous rocks), and Inca, Chulec, Pariatambo and Pulluicana Formations (mainly calcareous rocks).

Cenozoic rocks composed mainly of volcanic rocks which in ascending order are Llama, Porculla and Shimbe Volcanics, distributed in western and southwestern parts of the survey area. Tamborapa Formation consists of conglomerate, with loose consolidation, being correlative with the Quaternary sediments. This formation occurs at the eastern flange of the survey area.

Intrusive rocks consist of gabbro, diorite and granite. Generally, gabbro and diorite are older than granite which intrude Porculla Volcanics. The absolute ages determined by K/Ar method are 119±6 million years for quartz diorite, 106±5 million years for quartz monzonite, 82.5±4 million years for granodiorite, 78±3.9 million years for monzonisyenite and 47.6±2.4 for adamelite. The intrusive trends are NW-SE and N-S, reflecting the geological structure.

Geological structure of the survey area is characterized by its situation which located at the south flange of a distorted zone of general Andean Trend. This distorted zone, so called Huancabamba Deflection Zone, corresponds to the area where the general NNW-SSE direction, the basic trend of the Andes, changes direction to the NE-SW trend of the Colombia-Venezuela area. This deflection zone is assumed to have been formed during the Mesozoic tectonic movement.

Two combined fault systems are observed in the survey area. One is a set of E-W and NE-SW which is caused by an east-west lateral compression, and another is a set of N-S and NNW-SSE caused by northwest-southeast compression. Both fault systems reflect the tectonic movement at the time when the Huancabamba Deflection Zone was formed.

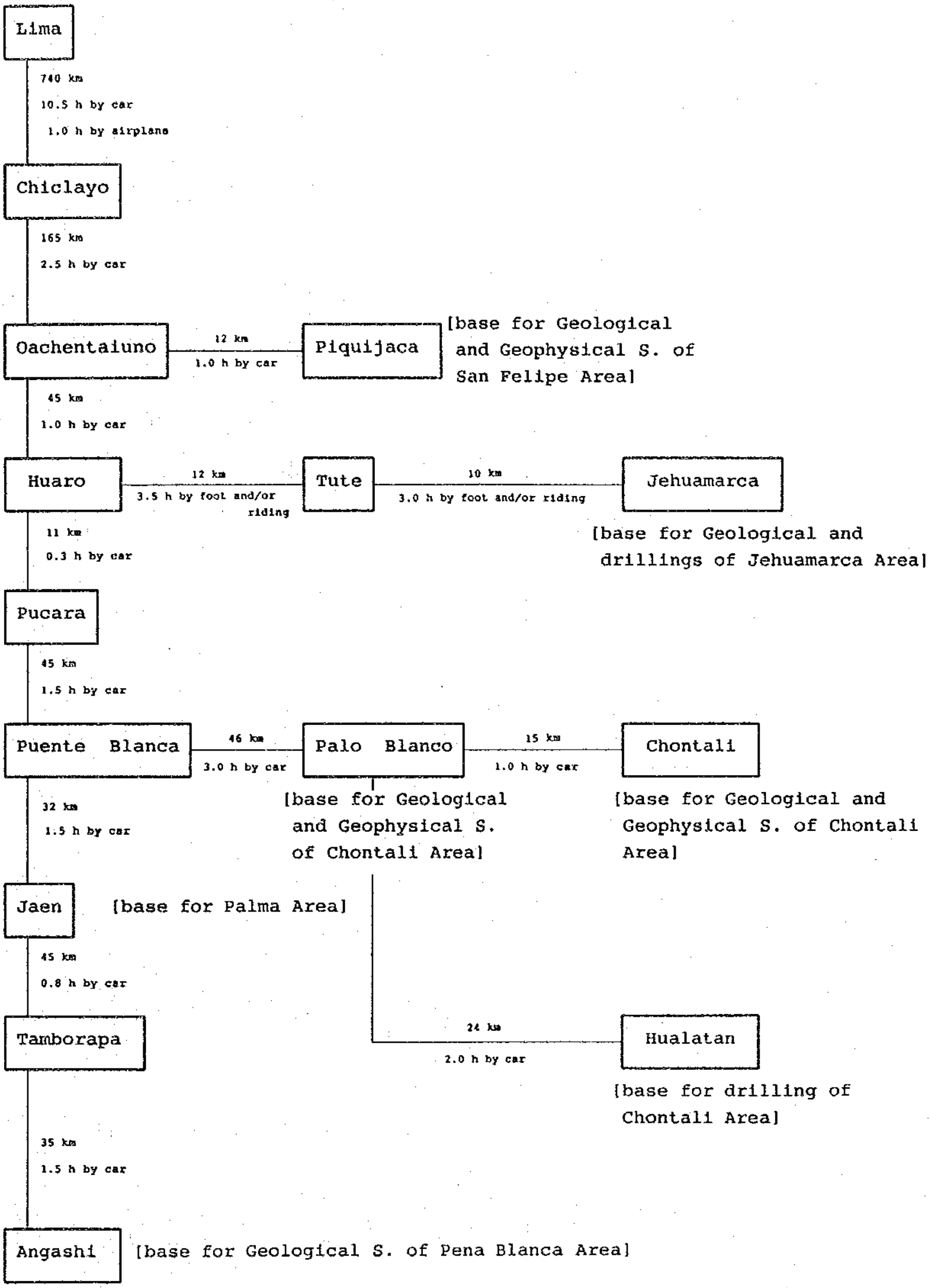


Fig. I-6 Summarized Accessibility of the Survey Area

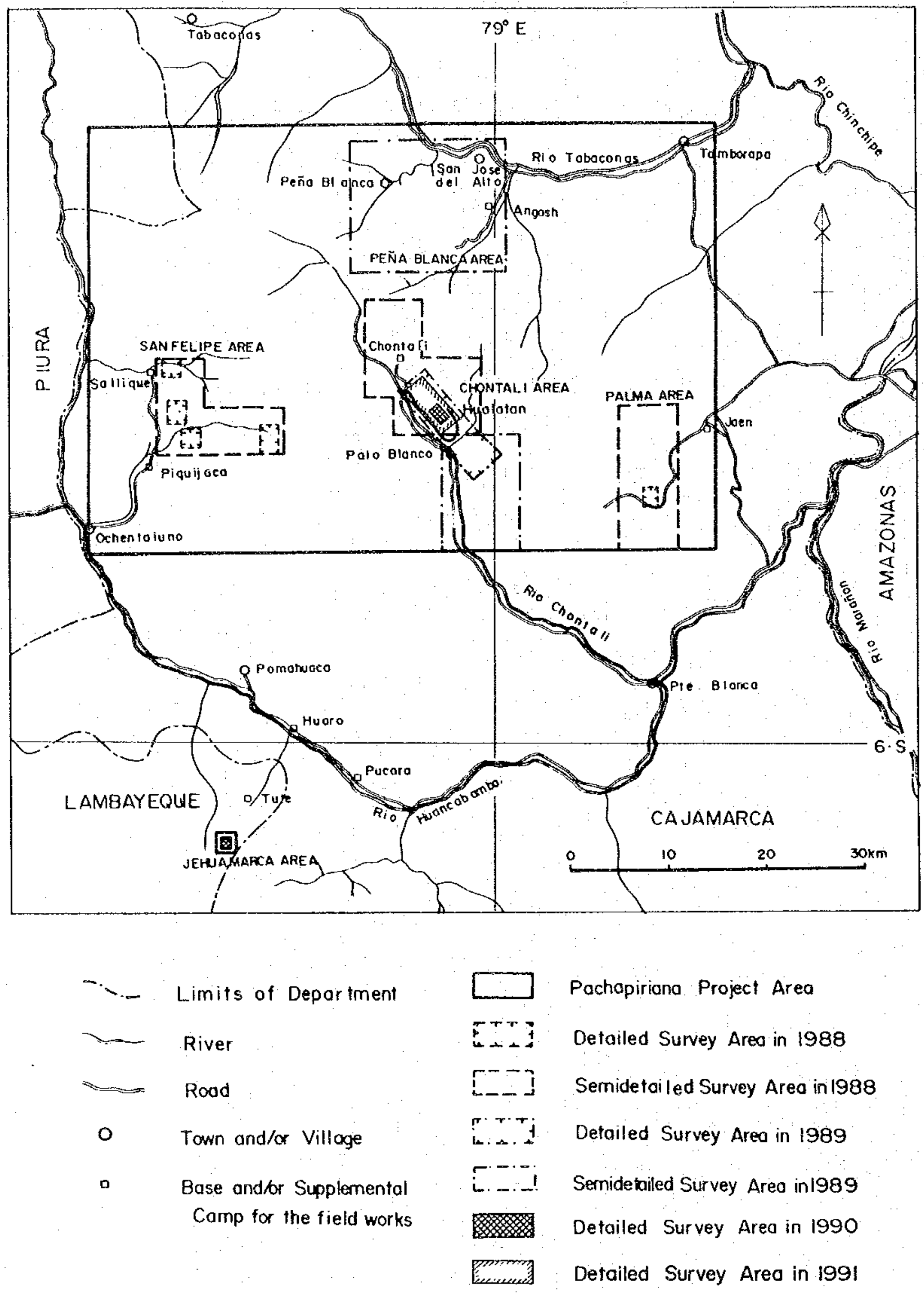


Fig I−7 Location of the Survey Area

Chapter 4 OUTLINE OF THE SURVEY AREA

4-1 Location and Access

Location and access to the each base camp set up in the survey area are as shown in Fig. I-6.

From Lima to Ochentaiuno the road is paved. From Ochentaiuno to Jaen, however, the road has been only partially paved by the road construction project planned under the administration of former President Belaunde. Under President Garcia's administration, the project was suspended and a major part of the road remains unpaved and without repair for the paved portion, thus traffic is very difficult during the rainy season. All minor roads were simply graded by bulldozer and have not been gravelled, therefore, passage is difficult even during the dry season.

There are only a few road in the survey area (see Fig. I-7). The main access are practically by riding on horseback. Even such trails are not yet sufficiently developed in the survey area as vast tropical rainforests still remain unexploited. So, a path clearing group was organized to obtain the survey routes in this survey.

4-2 Topography and Drainage System

The major part of the survey area is occupied by the Sallique mountain range according to the topographic division of Peru, with elevations of 700 meters to 3,800 meters above sea level, and is topographically young stage. In the west of the survey area, the Western Andes mountain range forms the watershed of the South American Continent and the lowlands of Huancabamba falling in between. The east end of the area the lowlands of Maranon of which topography is older stage having gentle undulation is situated.

As the Sallique mountain range was separated from the Western Andes by glaciation, remnants of glacial terrain such as U-shaped valley and glacial cirque are remained in low lands. Characteristic glacial terrains such as aiguilles, horns and grats are preserved throughout the high lands.

All drainage systems in the survey area flow into Atlantic Ocean via Amazon River. Major rivers include Huancabamba that runs along the west boundary of the survey area from north to south and changes direction to east-west in the southern part of the area, the Chontali that crosses the center of the area with a NW-SE direction, and the Tabaconas that runs along the north flange. All these rivers join the Maranon, one of the major tributaries of the Amazon in Peru.

With its abundant water resources, the Huancabamba is thought as the source of the irrigation channels to cross the Western Andes mountains to provide sufficient irrigation to the vast desert extending over the western part of the mountain range.

4-3 Climate and Vegetation

Climate and vegetation in the survey area is variable according to the altitude of which difference reaches about 3,000 meters.

Above the elevation of 3,000 meters from sea level, the distinctive Puna (high Andean plateau) climate is common, which is a part of cold zone. Vegetation is predominantly aciculate plants locally called "ichu" and low shrubs, which, coupled with steep glacial terrains, make difficult land utilization of this zones.

The areas between 1,500 and 3,000 meters above sea level are subtropical, having high temperatures and humidity, and form a main agricultural zone. A part of the highland subtropical rainforest zones remains uncultivated, forming a virgin area because of its steep topography. Bush burning is common in the cultivated part of these zones, secondary vegetation grows densely in the area left after burned-over. It is said that rain fall is decreasing in the western part of these zones as cultivation advances, gradually making the land into desert. There was abundant vegetation in the area downstream of Grande River, a tributary of the Huancabamba, whereas at present what remains is rocky desert.

Zones below 1,500 meters above sea level belong to the high temperature, high humidity tropical rainforest zone. At present, however, after progress in cultivation, the tropical rainforest zones remain only locally along river.

Although climate in the survey area seems to show remarkable local variation, it is difficult to systematize the variation because meteorological observation stations are few and meteorological data are poor. Table 5 summarizes the meteorological observation data at Jaen and Chontali as well as at Tabaconas (out of the survey area, northeastern extension).

Temperature shows a remarkable variation due to the altitude. The average values are higher at Jaen situated in lower land, decreasing as the altitude becomes higher toward Tabaconas via Chontali. At the three stations shown above, the average temperature variation for each month is so small that it can be said the seasonal variation of temperature is slight. However, it is suggested that the diurnal variation is very large, as the difference between maximum and minimum temperatures for each month is more than 10℃ at the three stations.

Humidity tends to be higher as the altitude becomes higher in contrast to the case of temperature. Judge from the average humidity for each month, the humidity seems to reversible with that of average temperature, independently to dry or rainy season.

Rainfall is not dependent to the altitude but is fairly influenced to the presence of virgin forest in the surrounding. At Jaen station where reclamation advances and the area is used as agricultural or pasture land, numbers of rainfall days are similar to those of other stations, but the amount of rain is only around 70% of the others. The rain fall data of Chontali suggest a thick vegetation condition as the observation station is located in the area where virgin forest is still preserved near Pena Blanca. The data of Tabaconas suggests that the environmental condition there is mediate between the above mentioned two stations.

Annual variation of rain fall is not so remarkable at the three station and there is not a clear distinction between the rainy and dry seasons. If a month belongs to the rainy season is defined as with more than 100mm rain fall, the rainy season covers December to May and the dry season June to November. Among the

Table 5 Meteorology of the Survey Area

Precipitation (mm)

		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Tabaconas	Mean	114.1	107.1	115.1	113.3	90.6	67.7	53.4	58.0	54.4	88.1	73.1	111.4
	Max.	232.2	233.4	179.6	229.2	145.2	158.8	93.2	134.1	114.4	257.8	182.8	256.9
	Min.	63.1	42.2	45.4	41.7	25.1	13.5	16.2	13.0	5.6	11.6	10.0	0.3
Chontali	Mean	159.5	119.6	173.7	152.3	102.1	71.8	46.2	35.1	52.1	90.1	80.8	87.5
	Max.	676.5	204.9	830.0	380.8	206.5	187.0	123.3	79.9	134.3	195.4	221.5	215.5
	Min.	22.1	29.2	55.2	23.1	28.3	24.8	10.2	13.3	6.3	6.0	25.0	4.2
Jaen	Mean	73.2	79.2	110.2	100.9	70.4	42.5	33.6	25.9	46.4	74.0	65.1	62.8
	Max.	159.7	174.0	284.7	194.0	176.7	142.1	174.1	41.9	216.8	139.7	153.5	174.1
	Min.	11.0	13.0	23.9	40.9	17.4	7.8	10.0	6.5	5.4	14.2	11.7	9.2

Rainy Day (days)

		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Tabaconas	Mean	17.7	17.5	17.1	17.1	15.7	15.0	13.1	12.1	13.0	14.0	12.4	16.0
	Max.	27	25	26	26	22	25	21	19	19	20	23	22
	Min.	7	8	10	9	5	8	7	1	5	5	7	1
Chontali	Mean	14.8	13.7	17.8	16.4	15.7	12.3	10.1	8.4	9.2	11.4	10.1	11.7
	Max.	25	20	26	25	24	19	14	15	16	24	15	22
	Min.	6	5	8	5	8	6	6	4	2	2	3	1
Jaen	Mean	13.9	13.6	16.3	15.9	13.5	12.1	10.6	10.0	10.5	12.6	11.1	12.5
	Max.	23	22	28	22	21	21	19	16	17	20	19	20
	Min.	6	7	3	8	6	3	4	5	3	6	4	1

Temperature (℃)

		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Tabaconas	Mean	17.3	17.6	17.6	17.6	17.3	16.6	16.1	16.6	17.1	17.8	18.3	18.0
	Max. highest	23.6	23.1	23.1	23.0	22.5	22.1	22.0	23.1	23.2	24.2	24.8	28.1
	lowest	19.9	20.0	20.6	21.3	20.7	19.8	19.1	19.9	20.7	21.1	22.3	20.6
	Min. highest	8.4	8.4	8.4	8.4	6.6	5.9	6.4	5.7	5.8	8.3	7.7	7.5
	lowest	14.5	14.9	14.7	14.8	14.7	14.1	13.4	14.4	13.7	14.4	14.2	14.4
Chontali	Mean	19.1	19.2	19.3	19.4	19.2	18.7	18.3	18.7	19.1	19.6	19.9	19.7
	Max. highest	26.0	26.0	25.5	25.6	25.2	25.1	25.2	25.6	26.9	27.0	28.5	26.5
	lowest	21.4	22.2	22.6	22.9	22.6	22.1	22.2	22.2	23.4	22.8	23.2	23.1
	Min. highest	12.4	12.4	13.2	12.7	12.5	11.5	11.0	11.4	11.8	11.5	12.1	12.4
	lowest	16.9	16.4	16.5	15.8	16.6	15.1	14.6	14.5	15.6	15.6	15.5	16.5
Jaen	Mean	24.8	24.8	24.6	24.7	24.5	24.1	24.0	24.7	25.5	25.7	25.8	25.5
	Max. highest	33.6	32.6	31.5	32.4	30.7	30.9	30.8	32.6	32.6	33.3	33.0	34.0
	lowest	27.8	28.1	27.7	28.4	28.3	27.5	28.3	27.9	29.5	29.4	29.8	29.5
	Min. highest	17.6	16.6	17.2	16.4	16.4	16.5	16.0	16.5	16.4	16.6	16.3	17.4
	lowest	22.0	21.5	21.0	20.8	21.4	20.4	20.2	20.9	21.5	21.8	22.0	21.7

Humidity (%)

		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Tabaconas	Mean	87.1	87.6	88.0	88.8	89.1	90.0	88.7	88.0	87.9	85.9	83.5	84.7
	at 7 am.	91.3	91.6	93.6	93.7	94.5	94.9	95.1	94.7	95.1	93.4	90.7	90.2
	at 1 pm.	82.5	83.0	81.9	81.7	83.5	84.2	82.0	80.6	83.1	82.5	78.5	79.8
	at 7 pm.	88.1	89.4	90.0	90.6	91.0	90.3	91.9	90.2	91.5	89.7	87.8	88.3
Chontali	Mean	85.5	86.5	87.0	85.7	85.9	84.5	83.9	82.6	81.9	83.9	82.3	82.7
	at 7 am.	95.0	94.5	94.2	96.5	95.0	95.0	95.8	93.4	93.9	95.0	94.1	93.1
	at 1 pm.	82.8	81.3	81.0	79.5	79.7	77.8	75.8	75.6	75.8	80.1	77.6	77.6
	at 7 pm.	87.0	87.3	88.5	87.3	87.2	86.0	86.0	84.9	84.5	85.1	85.1	84.5
Jaen	Mean	70.3	72.9	74.6	75.1	74.4	74.0	68.8	66.6	65.5	66.4	65.9	67.9
	at 7 am.	86.5	88.4	88.5	90.3	89.7	89.8	85.4	84.8	82.5	81.9	81.2	82.5
	at 1 pm.	61.1	61.5	60.7	60.8	61.0	60.0	53.0	52.9	51.4	53.6	54.1	56.5
	at 7 pm.	71.5	72.4	74.1	76.3	76.7	74.9	67.6	67.0	66.5	66.9	67.1	67.2

	Elevation	Lat.	Long.
Tabaconas	1860 m	5° 19'	79° 17'
Chontali	1610 m	5° 45'	78° 58'
Jaen	620 m	5° 40'	78° 51'

periods, January to April is most dry and July to September are most rainy, respectively.

Chapter 5 CONCLUSION AND RECOMMENDATION

5-1 Conclusion

Three types of mineralization, skarn type, porphyry copper type and epithermal dissemination or vein type were recognized in the survey area. Emplacement of the showing of those mineralization is confined to the certain formations such as Leche Limestone, Oyotun Volcanics and Porculla Volcanics.

The showings of skarn type mineralization occur only within Oyotun Volcanics at Paramo of San Felipe area, Miraflores Sur of Palma area and within Leche Limestone at Angashi of Pena Blanca area. All showings of this type, however, appear to be too small and low grade to be a workable ore deposits.

The showings of porphyry copper type mineralization can be observed in Oyotun Volcanics at La Huaca of San Felipe area and Zonanga of Palma area. Zoning of rock alteration and geochemical anomalies of those showings indicate an existence of porphyry copper type ore deposits. Beside a wide spread low resistivity anomaly was found by electro-magnetic survey at La Huaca.

The showings of epithermal dissemination or vein type occur in Oyotun Volcanics at Pena Verde of San Felipe area, Hualatan of Chontali area and in Porculla Volcanics of Jehuamarca area. Low resistivity anomalies by electro-magnetic survey were found on those showings.

A high resistivity body within a low resistivity background which indicate a mineralized body was found and then drilled in Jehuamarca area. Diamond drilling has revealed an existence of copper-zinc-lead dissemination body, associate with silicification. The grade of the dissemination body was too low to be economical at present metal price. Thus this deposit is to be considered as a future resources.

In Hualatan of Chontali area, a gentle dome of high resistivity basement which suggest an intrusive body was detected in a zone of shallow gravity basement. Then auriferous mineralization zone in quartz vein, presumably steeply dipping south were found by diamond drill hole, drilled in slope of the dome. Taking the deflection of quartz veins and the distribution of the grade of outcrop, it can be assumed that the mineralization zone inclines (plunge) steeply southward.

From the facts that the average of homogenization temperature of vein quartz shows 151℃ which is too low for gold deposition and the grade of the vein near the surface (200m below) is rather low and erratic, it is expected that the grade of vein may be improved in the depth.

5-2 Recommendation

As the Hualatan of Chontali area is potential for gold deposits, it is recommendable to conduct the following exploration.

1) Detail mapping and sampling on the outcrop of quartz veins to determine the plunge of mineralization zone and quartz vein.

2) Then diamond drilling to confirm the lateral and vertical extent of the

mineralization zone and its plunge.

Further more, application of geophysical survey is recommendable to the showings of porphyry copper type mineralization in Sonanga of Palma area and La Huaca of San Felipe area which were remained without detailed survey.

Part II RESULTS OF SURVEY

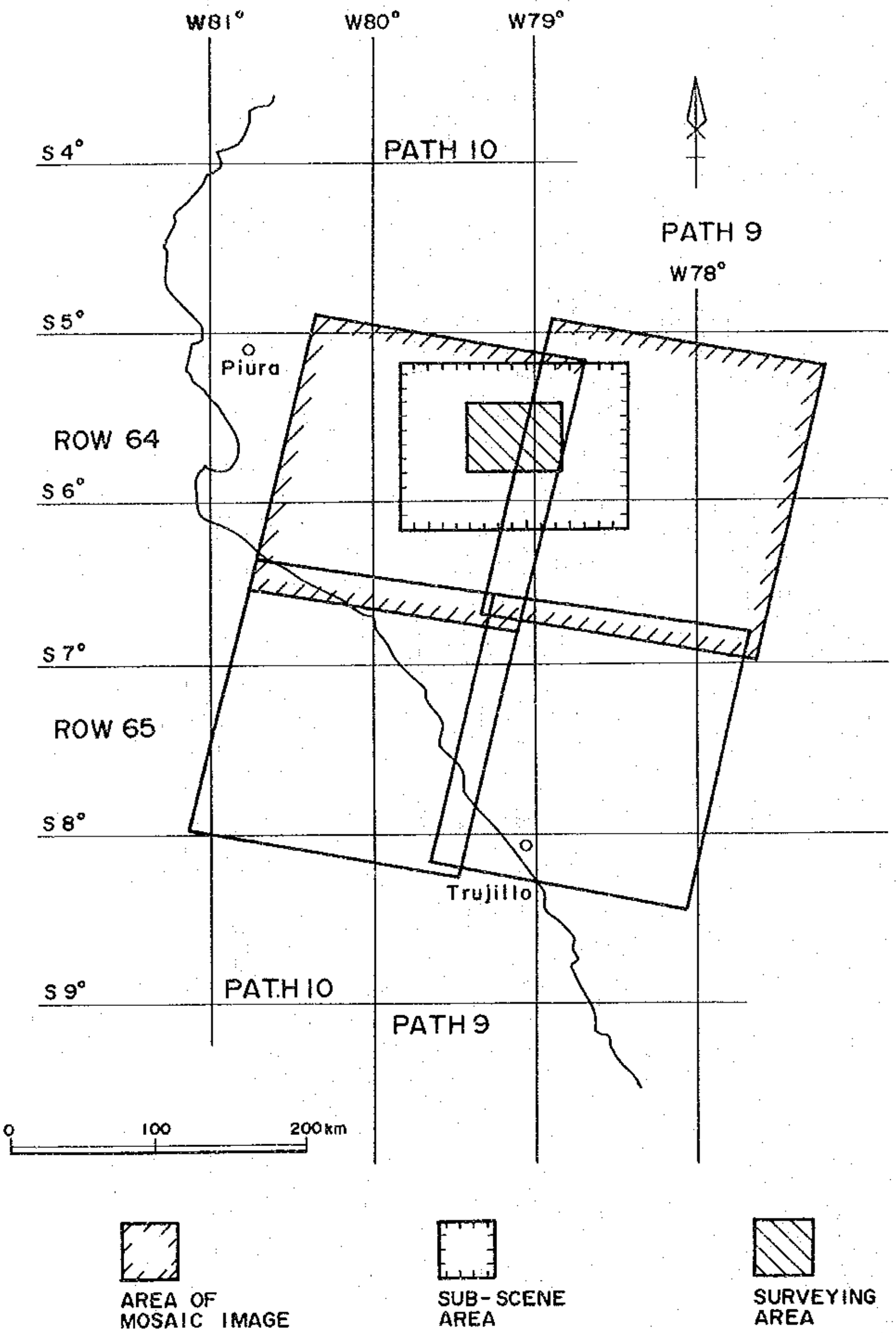


Fig.II−1 Location Map of Landsat Image

Chapter 1 ANALYSIS OF LANDSAT IMAGE

1-1 Procedure of Analysis

Prepared a false color sub-scene image and No.7 band black and white image by computer from MSS data. Then using these images extraction of linearments and geological interpretation were made for the whole survey area.

As the MSS data used for this analysis was Brazilian BIP12 (Band Interleaved by 2 Pixels) proper conversion and modefication were made in producing images. Area of the images are shown in Fig. II-1.

1-2 Result of Analysis

1-2-1 Linearments

The regional geological structure changes between northern part of Peru and sourthern part of Equador. The Andes Cordillera that consist of three mountain ranges change their trend from NW-SE in the south to NE-SW in the north. Sub scene covers the northwestern end of Andes which shows NW-SE trend. This trend can be seen on the strikes of sedimentary rocks of the northeast corner of the scene, and on the strong linearments of south/southeast and north of the surveying area. In the east part of the scene there are anticlinal/synclinal axes which have also NW-SE trend. NE-SW linearments normal to NW-SE are notable in the south-eastern part. N-S trend can be seen in the west of the Huancabamba river.

In the survey area linearments of NW-SE and NE-SW trends are not remarkable, but N-S and E-W trends are dominant. The latter can be seen in the lineatments at west of Jaen, south of Chontali and south of Piquijaca.

Fig. II-2 shows a rose diagrams of linearments of the survey area. An upper semicircular shows frequency and a lower semicircular shows total length. There are 81 strong linearments and the total length of them is about 500km. Mode direction is N15° W in frequency and N5° W in total length and E-W is sub-dominant direction. Mode of Linearment length is 3 - 4km.

There are 306 weak linearments and the total length amounts to about 900km. Mode direction is N20° W in frequency and N10° W in total length and those value shows 5 degrees westward rotation compared to the strong linearments. Mode of linearment length is 1- 2km. As a whole linearments of N-S and E-W are dominant compared with Andes trend (NW-SE) or Equador-Columbian trend (NE-SW).

1-2-2 Ring Structure

There are 9 ring structures, 5 along the south end of the survey area, 2 at southern end of the scene and 2 in other area. The diameter of those structures is 4 - 14km. Among those, a typical ring can be seen at the southwestern end of the survey area. Huancabamba river and Piquijaca river which join at Ochentaiuno make a semicircular, and its branchs make the rest part of circle.

1-3 Review

1) San Felipe

Only a few linearments are interpreted in this area because of cloud cover. Linearments interpreted show N-S and E-W directions, and obvious E-W linearment extends from Piquijaca to Chontali site.

2) Chontali area

NNW-NW direction is dominant which is concordant to the main trend of the Andes mountain range . NNE-NE can also be seen, which may be caused by the fault, descriverd latter.

3) Palma area

There are a few remarkable E-W linearments in the northern part of the area, and the strongest one extends to east of Jaen. NNE strong linearment and NE weak linearment can be seen.

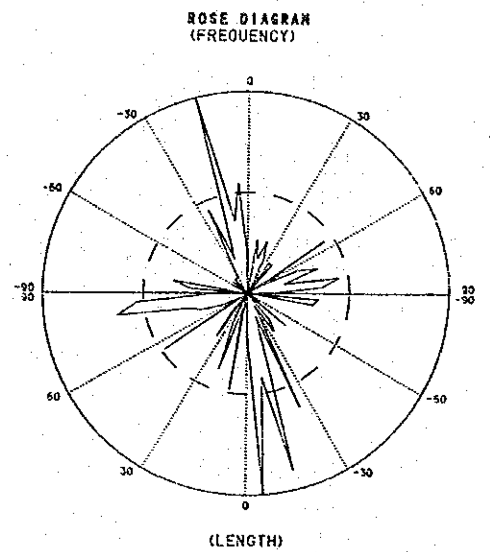
4) Jehuamarca area

Because of cloud cover, only two linearments are interpreted, and their directions is NNW.

ROSEDIAGRAM OF LINEAMENTS

HISTOGRAM OF LINEAMENTS

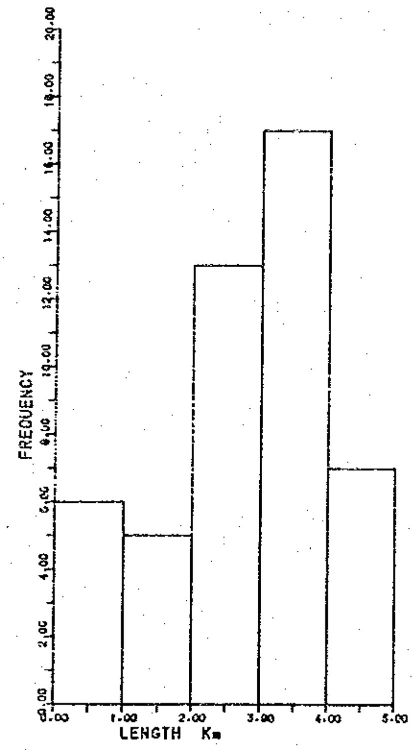
LIST OF LINEAMENTS



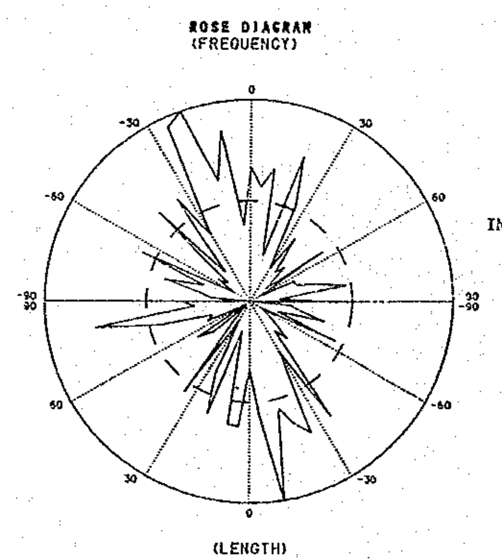
MAJOR LINEAMENTS

NTOTAL = 81
NMAX = 11
MAX-AZIM = -15(DEG.)

TOTAL-KM = 503.4(Km)



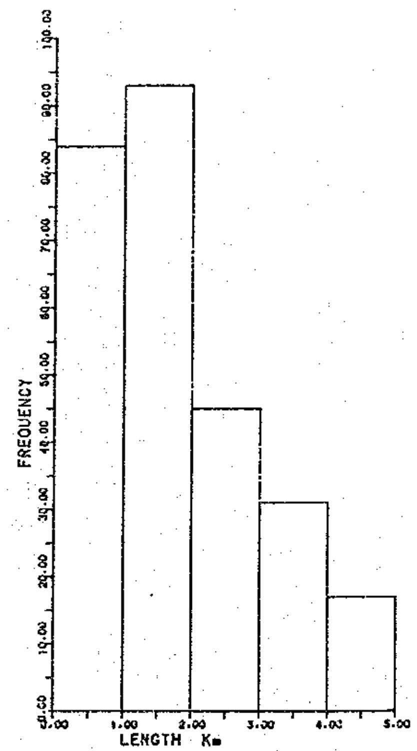
DIRECTION	NUMBER PCS	NUMBER %	LENGTH KM	LENGTH %
N90.0E-N87.5E	1	1	8.8	2
N87.5E-N82.5E	4	5	30.7	6
N82.5E-N77.5E	5	6	36.9	7
N77.5E-N72.5E	2	2	16.7	3
N72.5E-N67.5E	4	5	13.9	3
N67.5E-N62.5E	3	4	8.1	2
N62.5E-N57.5E	1	1	2.4	0
N57.5E-N52.5E	5	6	27.9	6
N52.5E-N47.5E	0	0	.0	0
N47.5E-N42.5E	0	0	.0	0
N42.5E-N37.5E	2	2	7.3	1
N37.5E-N32.5E	2	2	14.8	3
N32.5E-N27.5E	0	0	.0	0
N27.5E-N22.5E	2	2	8.8	2
N22.5E-N17.5E	3	4	23.1	5
N17.5E-N12.5E	2	2	4.7	1
N12.5E-N 7.5E	3	4	27.9	6
N 7.5E-N 2.5E	0	0	.0	0
N 2.5E-N 2.5W	2	2	11.6	2
N 2.5W-N 7.5W	6	7	57.7	11
N 7.5W-N12.5W	4	5	24.4	5
N12.5W-N17.5W	11	14	52.3	10
N17.5W-N22.5W	2	2	6.9	1
N22.5W-N27.5W	5	6	35.8	7
N27.5W-N32.5W	1	1	4.1	1
N32.5W-N37.5W	1	1	13.1	3
N37.5W-N42.5W	1	1	9.8	2
N42.5W-N47.5W	0	0	.0	0
N47.5W-N52.5W	1	1	14.1	3
N52.5W-N57.5W	0	0	.0	0
N57.5W-N62.5W	1	1	2.8	1
N62.5W-N67.5W	0	0	.0	0
N67.5W-N72.5W	0	0	.0	0
N72.5W-N77.5W	0	0	.0	0
N77.5W-N82.5W	4	5	18.7	4
N82.5W-N87.5W	3	4	19.9	4
N87.5W-N90.0W	1	1	8.8	2
SUM TOTAL	81		503.4	



INCLUDING MINOR LINEAMENTS

NTOTAL = 306
NMAX = 21
MAX-AZIM = -20(DEG.)

TOTAL-KM = 912.1(Km)



DIRECTION	NUMBER PCS	NUMBER %	LENGTH KM	LENGTH %
N90.0E-N87.5E	9	3	23.9	3
N87.5E-N82.5E	3	1	18.8	2
N82.5E-N77.5E	10	3	53.2	6
N77.5E-N72.5E	7	2	31.4	3
N72.5E-N67.5E	5	2	13.8	2
N67.5E-N62.5E	5	2	15.5	2
N62.5E-N57.5E	1	0	1.4	0
N57.5E-N52.5E	9	3	21.6	2
N52.5E-N47.5E	2	1	16.3	2
N47.5E-N42.5E	5	2	2.0	0
N42.5E-N37.5E	4	1	9.1	1
N37.5E-N32.5E	8	3	38.6	4
N32.5E-N27.5E	4	1	7.7	1
N27.5E-N22.5E	11	4	27.7	3
N22.5E-N17.5E	16	5	41.8	5
N17.5E-N12.5E	5	2	10.4	1
N12.5E-N 7.5E	14	5	43.6	5
N 7.5E-N 2.5E	12	4	43.9	5
N 2.5E-N 2.5W	14	5	23.6	3
N 2.5W-N 7.5W	8	3	40.0	4
N 7.5W-N12.5W	18	6	70.4	8
N12.5W-N17.5W	13	4	38.8	4
N17.5W-N22.5W	21	7	45.4	5
N22.5W-N27.5W	20	7	50.4	6
N27.5W-N32.5W	8	3	20.4	2
N32.5W-N37.5W	13	4	48.8	5
N37.5W-N42.5W	4	1	13.2	1
N42.5W-N47.5W	13	4	18.2	2
N47.5W-N52.5W	3	1	10.7	1
N52.5W-N57.5W	4	1	7.0	1
N57.5W-N62.5W	2	1	4.6	1
N62.5W-N67.5W	12	4	32.3	4
N67.5W-N72.5W	5	2	10.4	1
N72.5W-N77.5W	9	3	26.4	3
N77.5W-N82.5W	5	2	17.1	2
N82.5W-N87.5W	4	1	13.9	2
N87.5W-N90.0W	9	3	23.9	3
SUM TOTAL	306		912.1	

Fig.II-2 Lineaments Analysis

Chapter 2 SAN FELIPE AREA

2-1 Geological and Geochemical Surveys

2-1-1 Purpose of the Survey

The San Felipe area includes mineralized zones at La Huaca, Pena Verde, Vega and Paramo, which were extracted by the "Proyecto Geoquimico del Norte". Of these mineralized zones, in La Huaca a preliminary survey including drilling (seven holes with a total length of 572 meters) was performed by Bureau de Recherches Geologiques et Minieres (BRGM), France. For the remaining three mineralized zones, preliminary surveys were partially conducted by INGEMMET.

This survey included a semi-detailed geological survey combined with geochemical survey was conducted for the purpose of defining the correlation and geological settings of these mineralized zones. A detailed geological survey combined with geochemical survey was also performed to identify the potentials for each mineralized zone. Trenching was also conducted in order to determine the size and occurrence of silicified rocks which is related to porphyry copper type mineralization found in La Huaca.

2-1-2 Geology

According to Reyes et al. (1987), it is reported that in the western part of the survey area (including Pena Verde, La Huaca and Vega mineralized zones), the basement is formed by Mesozoic rocks consist mainly of sedimentary rocks, which is unconformably covered by Tertiary Porculla Volcanics, these geological units are in contact with faults. In its eastern part (including Paramo mineralized zone), the basement is Paleozoic Salas Group, which is unconformably covered by Porculla Volcanics, and dioritic intrusive rocks extending in N-S direction are distributed in the middle of the both areas.

The Mesozoic rocks extend in N-S direction at the western flange of the survey area, consist of the formation of Tinajones, Inca, Chulec, Pariatambo and Pulluicana superposed in this sequence from its east flange, and unconformably covered by Porculla Volcanics at the western end. Tinajones Formation, located at the eastern flange of the survey area, covers Porculla Volcanics distributed in its eastern part by a thrust fault. Reyes et al. also reported that the mineralized zones extracted by INGEMMET at Pena Verde, La Huaca and Vega occur in Porculla Volcanics.

2-1-3 Survey Results

1) Geological survey

Basement of survey area is composed of metamorphic rocks that consist mainly of gneiss with minor amount of crystalline schist. This basement rocks are covered unconformablyby pyroclastic rocks that contain andesite and/or dacite. Over this, calcareous or tuffaceous sedimentary rocks with intercalated limestone and marl are distributed. Diorite-granodiorite, granite, monzonite, and quartz porphyry-granite porphyries intrude into them (Fig. II-3).

At two localities, the eastern flange of detailed survey area in La Huaca (center of the western part of the San Felipe semi-detailed survey area) and the northwestern part of the Paramo zone, were observed metamorphic rocks with foliatin. Judging from their metamorphic grade, it is assumed that they are correlative with Olmos Complex near the contact of intrusive rocks.

Olmos Complex is unconformably covered by volcanics. These volcanics in the western region distribute elongating nearly north to south, and the Olmos Complex is observed in the central part of the area. Overall, therefore, it can be interpreted that the volcanic rocks in the northern part are dipping to north, and those in the southern part to the south from the Complex. Therefore, it can be concluded that there is an uprising of basement near La Huaca. In the eastern area, on the other hand, andesitic lavas are distributed directly on the Complex with a little amount of tuff or tuff breccia intercalting in it. The age of their sedimentation cannot be readily determined because no fossils are found nor absolute age determination are available. It, however, may be correlative with the Oyotun Volcanics through the fact that they were covered by Cretaceous sedimentary rocks, and they were intruded by the rock belongs to the upper early Cretaceous Period.

The major distribution of sedimentary rocks in the survey area extends in the north-south direction along the western flange of the area, and in a few portion covering Oyotun Volcanics with conformity. Most the sedimentary rocks extending in the north-south are in contact with Oyotun Volcanics with fault. The quarzite occur in contact with Oyotun Volcanics is about 20m in thickness and is covered with shale. Further up, there are relatively thick tuffaceous and/or calcareous shale and sandstone with intercalated limestone. Ammonites, and other fossils are generally found out among the calcareous rocks. According to the assessment by Ms. Lidia Romero Pittman, INGEMMET, these obtained fossils (Apx. 12) correspond to the upper part of lower Cretaceous to the lower part of upper Cretaceous System, and can be assumed to be correlative with the Inca, Chulec, Pariatambo and Pulluicana Formations classified by Reyes (1987).

Intrusive rocks in the central to eastern area are composed of diorite-granodiorite intruded into the above mentioned geological units and granite as stocks with short axis of 0.5 to 1.5 km and long axis of 1 to 3 km intruded into the contact of the above mentioned diorite-granodiorite and in the western area monzonite-monzonite porphyry as dykes of 10 to 150 meters in width and 50 meters to 3 km in length intruded into Oyotun Volcanics, and quartz porphyry, granite porphyry and andesite which are also as dykes with width of several ten centimeters to several meters.

Under the microscope, the samples taken from the granite-granodiorite bodies show rock facies variation from diorite, granodiorite to tonalite. Although the absolute age of granodiorite is estimated at 82.5±4.1 million years (middle Late Cretaceous) by the K/Ar method, somewhat older age could also be possible since the potassium feldspars were altered to sericites.

The monzonite are remarkablly altered in general. Under the microscope, the

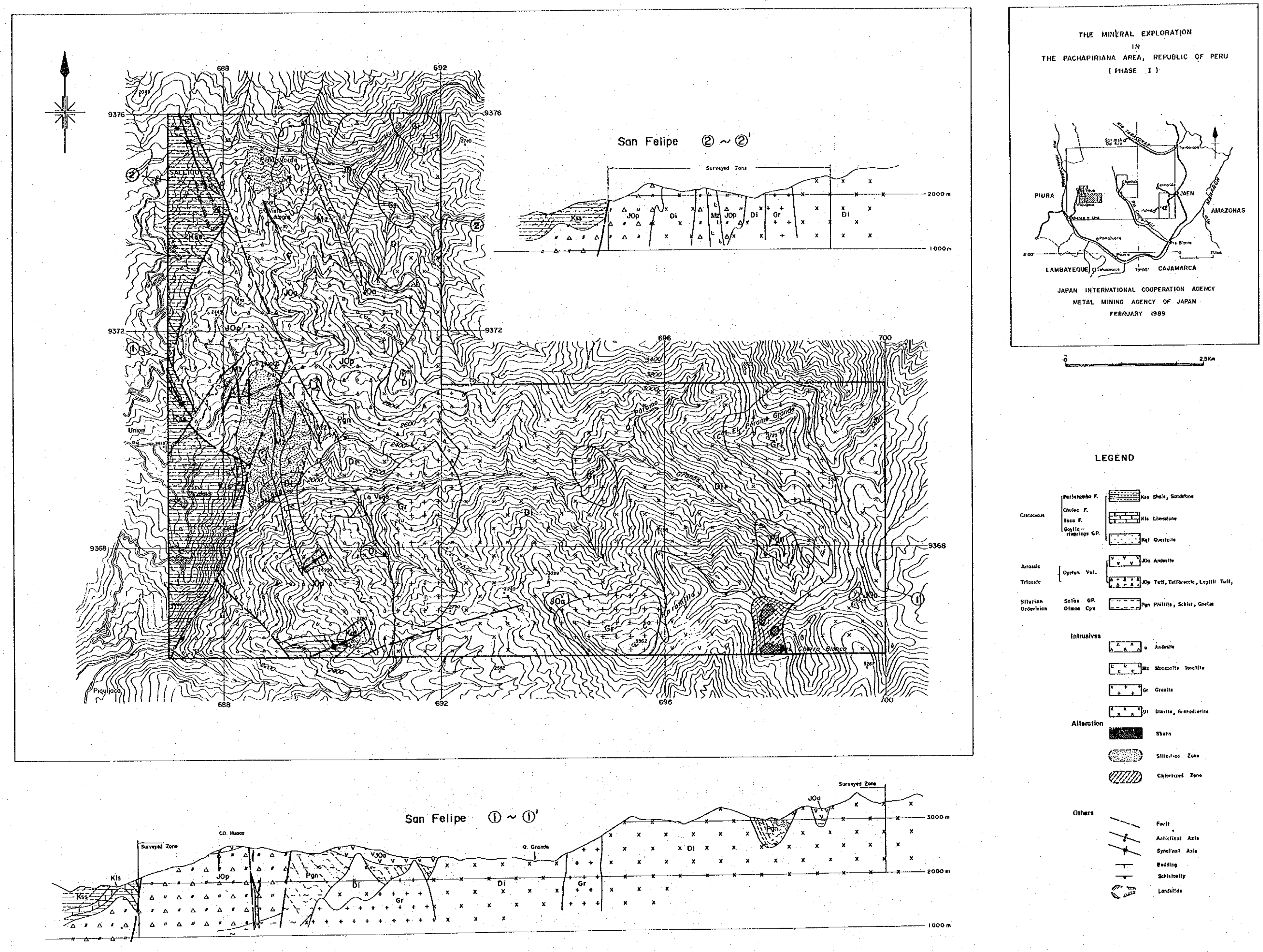


Fig.II－3 Geological Map and Profiles of The San Felipe Area

monzonite correlative with monzoni syenite to quartz diorite. Whilst the absolute age is estimated at 78.0±3.9 million years (Late Cretaceous) by the K/Ar method, somewhat older age could be possible since the sample is altered strongly as mentioned above. Quartz porphyry-granite porphyry intrude into the aforementioned intrusive rocks and appear mainly in the periphery of the granitic body. Andesite are observed in the whole survey area, with a great variation of its rock facies, thus suggesting a considerably wide range of periods of intrusion. They are roughly divided into those porphyritic and aphanitic, and the latter mainly appear in the distribution area of Oyotun Volcanics.

Remarkable fault fissures run in the area of Mesozoic rocks located in the western part, are in directionof NW-SE and NE-SW. Both fissure systems are steeply dipping and younger geological units apppaer in the western block of them. Based on the analysis of airphotographs, the continuation of these fault become is unclear in intrusive rocks area; this suggests that they were formed before the intrusion and controlled their intrusion.

Alteration occurs with characteristic facies to the areas of Oyotun Volcanics and calcareous rocks in the west, and Oyotun Volcanics in the east. Alteration in the western Oyotun Volcanics is attributable to hydrothermal effect and distributed of 2 km in width and 9 km in length trending north-south, containing mineralized zones of Pena Verde, La Huaca and Vega extracted by INGEMMET. Alteration zones mainly consist of argillization around Vega in the south, combined silicification and argillizationin the center, La Huaca, and silicification in the northmost part, Pena Verde. It is supposed that the alteration would have been formed as a result of post-igneous activities of diorite-granodiorite and/or monzonite, through the said fault fissure systems. As the result of an X-ray diffractiveanalysis, quartz, sericite,smectite, kaolinite, halloysite and chlorite, all of which are clay minerals characteristic to hydrothermal alteration, were detected. The sericite polytype, sampled in the combined alteration zone of LaHuaca refers to 2M, which suggests that they were formed in relatively high temperature.

The alteration observed in the eastern Oyotun Volcanics is attributable to the contact metasomatism, which is characteristic with skarn minerals such as chlorite and epidote. In addition, large amounts of magnetite were found in the same zone, and a very few amount of cubanite coexisting with pyrite were observed. Argillization was observed in the bedding plane and/or along the cracks of the sedimentary rocks distributed in the western flange of the survey area. Based on the result of an X-ray diffractive analysis, it is supposed that this alteration contains kaolinite, sericite, pyrophyllite, alunite and jarosite, forming the outer zone of the hydrothermal alteration mentioned above.

2) Geochemical survey

Compared with the other areas, copper mineralization is predominant in the San Felipe area. The average values of gold (56.67 ppb), lead (538.61 ppm) and copper (480.05 ppm) is higher than those obtained in other areas, inparticular, the copper content is more than twice of the average value (190.86 ppm) of the whole area. Analyzing the distribution of anomalous values or zones of each element (Fig. II-4), it is noted that the anomalies of gold, lead and silver are extremely sporadic and very small. The anomalies of molybdenum are also appeared small. Those of zinc and copper appear to be large and consistent.

In correlation which geology, the anomalies of gold are distributed around the periphery of diorite-granodiorite body, and the anomalies of silver are in Oyotun Volcanics and intrusive rocks. The majority of lead anomaly is also found out in the Oyotun Volcanics and instrusive rocks. Zinc and molybdenum are distributed throughout the area, with the tendency to concentrate around fissures and intrusive rocks. Geochemical anomalies of copper correspond to the alteration zones of Oyotun Volcanics.

From the viewpoint of zonal arrengements of geochemical anomalies in La Huaca, the copper anomalies are surrounded by those of zinc, which in turn are sorrounded by those of lead. In Pena Verde, the tendency is that the silver anomaly is surrounded by the copper anomaly.

2-2 Geophysical Survey

2-2-1 Outline of the Survey

In order to make clear the underground resistivity structure and its relationship to the geological structure and mineralization, electro-magnetic survey by CSAMT method was carried out at 71 stations in the area of 21km2 in Pena Verde-La Huaca site where pophyry copper type mineralization and vein type mineralization were expected.

Apparent resistivity was measured in the cycles of 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048. This result combined with the measurement of several representative rock specimen are used for interpretation of resistivity distribution of the area.

2-2-2 Results of Analysis

A-A' Section

This section runs the low resistivity zones of Pena Verde in NE-SW direction. Sedimentary rocks, pyroclastic rocks and granodiorite are distributed from the west toward the east through the section.

Medium resistive layers are presumed to extend broadly from the surface to the great depth except for the silicified and argillized alteration zones around the station 51 and a small-scale low resistivity layer in the shallow part of the surface layers which coincides with the intrusive body of andesites. In the south of the station 57 the medium resistivity layer is divided into two the surface layer and its lower layer. Under this medium resistivity layer a relatively higher resistivity layer of around 300 to 800 Ωm, is assumed. This high resistivity layer was not observed near the stations 51 and 52 where pyroclastic rocks are distributed.

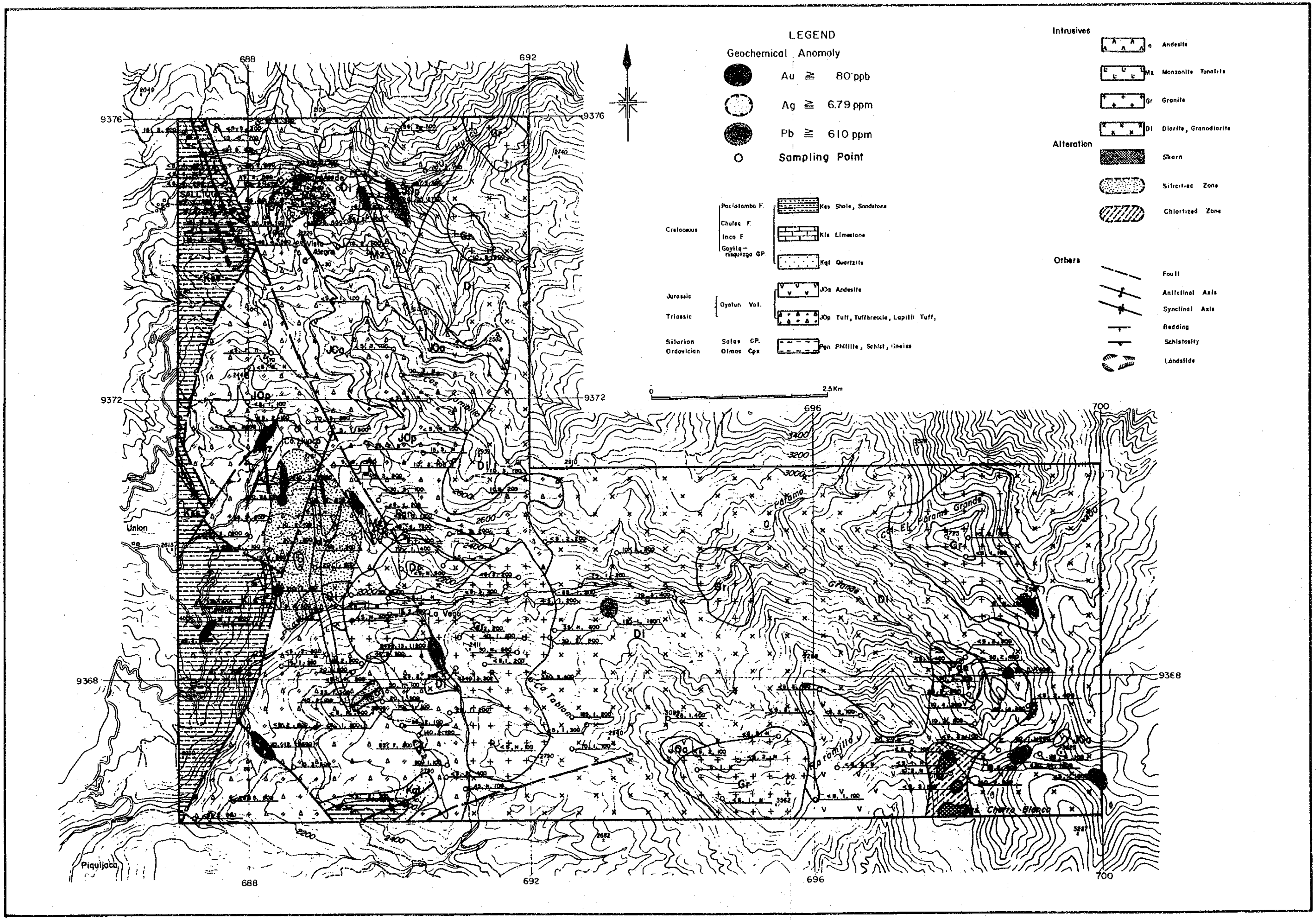


Fig. II −4(1) Geochemical Map of The San Felipe Area (Au, Ag and Pb)

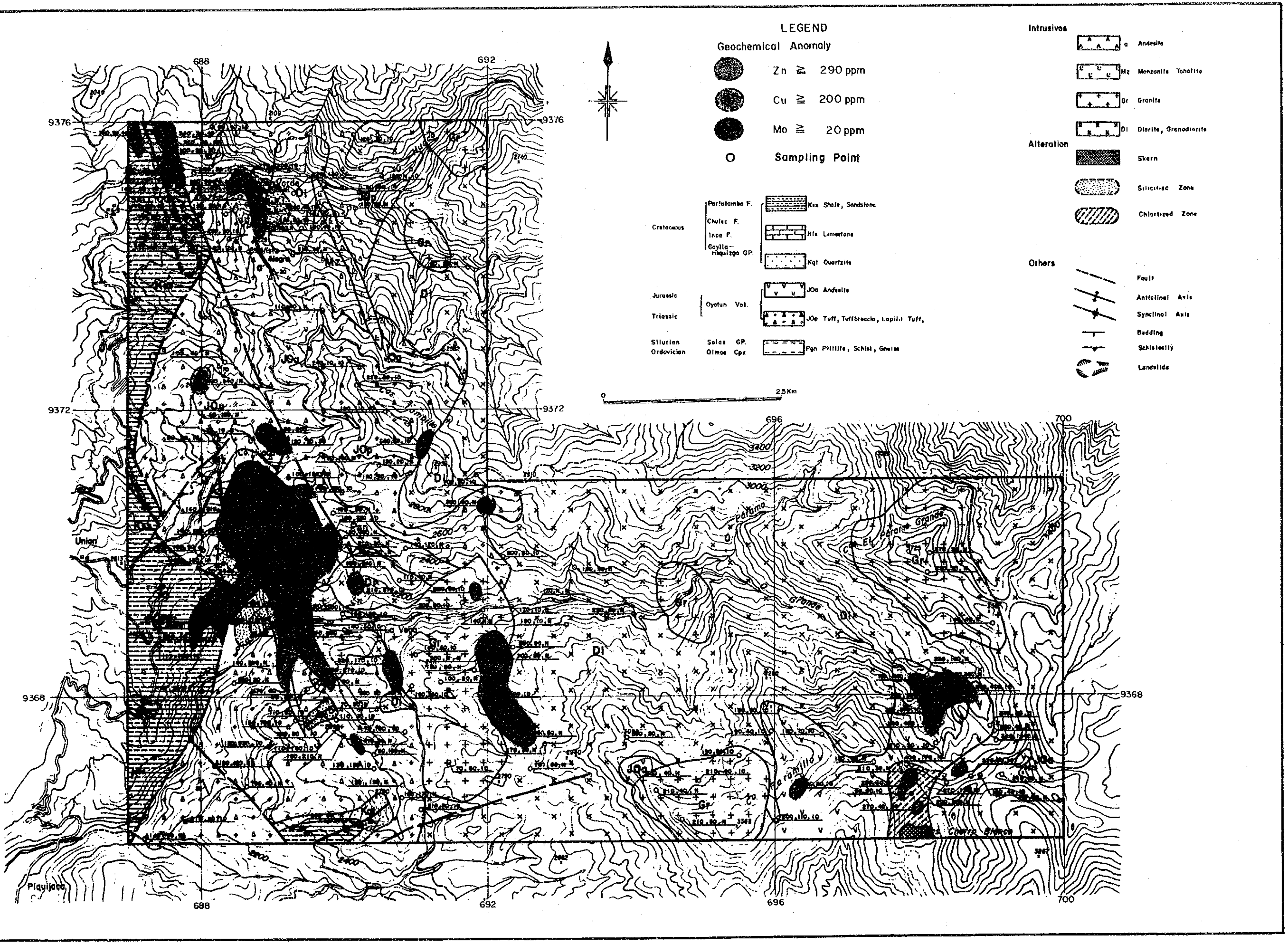


Fig. II −4(2) **Geochemical Map of The San Felipe Area (Zn, Cu and Mo)**

B-B' Section

This section runs the survey area in N-S direction. Distribution of pyroclastic rock is found throughout this section. Low resistivity layers are assumed to be both around Pena Verde and La Huaca.

In La Huaca, a low resistivity layers of between 50 to 100 Ωm are found between the stations 1 and 10, and around the station 27 near the shallow part of the surface layer at the maximum depth of 500 meters. Below these layers there is a medium resistivity layer of 100 Ωm or higher. The low resistivity layer of the south from station 10 corresponds to the distribution of monzonite and of alteration zones. In the north from station 10 to the vicinity of Pena Verde, a relatively higher resistivity layer, above 700 Ωm, lies as a bottom layer under the medium resistivity layer.

C-C' Section

This section is in NW-SE direction to traverse across the low resistivity zones in La Huaca. The section extends across pyroclastic rocks and monzonite, granodiorite and granite which are intruded into the pyroclastic rocks.

A low resistivity layer found near the surface at the station 17 is deeper at the stations 18 and 30. This low resistivity layer is located at the center of the argillized alteration zones, corresponding to the place where monzonites intruded. The medium resistivity layer, of several hundreds Ωm, found around the above conductive layer is in depth around the station 30 to the station 9 and lies between two relatively higher resistivity layers of 800 Ωm or more. These high resistivity layers correspond to the distributions of granite and diorite on the eastern part of the section.

2) Resistivity Structure Map (Elevations of 2,000 and 1,500 meters)(see Fig. II-6)

i) As it is obvious from B-B' and C-C' sections, a low resistivity layer was found in La Huaca near the surface. While it has a trend of NE-SW and N-S directions at the level of 2,000 meters, at the level of 1,500 meters it change to NE-SW and NW-SE directions.

ii) In Pena Verde, a low resistivity layer of 20 Ωm or less was found near the surface around Vista Alegre on a small scale.

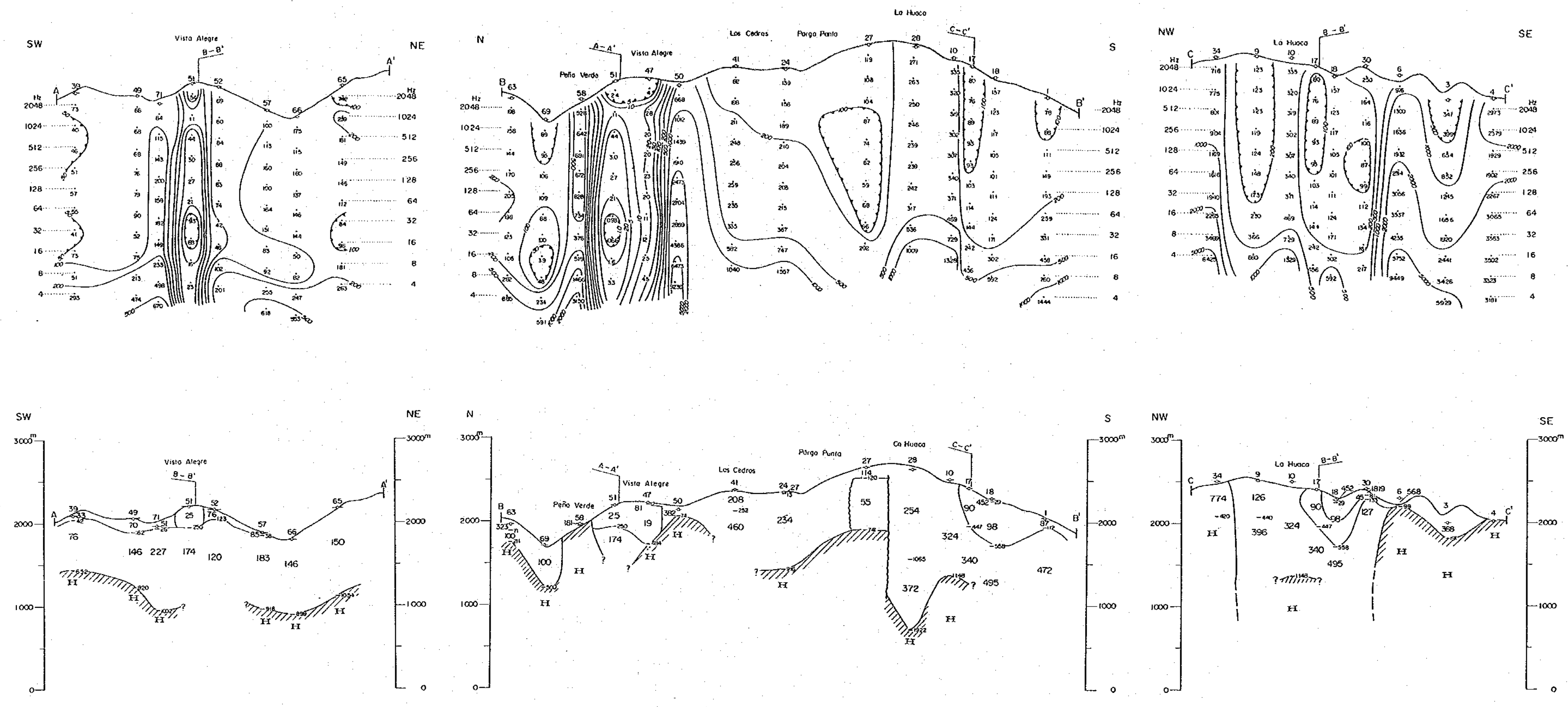
iii) A low resistivity layers of 100 Ωm or less lays in the center to the west of the area extend in NS direction with relatively extensive distribution in the levels from 2,000 to 1,500 meters, and lateraly extend NE to SW to include the low resistivity layer of Pena Verde.

2-3 Review (Consideration)

Geology of the San Felipe area consists of Olmos Complex as basement, Oyotun Volcanics, Goyllarisquizga Group, overlying sedimentary rocks and intrusive rocks which intrude into them. The sedimentary rocks are mainly found in the western flange of this survey area, and are separated from Oyotun Volcanics by fault of NW-SE and NE-SW. Oyotun Volcanics contain silicified zone and combined silicified and argillized zones haviang an approximate area of 2 km in width and 9 km in length, trending north-south. Within the above alteration zone the mineralized zones of Pena Verde, La Huaca and Vega are previously known. Geochemical survey showed the existence of zonal arrangements of copper, zinc and silver from the inside, centering on monzonite intrusive in La Huaca, and silver anomaly corresponds to silicified zone surrounded by copper anomalies in Pena Verde.

In geophysical survey, basement rocks and non-altered volcanics are normally represented with medium to high resistivity. In La Huaca, a low resistivity zone was detected in monzonite body situated in the combined silicified and argillized zones. In Pena Verde, a small but extremely low resistivity zone was detected, in the south of the silicified zone.

In summary, it can be said that the mineralization zones of La Huaca are considered as a porphyry copper type mineralization. Based on this view, the distribution of molybdenum anomalies can be regarded as the periphery of such porphyry copper type mineralization. Therefore, the results of drilling conducted by BRGM had only been restricted to the findings at the western flange of the mineralized zones. The mineralized zone in Pena Verde have the same characteristics with those of epithermal alteration as in the Jehuamarca area described in a later chapter.



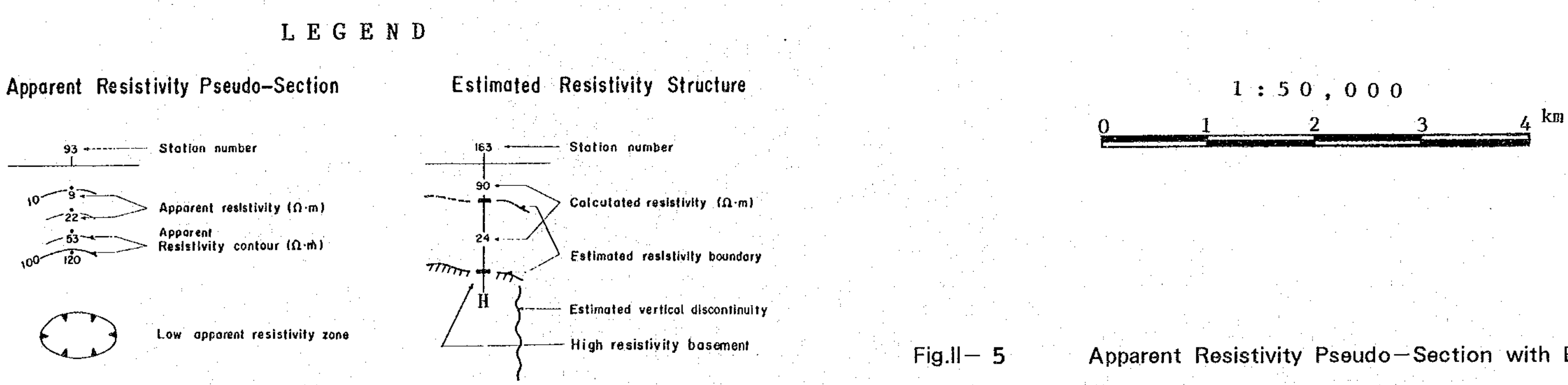


Fig.II− 5 Apparent Resistivity Pseudo−Section with Estimated Resistivity Structure in The San Felipe Area

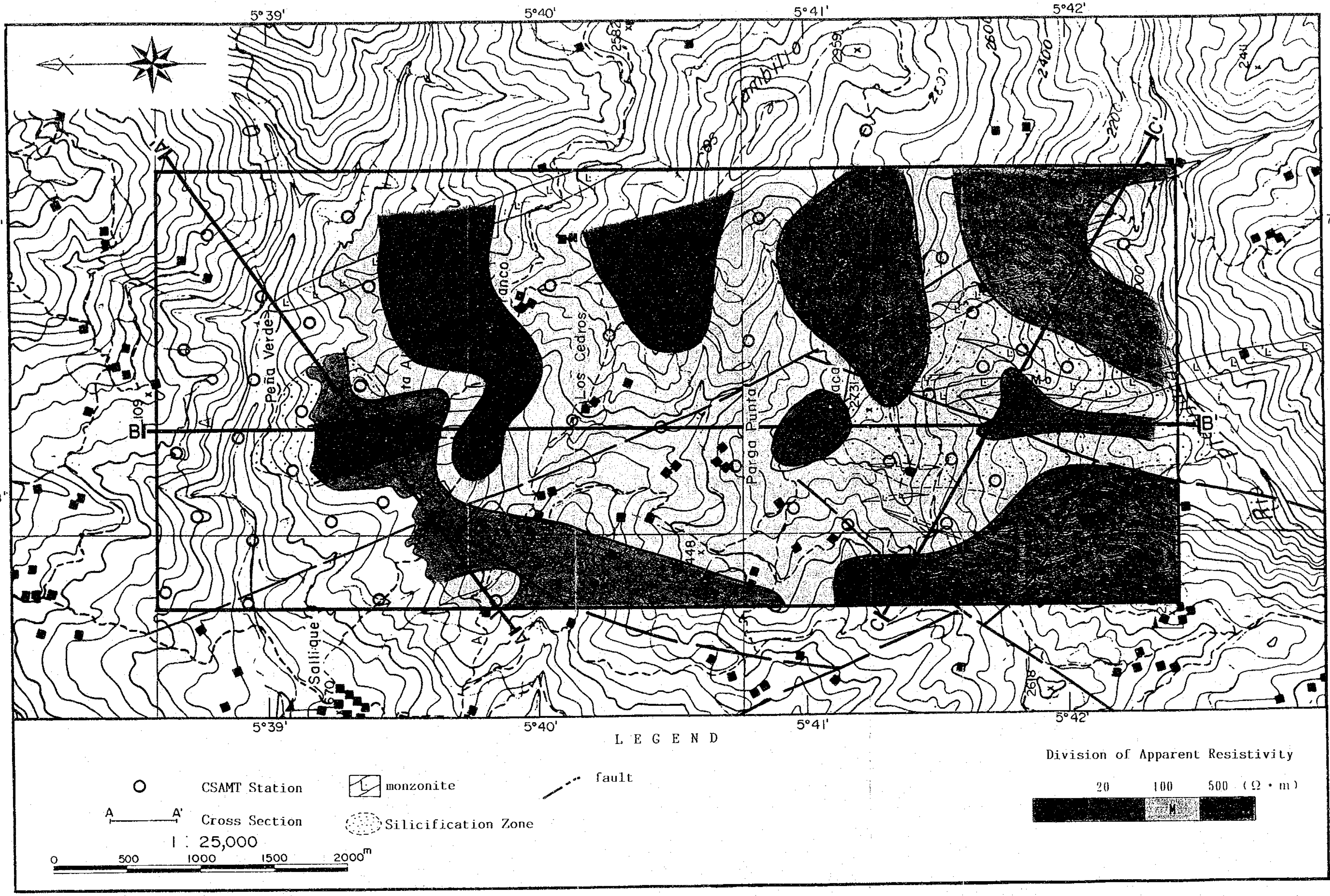


Fig. II –6(1) Resistivity Structure Map of The San Felipe Area (+2,000m)

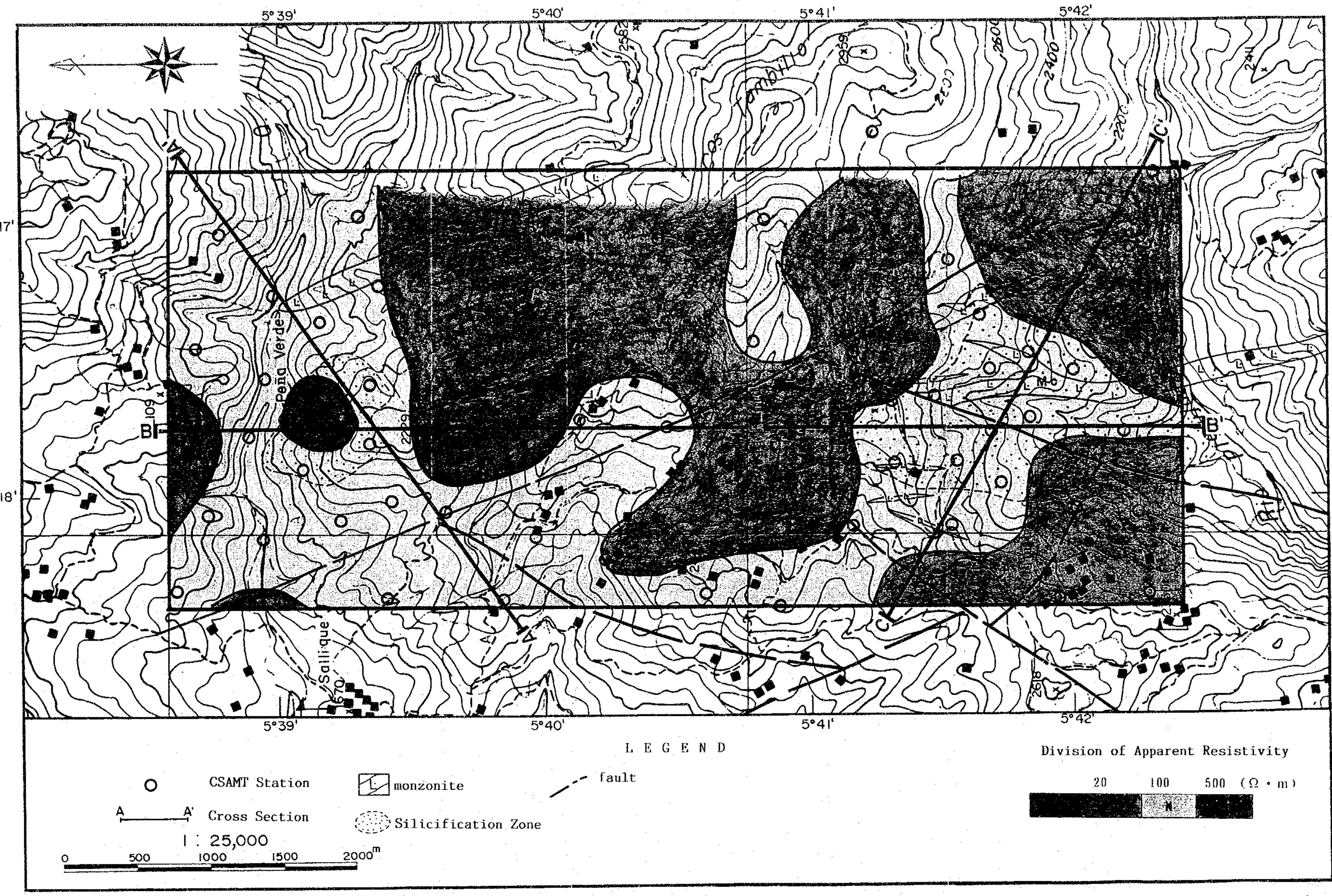


Fig. II -6(2) Resistivity Structure Map of The San Felipe Area (+1,500m)

Chapter 3 PALMA AREA

3-1 Geological and Geochemical Surveys

3-1-1 Purpose of the Survey

The Palma area contains the zones where anomalies were extracted by geochemical survey using the stream sediments as a part of the "Proyecto Integral Chinchipe". After the survey, no follow-up study has been performed. This survey included a semi-detailed geological survey to find out the source of said anomalies, to clarify geological setting of such anomalies and to evaluate the possibility of an existence of ore deposits. In addition, detailed geological mapping for the mineralization showings was conducted.

3-1-2 Survey Results

1) Geological survey(Fig. II-7)

The survey area consists of volcanics with abundant lapilli tuff, quartzite, siliceous sandstone, arkose sandstone with intercalating shale, alternation of sandstone and shale and intrusive rocks.

The volcanics are widely spread throughout the survey area. However, in the north area andesite and decite with intercalated lapilli tuff and in south area tuff breccia accompanying with rounded substancial and accidental gravels predominate. Particularly, in the southern part, intercalated thin tuffaceous shale were found out, allowing to assume that their sedimentary environments are very different between northern and southern areas.

Another distinctive aspect is that the volcanics in this survey area contain several layers of dark claret agglomerate throughout. This suggests that these layers could be used as a key bed for correlation of the strata in the area. Additionally, thin layers and/or boulder zones of limestone which were observed through the center from north to south may be also used as a key bed. The age of these volcanics cannot be obtained as there is no available fossil. However, judging from their rock facies and the fact that being intruded by the early Tertiary granite, it may be correlative with Oyotun Volcanics.

Sedimentary rocks are found at the central part of the eastern and southeastern flanges of the survey area. In the eastern part they conformably overlie the Oyotun Volcanics. The base is quartzite having cross bedding and grading upward siliceous sandstones to arkose sondstone with intercalating shale. The sedimentary rocks distributed in the west of Naranja are very brittle, apparently resembling quartz sand. The sedimentary rocks exposing along the southeastern flange has fault contact with Oyotun Volcanics, which are formed of alternation of sandstone and shale, being very different from those of the eastern flange. Their geological structure is different, the sedimentary rocks of the eastern flange are folded together with Oyotun Volcanics in relatively short wave lengths while those around the southeastern part show monoclinic structure trending NW-SE and dipping slightly toward northeast.

From these findings, sedimentary rocks of both localities could have deposited in different ages, but this could not be clearified in this survey, therefore, for reasons of convenience, they are dealt as the same geologic unit in this paper. Although no fossils were available from these sedimentary rocks of east end of the central part, they may be correlative with the Goyllarisquizga Group as they conformably coverlie Oyotun Volcanics and are intruded by the early Tertiary granite.

Relatively large intrusive bodies are found out on the central part of this survey area, and smaller bodies in the northern part. Main intrusive rocks in this area consist of diorite-granodiorite, granite, monzonite, quartz porphyry-granite porphyry and andesite, as same as in other semi-detailed survey areas.

Diorite and granodiorite in this area are very small in size, the largest one in the center slightly toward north of the area is 1 km x 2.5 km. Other significant differences with other semi-detailed survey areas are that they are fine-grained and that accompany with disseminated pyrite due to hydrothermal alteration around their periphery and/or in themselves. Assay result of an altered small body shows 0.75 g/t Au, indicating that the existance of gold mineralizationoccurs in hydrothermal alteratio stage.

Granite intrudes into diorite-granodiorite. The granite in this area is megascopically characterized by their pink color as abundent pink potassium feldspars are contained. Also, minor granite bodies in the north contain many xenoliths of andesite and andesitic tuff breccia. Under the microscope, they vary from granite to syenite. The absolute age of granite body is estimated at 47.6 ± 2.4 million years (Eocene) determined by the K/Ar method. However, sericite is observed as alteration minerals, it may be a younger age.

Monzonite intruds into the above-mentioned rocks and found out toward the north from the central part of this area. Quartz porphyry, granite porphyry also appear in the north of the central part of the area as small dykes intruded into all geological units previously described. These porphyry are generally characterized by their hydrothermal alteration and contact metasomatism with wall rocks. Andesite occurs also as small dykes in the whole area. As their facies and alteration grade varies, it can be presumed that the age of their intrusion is ranged widely.

Fault fissure system in this area are combined by two systems, one trending NE-SW and the other NW-SE. The former constitutes the major tectonic line of this area, causing a great dislocation of geological units. Although this fault system was identified directly at only one occurrence in the southeastern end of the area, based on the airphotograph analysis. It is supposed they dip very steep and are right lateral slip faults. The latter, NW-SE system was observed in the southern part of the area. A fault trending NNW-SSE, apeared to have been derived from this fault system is also a right lateral slip fault, therefore, the whole fault system should have been laterally slipped toward the right in the same way as the former.

Alteration which is related to mineralization in this area occurs in two zones: one along the south bank of the Miraflores River, and the other along the east bank of the Zonanga. The former is a contact zone between granite, quartz porphyry, granite porphyries and Oyotun Volcanics, forming chlorite-epidote skarn zone. This skarn zone is fine grained, compact, and no ore minerals were observed. Assay

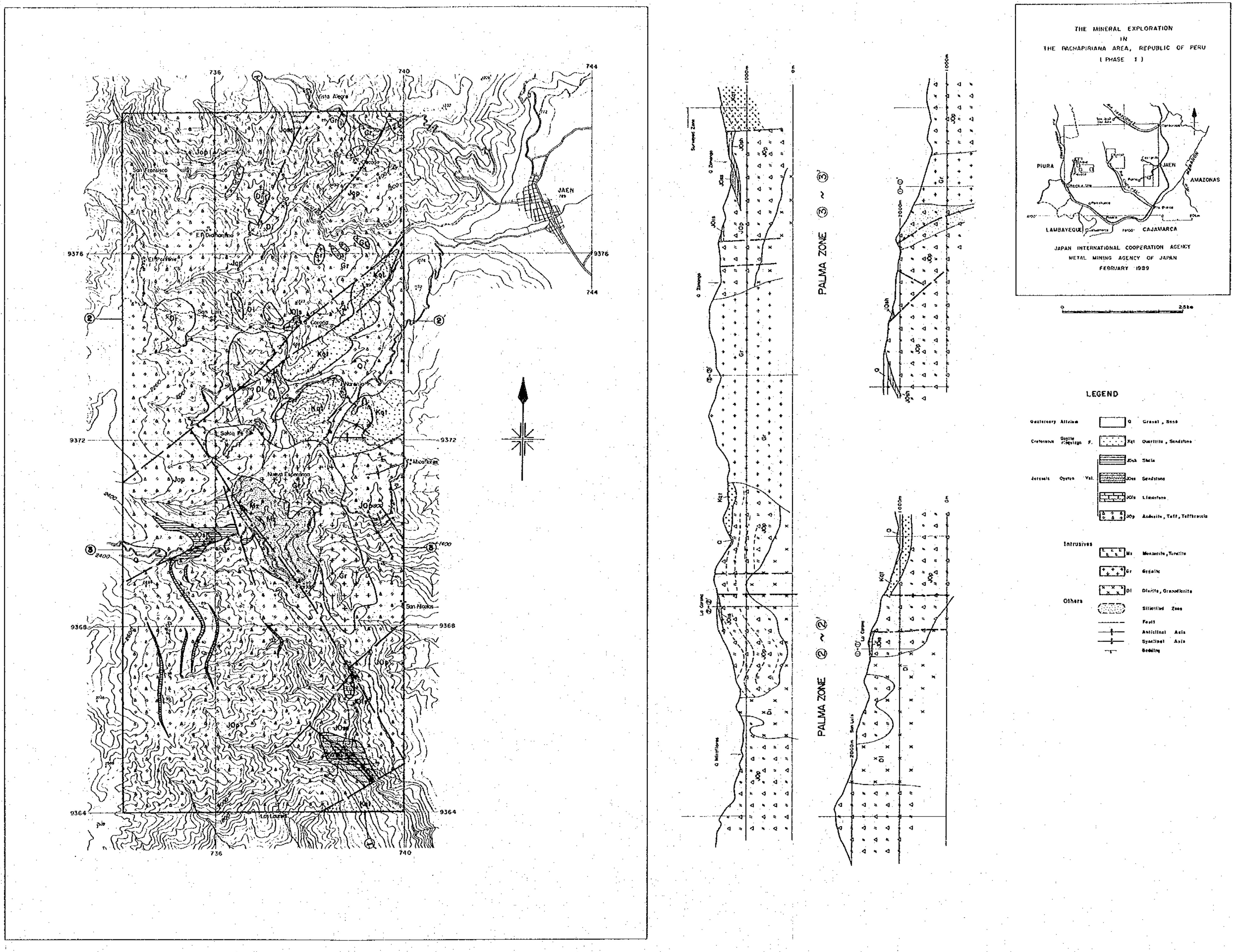


Fig.II－7　　Geological Map and Profiles of The Palma Area

result shows under the geochemical threshald value except for Zinc. Its size is also relatively small about ten and several centimeters to several meters in width and several meters to several 10 meters in length. The latter, in Zonanga there is a hydrothermal alteration zone in the Oyotun Volcanics, extending between the granite and the NW-SE fault. The alteration here is relatively strong and spreads widely, its size is about 1.5km in width (NE-SE) and 3 km in length (NW-NE), including silicified and/or combined silicified and argillized zones. Through X-ray diffractive analysis quartz, sericite, chlorite, halloysite and smectite were identified as altered minerals. A detailed survey was carried out in this hydrothermal alteration zone and green copper was found at the fault zones and the silicified zone.

2) Geochemical survey

Comparing the average value with other survey areas, this area is characterized by its high molybdenum grade (11.02 ppm). Other elements show very low grade. Analyzing the distribution of anomalies of each element, it is noted that those of gold is relatively concentrated in northern part, whereas lead and silver are small and spread widely. Zinc distribution is relatively extensive, without continuity. Distribution of copper is small and tends to be clustered. The anomaly of molybdenum is relatively extensive having relatively good continuity.

In correlation with geological units, all the elements are distributed in the Oyotun Volcanics and intrusive rocks except molybdenum which is found also in the Goyllarisquizga Group. Molybdenum may be related to the small fissure trending NW-SE observed nearby. On gold, of which a little mentioned in paragraph of alteration previously, tends to concentrate to the diorite rocks distributed mainly in the northern part of the area.

Relationship of geochemical anomalies of each element is extremely irregular. In the Zonanga detailed survey zone and its periphery, it is observed such a zonal pattern as a small-scaled gold and lead anomalous zones as core, overlapped by the copper and molybdenum anomaly, which is surrounded by small zinc anomaly. It is recognized that the extension of these geochemical anomalies also trend NE-SW as well as NW-SE which trending coinside with abobe-mensioned fissure, thus suggesting the existance of NE-SW trending agglutinated fissure by alteration. No significant anomaly was found along the south banks of the Miraflores extracted as the skarn distribution zone, it may be concluded that it is an unmineralized skarn zone, as described in the paragraph of alteration.

3-2 Review

The Palma area consists of Oyotun Volcanics as basement, Goyllarisquizga Group covers on it and intrusive rocks intrude into the formers. Oyotun Volcanics contain alteration zone of silicification and argillization having an approximate area of

1.5 km in width and 3 km in length in Zonanga. Overlapping with this alteration zone is found out lead, copper and molybdenum anomalies which are in turn surrounded by small zinc anomalies. These zonal distributions may suggest the possibilily of an existence of porphyry copper type mineralization.

No singnificant anomalies were found by geochemical prospecting in the skarn zone. This fact may suggest to conclude that there is little possibility of an existence of skarn deposits.

Small molybdenum anomalies were found in Oyotun Volcanics almost coincide with the alternation zones, which therefore suggests the presence of hidden intrusive rocks. It is also suggested that the diorites accompanies with gold mineralization.

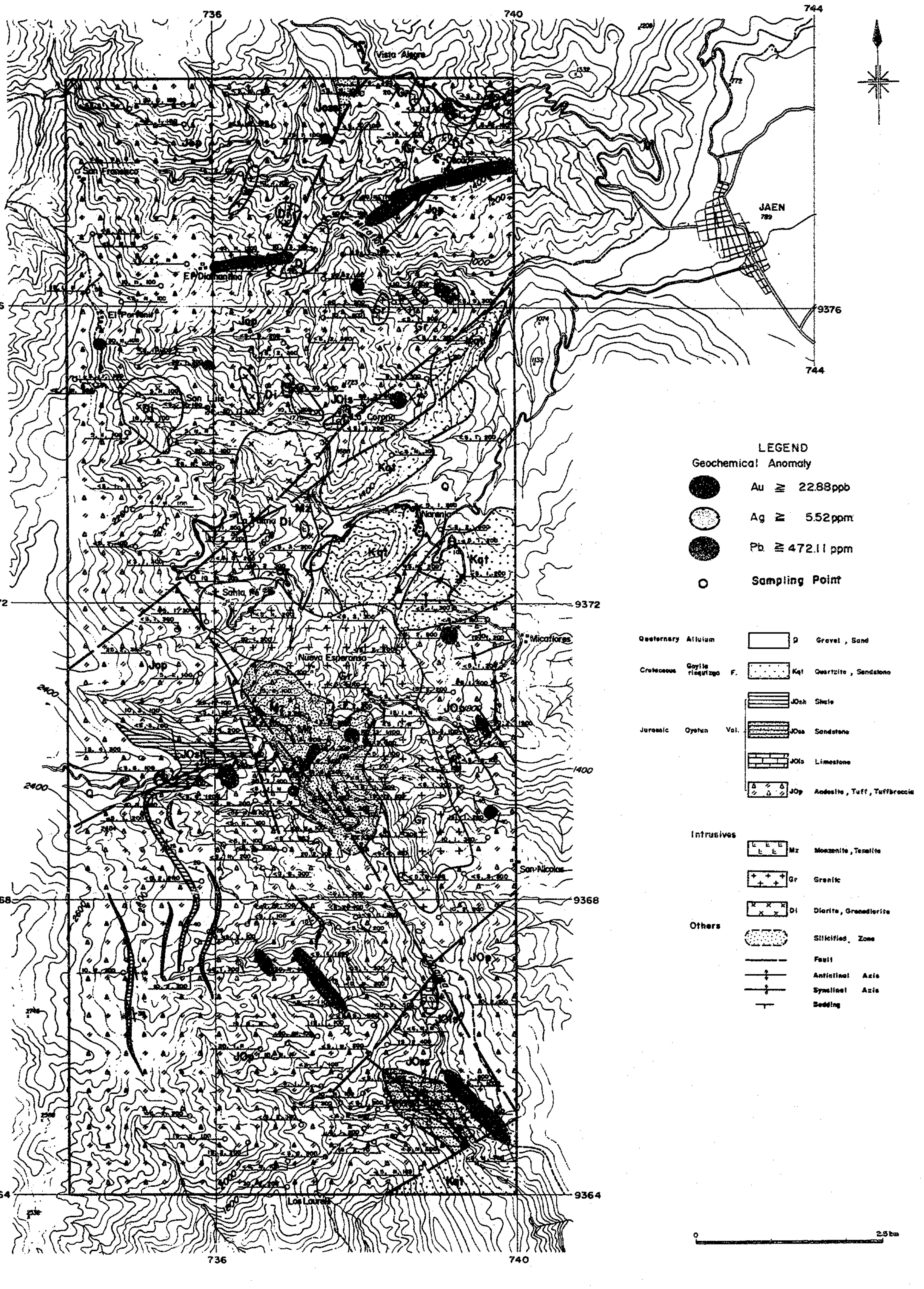


Fig.Ⅱ-8(1)　Geochemical Map of The Palma Area (Au. Ag and Pb)