REPUBLIC OF HONDURAS

REPORT ON GEOLOGICAL SURVEY OF THE WESTERN AREA

VOL. 5
(OLANCHO AREA)

FEBRUARY 1980

METAL MINING AGENCY
JAPAN INTERNATIONAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

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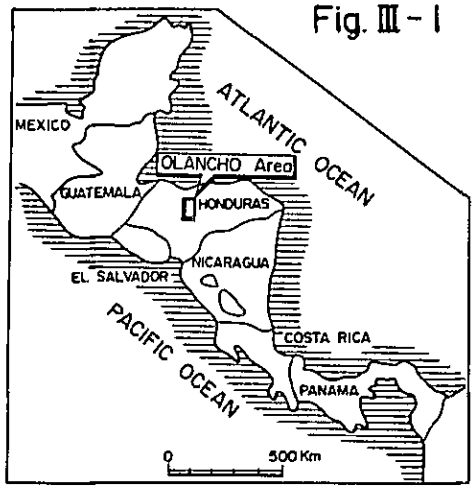
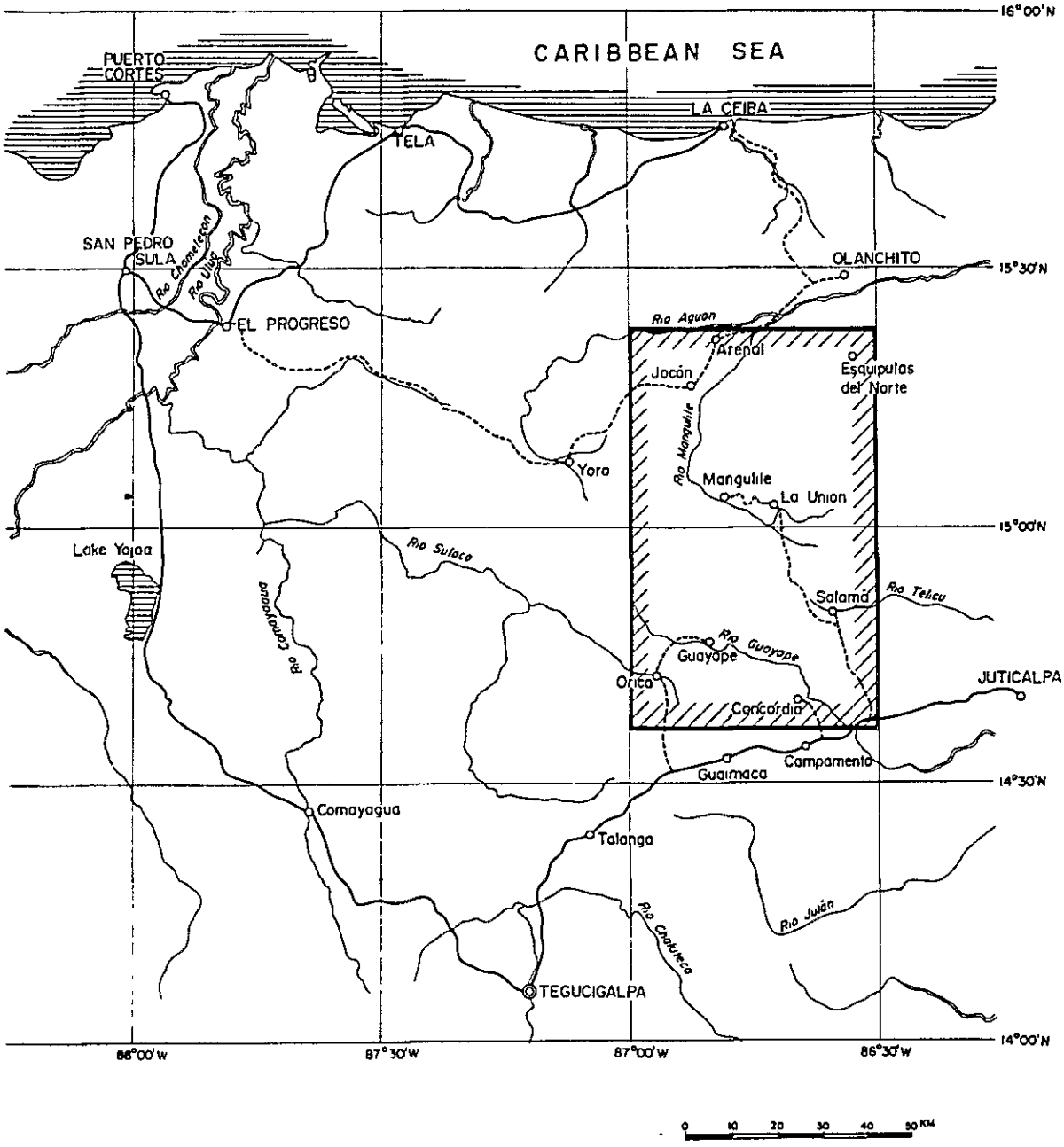




ABSTRACT

(Olancho Area)

The subject area is located in a mountainous land in the State of Olancho in the central part of the Republic of Honduras, occupying an approximate area of 4,700 km^2.

In this area, Direccion General de Minas e Hidrocarburos of the Republic of Honduras carried out geochemical exploration by soil samples and compilation of geological map in the whole of the survey area and detailed geochemical survey in the selected areas.

The present survey has been performed mainly by means of geological reconnaissence survey in the area, for the purpose to extract favorable areas for further investigation for the possibility of emplacement of ore deposits, refering to the results of the above surveys.

In this area, Paleozoic metamorphic rocks are distributed in the southern part and in the central to northern part of the area, fundamentally trending in the direction of east and west, comprising complicate foldings. They are composed mainly of mica schists with some marbles.

Between the southern part and the central part of this area, there are distributed El Plan Formation correlated with Jurassic of the Mesozoic Era, mainly of clastic rocks, Jurassic Todos Santos Formation red in color, the Yojoa Group of lower Cretaceous limestone and calcareous sediments, the Valle de Angeles Formation composed of upper Cretaceous red clastic rocks and pyroclastic rocks, and the sediments of the Esquias Formation mainly of limestone of Cretaceous or younger age. The trends of the beds of these formations are mainly east and west, but the beds of the upper part of the sequence exhibit directions of northwest-southeast and northeast-southwest, which show geosynclinal sedimentation structure.

In the central to northern part of the area, more than four places of small-scaled basin structure are developed in the area occupied by the metamorphic rocks, where the sedimentary rocks of the Valle de Angeles Formation and the younger limestones are distributed.

Along the north rim of the metamorphic rocks found in the southern part of the area, intrusive rocks as diorite porphyry and granodiorites are distributed 3 to 8 km wide in extension of over 35 km in the direction of west-north-west and east-south-east. They are observed to have intruded the metamorphic rocks and to be covered with younger sedimentary rocks. In the northwestern part of the area, intrusive rocks mainly of granodiorite and granite are distributed in Perico area and Carrizal area. Acidic intrusive rocks composed of quartz porphyry and aplite are found in Conce area, where they are observed to be in contact with sedimentary rocks as stocks. It is necessary to study whether they are related to mineralization in this area.

There are several known indications of mineralization such as those of copper skarn type at Conce and at Suyapita in the southern part and those of copper dissemination and vein type contained in the intrusive rocks at Llano Mejia, Portillo and at Concordia South, located around Concordia village. Detailed geochemical survey was carried out in parts of the area by Direccion General de Minas e Hidrocarburos of the Republic. The subject area is thought to be favorable for the emplacement of mesothermal to hypothermal ore deposits.

In the vicinity of La Union, there are confirmed indications of mineralization as antimony ore veins in the tuffaceous sandstone of the Valle de Angeles Formation, copper ore veins in the andesite of the same formation at Chica Leona, and gold ore veins in the mica schists at Mangulile. The area is thought to be favorable for emplacement of ore deposits of

epithermal type. No indication of mineralization has been found in the northern part of the area.

In the southern part of the area, where the metamorphic rocks and the intrusive rocks are distributed, it is necessary to study the relation between ore deposits of skarn type and the intrusive rocks, especially acidic intrusives, as the indications of mineralization are recognized scatteringly along the marginal zone of the intrusive rocks in the direction of west-north-west and east-south-east.

Through the present survey, the problems to be discussed have been pointed out as for geology, geological structure, volcanic activity and mineralization. The important conditions for high potentiality for the emplacement of mineral deposits are thought to be combinations of the area of the presence of many indications of mineralization, the area along the marginal zone of the Paleozoic metamorphic rocks, the area where the intrusive rocks are distributed, the area with many faults and fissures especially around the acidic intrusive rocks, the area of remarkable alteration and the area where the anomalies are distributed, which were shown by the geochemical survey carried out by Direccion General de Minas e Hidrocarburos of the Republic.

Considering combinations of the above-mentioned conditions, Conce-Condordia area in the southern part and La Union area and Mangulile area in the central part of the subject area would be favorable areas for the emplacement of mineralization. Therefore, it is recommended to conduct further geological survey, geophysical prospecting and diamond drilling for the confirmation of presence of indications of mineralization and for the comprehension of conditions for the emplacement of ore deposits, more in detail.

GENERALS

Chapter 1 Circumstances of the Survey

1-1 Circumstances of the Survey

1-1-1 The Subject Area (Refer to Fig. III-1)

The subject area is located in the State of Olancho in the central part of the Republic of Honduras, occupying an approximate area of 4,708 km^2 of about 53.5 km in east and west by about 88 km in north and south, limited by the following lines;

North latitude 15°23'45" and 14°36'25"

West longitude 86°30' and 87°00'

Partially the northwestern part of the area belongs to the State of Yoro and the western and the southwestern parts are in the State of Francisco Morazan, but most of the subject area lies in the State of Olancho.

The subject area is located in the mountainous land including the watershed which divides the Caribbean Sea side from the Pacific Ocean side, and the access to the most of the area is difficult.

1-1-2 Purpose of the Survey

In the subject area, there are thirty favorable areas selected through the detailed geochemical exploration carried out in the area including known indications of mineralization and many geochemical anomaly with Cu, Pb, Zn reagents by Direccion General de Minas e Hidrocarburos.

The present survey was conducted by means of geological mapping along selected routes, analysis of airphotograph and the geology, for the purpose to obtain informations to suggest principles for future exploration program in the area to be extracted carefully through the present survey, as high potential areas for the emplacement of mineralization where further investigations would be warranted.

1-1-3 Methods of the Survey

Topographical and geological particularities were studied by the analysis of the airphotographs over the whole area, summarizing critical problems by collecting existing data and reports for references. The field survey was carried out by means of geological mapping, on the base of the topographical map of the scale of 1 to 50,000. Synthesizing the results of the mapping with the data of chemical analysis and microscopy, geological map of the scale of 1 to 100,000 has been compiled by partial modification of the geological map prepared by Direccion General de Minas e Hidrocarburos of the Republic of Honduras. The field survey was conducted, using jeeps, by two parties composed of survey members of Japan side and Honduras side, in the term from June to September in 1979.

1-2 Outline of the Geography

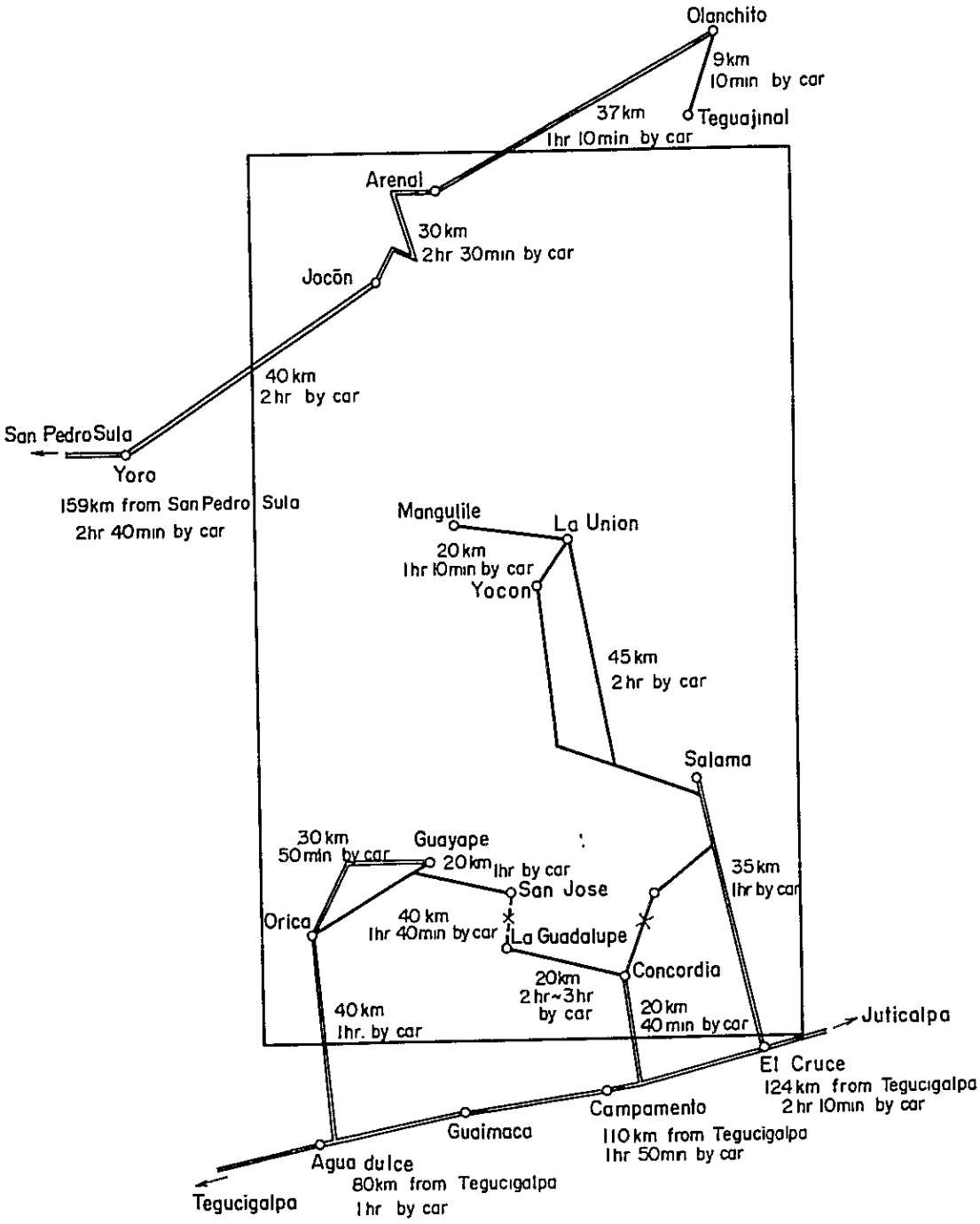
1-2-1 Access (Refer to Fig. III-3)

The subject area is located in a mountainous land in the central part of the Republic of Honduras, and the area is difficult of access. The access to the northern part of the area is possible by reaching the towns of Jocon and Arenal by the road to Olanchito in the east, through Yoro, from San Pedro Sula, the second largest town in the Republic, but the road conditions are so rough for vehicles as to take about 2 hours for the distance of 40 km between Yoro and Jocon. Access from this road to mountain land is by no other way than on foot.

In the southern part of the area a main national way was opened this year from Tegucigalpa, the capital, to Juticalpa in the east, and therefore the access is easy by this national way which is sealed and has two lanes.

The access to the southwestern part of the area is easy by vehicles, from Aguadulce along the main national way to Orica Guayape and from

Fig. Ⅲ-3 TRAFFIC MAP IN THE OLANCHO AREA



Campamento in the south to Concordia. However, the access to the central part of the area is rather hard with main roads unsealed, as there are such areas as vehicles can not afford rivers at the time of flood in the rainy season, although it is possible to reach La Union and Mangulile in the central part by vehicles, through Salama from El Cruce.

There is no other way to get into the central part of the area than on foot or on horse, as there is no vehicle road except for the above main unsealed roads. Especially, no route has been known to pass over the back ridge in the northern to central part of the subject area.

1-2-2 Climate and Inhabitants

There is no accurate weather record in the area. The annual rainfall is about 1,000 mm, and it is said that the rainy season is from June to September, while dry season is from December to March. Temperature is 10° to 30°C generally but it varies to lower grade according to seasons and altitudes. Humidity is generally low.

Most of the area is covered mainly with forests of pine trees, but broad-leaved trees also grow well. The area is poorly populated and agriculture, stock-farming and forestry are the chief industries. Power light has not been set up and the life circumstances are rather low in this area.

Population of the main villages are as follows;

Salama	about 5,000
Orica	about 5,000
Guayape	about 2,000
Santa Cruz	about 1,300
San Jose	about 300
La Union	about 3,000

In the area, dangerous creatures as serpent, scorpion etc. are there and it is said that outbreak of malaria was reported.

1-2-3 Topography

The subject area is located in a mountainous land in the central part of the Republic of Honduras, where the watershed of the Pacific Ocean side from the Caribbean Sea side is included.

The area is described here by dividing it into three parts, for convenience.

A) Southern part

In the southern part of this area, sheer mountains of the Misoco range with the main peak of El Volcan (altitude 2,153 m above sea level) are stretching east and west. In the south of this range there are ranges in the directions of east-west and north-south, and the altitude of the peaks changes with their positions from north to south. In the southern end, alluvial plain is developed and the back hills are dissected to a certain degree. The area south of Salama is divided into drainage basins of Yano River in the east, and Guayape River and El Panal River in the south, by the hills of El Montarren, La Pena and Pezo Junco. The drainage basins of Guayape River and El Panal River are with the hills ranging in the direction of north-north-west and south-south-east, which has been well dissected to form hill lands of relative height of 400 to 800 m. Especially, the hills of limestones in the east of Salama exhibit dome-topography with sheer cliffs, and there are many local name of "Caliche". Pattern shown by the distribution of rivers and streams is dendritic. In the drainage basin of Panal River, there is a plain (Valle de Ulua) surrounded by the ranges of the directions of east-west and northeast-southwest. At the southeastern end of this part vast plain (Valle de Lepaguare) has been formed near the boundary of the sedeimentary rocks and the Paleozoic metamorphic rocks.

It is utilized as pasture. Around Orica in the west, there is another hilly land of north and south, comparatively dissected. Malaque River flows westwards through Orica basin.

B) Central Part

In the western half of this part, a range of sheer mountains of the altitude of more than 1,000 m is stretching in the direction of east-west and northwest-southeast. This range is called La Flor range, and it includes high peaks of Chugurite Blanco (1,810 m above sea level), El Frontan (1,739 m above sea level), Armado (1,923 m above sea level) and Cumbre (1,826 m above sea level). Especially, such peaks as composed of limestone are soaring against the sky with high cliffs of more than 500 m in many places.

There is a range of hills in northeast and southwest, stretching from the north of Talgua village. The southeastern side of this range is the drainage basin of Telica River called Salama basin, including the town of Salama. On the other hand, the northeastern side of the range is the drainage basin of Grande River, which flows into Mangulile River passing through mountainous land. Pattern shown by the distribution of rivers and streams is dendritic, and water flows to northwest to the town of Mangulile, from where it runs to north and forms meandering amidst the mountainous land.

Bounded by Higuerales range, which includes high mountains of the altitude of 1,900 to 1,600 m as Muralla, Parras, Volcancitos, and Salitralos, the eastern side is the drainage basin of Comayaguela River, and the northern side forms Chiquito o Esquipulas drainage basin.

C) Northern Part

Peaks of Cañada (1,856 m above sea level), Campana (1,769 m above sea level) and Copete (1,362 m above sea level) are in a range of east-west

direction, showing sheer mountains.

Especially the mountains in the limestone area are recognized to form steep cliffs as high as several hundred meters.

As for the boundary between the mountainous land and Aguan River in the north, distinct topographical difference is recognized along the east-west line in the west of the town of Teguajal, while in the east of the town the boundary line is in the direction of northeast-southwest.

Mangulile River changes its name to Yaguala River in the downstream of the junction with Alao River, flowing to north or to northeast. It has confluence with Aguan River near the town of Teguajal. These rivers show dendritic pattern of distribution in the mountainous land, where meandering due to dissection is observed in many places, although fault valley is seen partly in the direction of north-south.

The eastern area of this northern part forms a drainage basin of Chiquito o Esquipulas River, where lineations of the directions of east-west and northeast-southwest are predominant. Small basin in east and west is recognized in the area around the town of Esquipulas del Norte. Little development of terraces has been confirmed. An alluvial plain is there along Agua River at the northern end of the area, where the land is fertile and is utilized as agrricultural land and stock-farming land.

1-3 Surveys and Studies in the Past

Almost no reports and studies on the geology and the ore deposits have been known in this area but the reports of the study of Mesozoic sedimentary rocks by Mills et al. (1969) and of the study chiefly of volcanic rocks by McBirney et al. (1969). The area is quite difficult of access and geological survey covering whole of the area has not been carried out yet.

Direccion General de Minas e Hidrocarburos of the Republic of Honduras

(hereinafter referred to DGMH) programmed regional geochemical survey in this area and conducted the geochemical exploration by stream sediments over two calender years from May, 1974 to December, 1975, employing UNDP methods, on the basis of geological map and drainage map. Total 30 areas which would require further investigations were selected by this geochemical survey. Among such areas where many anomalies of copper, zinc etc. were found, detailed geochemical survey partly with magnetic survey was carried out by establishing survey lines in several areas as La Conce and Concordia, and more favorable areas were extracted for further investigations.

The number of collected samples are total 4,096 including those taken at the detailed geochemical survey, and the density of sampling is 0.72 sample/ km^2. Total cost for the geochemical surveys was about 220,000 Lempiras.

Studying these samples and analysing the airphotographs of whole of the area, geological map has been compiled in a scale of 1 to 100,000. Also, as for the detailed geochemical survey, sample map was prepared in a scale of 1 to 2,000 in La Conce area, and total 4,774 samples of soils were collected in an approximate area of 5.5 km^2, at the points every 20 to 40 m along the survey lines with intervals of 40 to 80 m. The elements for assay are copper (hereinafter referred to Cu), lead (Pb), Zinc (Zn), gold (Au) and silver (Ag) and analysis was performed by atomic absorption method at the laboratory of DGMH.

1-3-1 Results of the General Geochemical Survey (Refer to PL. III-8, III-9)

Total 30 areas were selected by the general geochemical survey conducted by DGMH over whole of the subject area, by the anomalies detected on the following elements.

Summary of the results of the survey is shown here.

	Background	Anomaly Value (in ppm)
Zn	71	178 up
Pb	25.84	133
Cu	24	69
Au	0.03	0.12
Ag	0.54	2.20

Outline of anamalies found in each of the areas is described as follows;

Name of Block	Notes
Rio Maraque	Anomalies of Ag, Cu, Pb and Zn are found in alluvial sediments.
El Suyatal	Anomalies of Pb and Zn, partly of Cu, are found along the marginal zones of the metamorphic rocks.
Conce	Ag: 1 point, along the margin of the intrusive rocks. Cu: 8 points, along the margin of the intrusive rocks, 1 point, in the sedimentary rocks in the north, Pb: 1 point each, along the margin of the intrusive rocks and in the sedimentary rocks, Zn: 3 points, in the intrusive rocks.
Concordia Oeste	Cu: 2 points, in the intrusive rocks, 1 point, in the altered rocks.

Name of Block	Notes
Concordia Este	Au, Cu, Zn: 1 point, along the margin of the intrusive rocks, Cu: 3 points, along the margin of the intrusive rocks beyond the northeastern limit of the subject area.
Jutiapa	Cu: 4 points, in the sedimentary rocks in east and west direction, Au: 1 point, as above.
Queb de las Piedras	Zn: 2 points, in the conglomerate.
Rio Chiquito	Pb, Zn, Ag: 1 point in the sedimentary rocks.
El Salitre	Zn: 1 point each, in the volcanic rocks and in the alluvial sediments.
Queb. Guayabillas	Zn: 3 points, in the volcanic rocks, Pb: 1 point, as above.
Quintanilla	Zn: 1 point, in the volcanic rocks.
La Chelas	Cu: 3 points, in the metamorphic rocks.
Las Quebradas	Zn: 5 points in the metamorphic rocks in the west, Pb: 4 points, as above, Cu: 5 points, in the metamorphic rocks in the northern part of the east side, Ag: 2 points, in the limestone in the north.
Mangulile	Pb: 3 points, in the metamorphic rocks, 1 point, along the margin of the metamorphic rocks, 2 points, in alluvial sediments.

Name of Block	Notes
Mangulile	Zn: 6 points, in the metamorphic rocks, 1 point, in the limestone, 3 points, in the sedimentary rocks, Au: 1 point, in the metamorphic rocks, 2 points, along the boundary between the metamorphic rocks and other rocks, Ag: 1 point, along the contact zone of the metamorphic rocks to the limestone.
Los Indios	Zn: 4 points, in the northwestern part of the area occupied by the sedimentary rocks.
El Dictamo	Pb: 3 points, in the limestone in the north, near the boundary to the metamorphic rocks, Zn: 3 points, along the boundary between the sedimentary rocks and the limestone, Ag: 1 point, as above, Au: 1 point, in the sedimentary rocks.
Montana del Ecuador	Au: 2 points, in the metamorphic rocks, Ag: 1 point, in the metamorphic rocks in the east, Zn: 1 point, as above.
Queb. del Teocinte	Cu, Pb: 1 point each, in the metamorphic rocks.
Rio Comayaguela	Au: 2 points in the metamorphic rocks 1 point, along the contact of the limestone and the volcanic rocks.

Name of Block	Notes
Esparramada	Pb: 3 points, in the sedimentary rocks, Ag: 3 points, in the sedimentary rocks in the northwestern side.
Rio de Pueblo Viejo	Zn: 2 points, in the metamorphic rocks, 1 point, in the limestone, Ag: 2 points, in the limestone, 1 point, in the metamorphic rocks.
Rio de Jocon	Zn: 3 points, in the limestone, 2 points, in the Paleozoic formation, 2 points, in the alluvial sediments, Pb: 2 points, in the metamorphic rocks, Cu: 3 points, in the metamorphic rocks in the north, 1 point, as above but in the east, 3 points, along the boundary between the metamorphic rocks in the central part and the alluvial sediments, Ag: 3 points, in the metamorphic rocks in the north, 1 point, in the limestone in the west.
Puente Grande	Ag: 5 points, in the limestone, 1 point, in the alluvial sediments along the border to the limestone, 1 point, in the limestone along the border to the alluvial sediments.

Name of Block	Notes
Rio Macora	Cu: 3 points, in the metamorphic rocks, 3 points, along the margin of the metamorphic rocks partly along the border to the limestone,
Las Lagunas	Cu: 1 point, along the boundary between the limestone and the metamorphic rocks. Many points are scattered in the area beyond the limit of the subject survey area, Pb: 3 points, in the metamorphic rocks.
Queb. del Perico	Pb: 3 points, along the boundary between the limestone and the metamorphic rocks, Zn: 3 points, in the metamorphic rocks in the north, 1 point, in the metamorphic rocks along the boundary to the limestone, Au: 2 points, in the intrusive rocks, 2 points, in the metamorphic rocks.
El Carrizal	Au: 1 point, in the intrusive rocks.
Queb. de Pueblo Nuevo	Au: 2 points in the metamorphic rocks, Ag: 1 point, as above.
Zanja de Leon	Zn: 2 points, in the metamorphic rocks, 4 points, in the sedimentary rocks near the boundary to the metamorphic rocks, 9 points, in the alluvial sediments.

Name of Block	Notes
Zanja de Leon	Pb: 1 point, in the limestone in contact with the sedimentary rocks,
	Au: 1 point, in the limestone,
	Cu: 5 points, in the alluvial sediments.
Los Urracos	Cu: 1 point, in the metamorphic rocks in the southwest,
	3 points, in the alluvial sediments,
	Zn: 2 points, in the metamorphic rocks,
	1 point, in the alluvial sediments.

1-3-2 Results of the Detailed Geochemical Survey

The detailed geochemical survey in the Conce area was carried out, following the above survey, by collecting soil samples in the divided four blocks as 1, 2, 3 and 4. At present, the survey is being conducted by DGMH, in further western area as Conce No. 5 block.

Summary of the assay results of each element in the subject area for the detailed geochemical survey is as follows;

(in ppm)

Background	Anomaly Value
Cu 109	3,106
Pb 14.52	76.18
Zn 49	342
Ag 0.5	7.6
Au 0.04	0.26

The Cu anomaly of the values of over 3,106 ppm occupies an area of 60 m in width by more than 1 km in length. The anomalous areas are in correspondence with the southern part of Conce No. 3, where massive limestone is distributed, with the northern part of Conce No. 4 and with the breccia

rocks zone in Conce No. 2.

The Zn anomalies are mostly along the contact with limestone, while many of the Ag anomalies are found in contact zones between intrusive rocks and sandstone, on the southern slope.

Meanwhile, magnetic survey was carried out in this area, using magnetmeter of Flux Gate MF-1 type. High magnetic anomalies have been detected as shown below:

Conce No. 1
- In the acidic porphyry zone.
- Along the contact zone of breccia rock and
- granodiorite.

Conce No. 2
- Along conglomerate beds and breccia zone accompanying 2 layers of hematite-bearing silicification, extending to the northwest.
- In the contact zone between white porphyry and conglomerate in the east.

Conce No. 3
- In the contact zone of limonitized part with igneous rock.

Trenching (total length 4 km) was carried out using tractors in parts of the anomalies and the indications of skarn type mineralization have been roughly confirmed.

Through these investigations conducted in the Conce area, it was recommended for future program of exploration to carry out magnetic survey and electric survey (IP method), and considering the results of these surveys, to carry out pilot drilling, geological survey and semi-detailed geochemical survey.

Apart from the above-mentioned works, semi-detailed geological and geochemical surveys were carried out to reach respective conclusion in each area of Portillo No. 1 and No. 2, Llano Mejia, La Libertado, Quebrada los

Urracos, Zanja de Leon, Jocon, Macora, Rio Pueblo Nuevo, Puente Grande, Quintanilla and Salitre.

In Portillo No. 1 area, detailed geochemical survey was conducted and it was concluded that it would be desirable to carry out detailed geochemical survey, geophysical prospecting by IP method, magnetic survey and trenching.

In Portillo No. 2 area, detailed geological mapping, geochemical survey by soil sampling and magnetic survey were carried out, and the conclusion was that geophysical prospecting by IP method and trenching would be necessary to catch phenomena related mainly to the indications of vein type copper mineralization with quartz veins.

In Llano Mejia, detailed geological survey, detailed geochemical survey by soil sampling, and partly magnetic survey were carried out, and it was concluded that such explorations as geophysical prospecting by IP method and trenching would be recommended for the comprehension of the geology, although the area is thought to be by no means so much interesting.

In La Libertado area, geochemical survey was conducted, but the assay results were so low as to take it unfavorable for the existence of mineralization and the conclusion was to leave this area to further consideration.

In Quebrada los Urracos area, geochemical survey was conducted but the assay results of every element were low and it was recommended to cease further exploration.

In Zanja de Leon area, there are crystals of pyrite as well as vesicles after them in the schists, and the assay results of the soil samples collected through the geochemical survey conducted in this area were low and the recommendation was to abandon further exploration works.

In Jocon area and in Macora area, additional soil samples were collected, and in Rio Pueblo Nuevo area and in Puente Grande area additional stream sediments were collected.

However, the assay results of all of these samples revealed low content of any of the elements of Cu, Pb, Zn, Au and Ag. It was concluded that anomalies detected through the statistic treatment would be related not to mineralization, but to particularity of rocks, and that further exploration would not be necessary.

In Quintanilla area, geochemical survey by soil sampling was carried out and the assay results of the collected samples were low of the elements of Cu, Pb, Zn etc. However, it was concluded that additional samples of soils and rocks would be necessary near the contact zone of volcanic rocks and massive limestone in the eastern part.

In Salitre area, detailed geological survey and geochemical survey by soil sampling were conducted, but the assay results were as low as to conclude that there would be no interest as to prospecting for mineralization in the area.

As for other selected areas, detailed surveys are being carried out or reports are being prepared and also some of them are under consideration at present by DGMH.

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Chapter 2 Geology of the Olancho Area

2-1 Outline of the Survey

In this Olancho area, by DGMH of the Republic of Honduras, geochemical survey was carried out as a part of the fundamental ore mineral exploration program, and the geological map of the scale of 1 to 100,000 has been prepared on the basis of the geological survey and the analysis of airphotographs. Total 30 areas were selected by the results of the above survey as the area to warrant further exploration, and 16 areas among them are now under investigation by means of detailed geochemical survey, magnetic survey and so on.

The present survey has been conducted mainly in the selected areas, on the basis of the data and the reports by DGMH, for the pursuit of the relation of the geology to the results of the DGMH surveys, for the investigation of the indications of various metallic mineralization and for the consideration of types of expected ore mineral deposits. Furthermore, analysis of airphotographs, chemical analysis of rocks, microscopy, X-ray diffraction, determination of fossils and isotopic age determination were conducted for the solution of critical problems in this area. However, it can not be deniable that the present survey has brought forward some geological points for discussion rather than it has shown clear elucidation of geology, because of the difficulty of access to the area and of the shortness of men-works compared to the vastness of the subject area. The access to the survey points was quite difficult, especially to the central part of the area, where mountains of the altitude of more than 2,000 m are in a range, forming watershed between the Pacific Ocean side and the Caribbean Sea side. In rainy season, it is impossible to afford rivers in many places, and the survey routes were limited. Also, the topographic feature is very steep in the mountainous land and rock exposures are limited by the covering of forests mainly of pine trees.

Therefore geological observation was restricted widely.

The field survey was carried out by 3 Japanese geologists and 1 Hondurenean geologist, in the term from June 25th to September 15th in 1979. The routes for geological mapping were selected so that as many routes as possible would be included in the pre-selected geochemically anomalous areas, and route map was prepared in a scale of 1 to 50,000.

2-2 Geology (Refer to Fig. III-2, III-4 and PL. III-1, III-2, III-4)

The subject area belongs to a geologic structural unit of Sierra of Northern Central America, and is underlain by Paleozoic metamorphic rocks, Mesozoic sedimentary rocks and igneous rocks intruding them, with partial covering of volcanic rocks of Tertiary period.

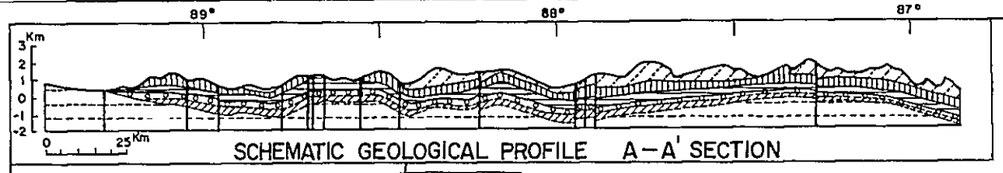
In the southern part of the area, Paleozoic metamorphic rocks are distributed with intermediate intrusive rocks in the northern side. The Paleozoic metamorphic rocks are also distributed extensively in the central to northern part of the area. In the narrow zone between the Paleozoic metamorphic rocks in the central part and those in the southern part, Mesozoic sedimentary rocks and Mesozoic or Tertiary andesites are developed, which reveal geosynclinal sedimentation with the folding axis of east and west. In the area occupied by the Paleozoic metamorphic rocks, there are several small-scaled basins where Mesozoic sediments partly with acidic intrusive rocks are accumulated. At the northern end of the area, there is an extensive alluvial plain with Aguan River flowing in east-west direction. Sedimentary rock expected to be underneath the alluvial plain is uncertain.

2-2-1 Metamorphic rocks

In the southern part of the area, the metamorphic rocks are distributed in east and west or in east-south-east and west-north-west. They are extensively developed in the area beyond the southern limit of the area.

Fig. Ⅲ-2

GEOTECTONIC MAP OF REPUBLIC OF HONDURAS, C.A.



T·N

0 50 Km

ATLANTIC OCEAN

Puerto Cortes

CHAMELECON FAULT

San Pedro Sula

MOTAGUA FAULT

GUATEMALA

PUEBLO NUEVO FAULT

Olancho Area

AGUAN FAULT

Lake Yojoa

Comayagua

Tegucigalpa

GUAYAPE FAULT

A

A'

EL SALVADOR

NICARAGUA

San Lorenzo

PACIFIC OCEAN

89° 88° 87° 86° 85° 84°

16° 15° 14° 13°

LEGEND

CENOZOIC
- Quaternary
  - Recent Sediments
  - Quaternary Volcanic Rocks
- Tertiary
  - Gracias Formation
  - Padre Miguel Group
  - Matagalpa Formation
  - Valle de Angeles Group

MESOZOIC
- Cretaceous
  - Yojoa Group
  - Todos Santos Formation
- Jurassic
  - El Plan Formation

PALEOZOIC
- Metamorphic Rocks

Intrusive Rocks

Fault (defined)

Fault (approximate)

Anticlinorium

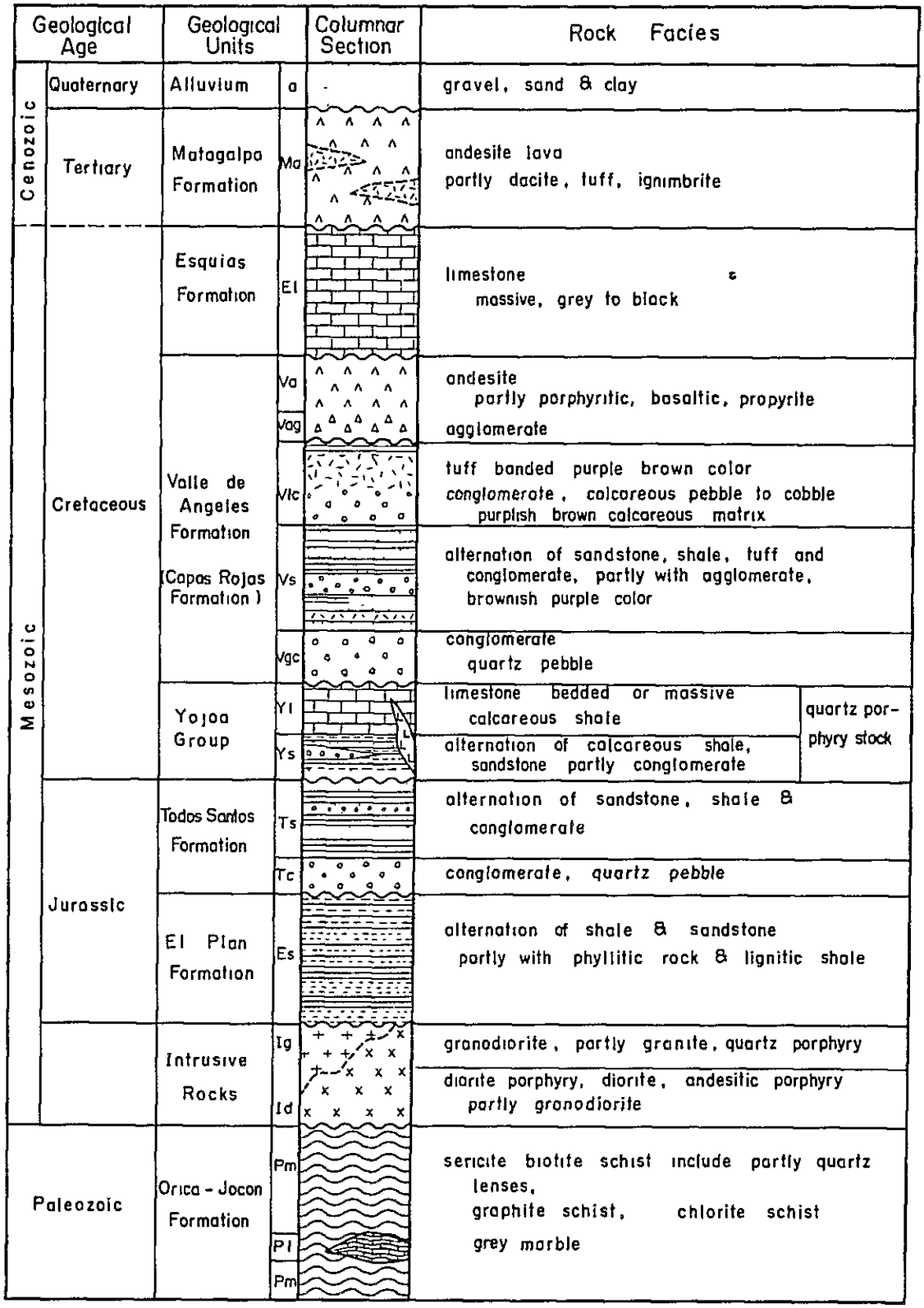
Synclinorium

Anticline

Syncline

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

Fig. Ⅲ-4 Schematic Geological Column of the Olancho Area



The metamorphic rocks are composed mainly of mica schists partly with insertions of crystalline limestone. The mica schists are well foliated and are mainly muscovite schist and two mica schist, with minor amount of chlorite schist, graphite schist, quartz schist and quartz-mica schist. The mica schists are homogeneous locally, composed mainly of micas. In many places, schistosity is remarkably developed and in places they are intensely folded. In the southern part of the area, the constituent minerals of this rock are, in most cases, chiefly muscovite, biotite and quartz with some graphite, chlorite, tourmaline and rutile. Stratification is often observed with the thickness of 5 to 20 cm. The mica schist is greenish grey to dark grey or dark colored to dark green, and weathering would show flakes of mica in the mica schist.

Along the east side of the Orica - Guaymaca road at the southern end of the area, limestone is observed to be inserted. It is in contact with the mica schists, showing characteristic topography of rounded hill top in the direction of east and west. The limestone is striped with color bandings of greyish white to grey or green, and is a sort of marble, with recrystallized crystals 0.5 to 1 mm in sizes. Generally it is massive with occasional joints 2 to 3 cm in thickness.

The metamorphic rocks distributed in the northern part of the area are, as is the case in the southern part, composed mainly of mica schists, with insertions of quartz schist, graphite schist and chlorite schist.

They are distributed in topographically depressed part in Zanja de Leon area, and the rocks are mainly mica schists and graphite schist. The mica schists are grey to pale green in color, and are mainly composed of sericite with abundant quartz bands or lenses. Disseminations of dot-like pyrites 3 to 5 mm in sizes have been recognized in this rock. Graphite schist is observed to be grey to dark colored rock 3 to 5 m in thickness, inserted in the mica schists.

In Perico area, quartz sericite schist and graphite schist are exposed. They are grey to dark grey in color, and schistosity is well developed. The quartz sericite schist has biotite in addition to medium grained sericite, with cubic crystals of pyrite and abundant free quartz. As accessory minerals, chlorite, actinolite, apatite, sphene and tourmaline are contained.

In Jocon area, the metamorphic rocks are composed mainly of sericite schist and graphite schist with occasional chlorite schist, as is the case above-stated.

Over whole of the area, the metamorphic rocks are composed mainly of mica schists with little variation of lithofacies, and are well stratified. Mills et al (1967) stated that the marble is of the age prior to Cretaceous in southwestern Olancho area, but that the metamorphic rocks are Paleozoic as they are intruded at several places by igneous rocks prior to Cretaceous, covered with Mesozoic sedimentary rocks, although more detailed division of age was not attempted there.

The metamorphic rocks are similar, as for lithofacies, to those distributed in Chamelecon area (in the State of Santa Barbara). The metamorphic grade is medium to weak degree, and the rocks are of pelitic origin. Therefore, as age of the formation of these metamorphic rocks is presumed to be same as those found in Chamelecon area, these metamorphic rocks, of pelitic origin, weakly metamorphosed, as reported by Horne and others, are thought to be of the comparatively younger age of Paleozoic Era, possibly of Permian period.

2-2-2 El Plan Formation

The El Plan Formation is distributed around the village of Jutiapa and around the Valle de Ulua basin in the southern part of the area. It is composed of marine clastic rocks such as sandstone and black shale with minor

quartzite, which are subjected to weak metamorphism, partially. Furthermore, there are sedimentary rocks mainly of black shale at about 2 km west of La Union, and also those chiefly of quartzite at northwest of Mangulite. Exposed in very small area, both of them have similar lithofacies to those of the above-stated El Plan Formation. Therefore, these sedimentary rocks are included in this formation, tentatively. There is no bed belonging to this formation in the central to northern part of the subject area.

The beds of this formation found around the village of Jutiapa are composed of alternation of well-stratified black shale and grey sandstone. The beds are as thick as about 300 m. The black shale is 1 to 5 cm in thickness and intensely folded. With grey shale (5 to 20 cm in thickness), the black shale forms alternation of the thickness of more than 2 m each. Also, the shale is alternated with grey medium to fine grained sandstone beds. The sandstone is white, grey and bluish in color and contains quartz and partly magnetite. The black shale is found intruded by kaolinized hornblende andesite dykes, along the vehicle road about 4 km east of Jitiapa. In the mountainous land at the north of Jutiapa, sedimentary rocks composed mainly of grey sandstone bed, rather massive, are distributed. Also, around the village of La Bolsa, about 5 km southwest of Jutiapa, there are shale beds (6 m in thickness) containing carbonaceous matter in the pelitic shale, which carry lignite layer of the thickness of 35 cm. Pollens contained in this lignite were studied but due to poor preservation, age determination was impossible.

The beds belonging to this formation distributed around Valle de Ulua are composed of alternation of black shale and grey to dark-colored sandstone, with stratification 5 to 20 cm in thickness.

Shale and arkose sandstones found around Conce are subjected to remarkable alteration such as silicification and hematitization with

fractuation, and lithofacies of original rocks are uncertain, but they are included in the formation which include the silicified shale and sandstone, here. Altered quartzite and partly breccia rock are inserted in them, and they are intruded by dykes of acidic rocks.

The beds mainly of quartzite distributed in the south of Concordia are isolated and are subjected to alteration and fractuation. Although there are severe silicified rock of other type rocks and would be lithological problems for correlation, these beds are included in this El Plan Formation, tentatively.

The beds distributed in the northwestern side of the Guarabuqui basin in the southwestern part of the area are constituted by well-stratified and tightly folded shale beds, with banding 5 to 20 cm in thickness. They are also included in this formation, as they have sharp conchoidal fracture and they are intensely folded, although color changes from grey, dark grey to black. Limestones, found in the topographically higher part in the east side, are recognized to cover this formation with unconformity.

In the central part of the survey area, beds of black shale have been observed to be exposed in as small area as 1 km square at the west of La Union. The rock is black or purplish black phyllitic shale, well-stratified to form layers 1 to 30 cm in thickness. Many lenticular layers of milky quartz, 10 to 40 cm thick and about 1 m in length, are contained. Veinlets of free quartz are also contained. They are exposed, surrounded by the Valle de Angeles Formation, but no particular relation has been confirmed of these beds to any other formation.

The beds mainly of quartzite, found about 5 km northwest of Mangulile are isolated, surrounded by mica schists. These beds are included in this formation, although further consideration would be necessary.

The reason to group these alternations of black shale and sandstone

distributed in this area into El Plan Formation is as follows;

According to Mills et al. (1967), "On the sedimentary rock found in the Olancho area, the base of the Mesozoic column contains dark grey to black, interbedded shale and sandstone similar to the El Plan Formation in the San Juancito Mountains (out of the area). These sediments crop out near Concordia, Salama, Catacamas (out of the area), and San Pedro. The best section is 15 km south of Salama where 1,500 ft was measured and described. Mullerried (1942 b) found cycad plant remains in similar sediments near Catacamas which he considered to be Early and Middle Jurassic (paleon. loc.G)" There is no additional evidence found in the present survey, but following to Mills, these beds are grouped into El Plan Formation in this report.

2-2-3 Todos Santos Formation

The Todos Santos Formation comprises clastic rocks, composed of alternation of brown sandstone, shale and conglomerate, which are distributed around the ridge between Valle de Ulua and Valle de Lepaguare to the south of the former.

The beds belonging to this formation reveal typical colors of brown or purple, brownish crimson. They comprise alternation of dark brown shale (stratified in layers 5 to 10 cm thick), greyish black to grey fine grained sandstone, grey medium grained sandstone and conglomerate (greyish black rock containing sub-rounded pebbles 1 to 5 cm in diameter, pebbles are mainly slate and quartzite with occasional volcanic-originated rocks). The total thickness is more than 200 m.

There is a narrow zone occupied by conglomerate mainly of quartzite, 1 to 2 km wide, extending in northwest and southeast along Guayape River in the northeast of Concordia. The conglomerate is distributed in a graben-like form between the mica schist and the intrusive body. It is thought that this conglomerate would be included in this formation. It is recognized that

this formation covers the metamorphic rocks unconformably and that the conglomerate along the Guayape River covers the intrusive rock with unconformity. Also, the beds of this formation is in contact with the black shale of El Plan Formation in Valle de Ulua side, by a fault which appears topographically in the direction of northeast and southwest.

Mills et al. (1967) stated that "On the Salama road, Todos Santos red shale, sandstone and conglomerate lie unconformably above the El Plan Formation". It is difficult to distinguish these beds from those of the Valle de Angeles Formation, which is described later, in such points as color and lithofacies, in addition to the fact that volcanic sediments are contained in both of the formation. Therefore, it is thought that the determination should be by fossils, but they are included in the Todos Santos Formation tentatively in this report, according to Mills and others.

2-2-4 Yojoa Group

(A) There is a distribution of clastic rocks mainly of calcareous sediments, in an area from the north of Guayape to Valle de Guarabuqui. This clastic rocks are composed of alternation chiefly of calcareous shale, fine grained calcareous sandstone, fine grained conglomerate including limestone pebbles and stratified limestone bed. They are overlain by massive limestone. The conglomerate found near Suyapita has pebbles, 1 to 20 cm and average 3 cm in diameter, mainly of quartzite with sandstone, black shale and green andesitic porphyry. Viewing from the fact that these beds are of calcareous clastic sediments which overlie the older intrusive rocks and are covered with Atima massive limestone formation, it is thought that they are correlated with Cantarranas Formation in Yojoa Group.

Meanwhile, in the central part of the survey area, there are another calcareous sediments in small scale within the areas occupied by Valle de Angeles Formation. About 8 km east of the village of La Union, beds of

grey hard shale (alternation of dark grey calcareous shale, greyish yellow massive limestone, dark-colored thin limestone and quartz rich layers in limestone, of the thickness of 3 to 10 cm) are exposed in an area of 2 km by 4 km. They are intruded by hornblende andesite. At about 4 km further east of the above exposure, sedimentary rocks containing stratified limestone are distributed. Along the road about 1 km south of the village of Salitre, sedimentary rocks of shale and sandstone, including clearly stratified layers of thin and hard shale as well as limestone mass are distributed in a small area, inserted in andesite layers. Furthermore, about 3 km southwest of Salama, calcareous sedimentary rocks are distributed in a small area of 2 km in the south of a fault running east and west. It is observed there that calcareous shale beds with insertions of several layers of limestones of the thickness of several centimeters are complicatedly folded, as drag fold, with the axes plunging 40° to the south. Toward the upper part of the sequence from there, rocks are varied to purple shale, yellowish grey calcareous shale, intraformationally folded shale of fine layers, dark to green thin layers of limestone, grey-colored banding shale and foliated shale. The thickness of whole of the beds is more than 150 m.

All the above-mentioned sedimentary rocks are included in the Yojoa Group as they are calcareous in lithofacies, though they are isolated, surrounded by the Valle de Angeles Formation or andesite. And also as they are overlain by limestones corresponding with Atima Formation in Guayape area it has been decided that they are correlated to Cantarranas Formation.

Although some calcareous sediments are found in a part of Jocon area in the northern part of the survey area, the existence of this formation in the northern part has not been confirmed.

(B) Around the peak at the southeast of Concordia, and around the tops of the mountains in the area from the north of Guayape village to the north

of Valle de Guarabuqui, in the north and the southeast of Conce, there are limestones, which show topographically particular features as rounded peak of mountains and remarkably steep slopes of mountain sides. These limestones are microcrystalline and greyish white to white, or partly dark grey to bluish grey in color. Containing thin calcite veinlets and very fine quartz grains, they are massive and poor in stratification, with the thickness of over 300 m. Especially, in Conce area, skarn minerals are recognized in the marginal zones of this limestone and it is thought that they have an important role for the mineralization in the area.

"After Mills et al (1967), the massive Atima Formation forms the rugged Boqueron mountain front. Only one paleontology locality near the base of the limestone in the Salama block, contained diagnostic fauna. This was determined to be Albian by Feray and Bonet. Reworked Jurassic (?) material containing reniform organisms also was found at the same locality."

Mullerried (1942b) found Toucasia texana in Atima limestone north of Catacamas and determined its age to be middle Albian (paleon . loc. H).

2-2-5 Valle de Angeles Formation

(A) The lowest bed of this Valle de Angeles Formation is conglomerate composed mainly of quartzite. It is distributed in east and west around the low ridge passing from Valle de Ulua to Salama basin. The conglomerate is composed of pebbles and subrounded breccias mostly of quartzite, 0.3 to 1 cm in sizes, with the biggest so far found of 5 cm in diameter. They are consolidated with purplish grey sands and yellowish grey sands.

The conglomerate beds are observed to overlie El Plan Formation with unconformity and to be covered with younger limestone. Therefore, geochronologically they are correlated to the lower part of Valle de Angeles Formation. As the afore-said conglomerate beds mainly of quartzite, exposed along Guayape River in the northeast of Concordia, are quite similar

to the above conglomerate beds lithologically, it is necessary to consider carefully the age of these conglomerate beds in future.

In the central part of the area, conglomerate beds composed mainly of quartzite are found in the east of La Union.

At about 10 km east of La Union, more than 3 beds of conglomerate mainly of quartzite are alternated with purple and coarse grained andesite layers about 3 m in thickness. The andesite found in this place is not sheet intruded into the conglomerate. There is no clear grading in the conglomerate beds, and shows the alternation with this andesite which correlated to the Valle de Angeles Formation, therefore it would be possible that this conglomerate might be younger.

(B) Main part of the Valle de Angeles Formation is composed of clastic rocks such as characteristically red and reddish purple colored shale, sandstone and conglomerate, which are overlain by volcanic rocks and pyroclastic rocks as andesites, propylite, andesitic tuff, white tuff and liparite. By the characteristics of the color, the clastic rocks are called Capas Rojas Formation (red covering bed). They are extensively distributed mainly from La Union to the south of Mangulile, and in the western part, from the upstream of Valle de Guarabuque to Jocon in the north western part. In the northern part, they are developed in the area along Mangulile River and in small basins around Perico.

(a) Around La Union:

There are alternations of brownish grey shale, massive sandstone and coarse grained sandstone bearing breccias (andesitic, about 1 cm in sizes), coffee-colored and as thick as 5 to 10 cm with the maximum so far found to be about 50 cm. They are gently folded.

In Mangulile area, remarkably stratified, rather hard and thin layers of shale and coarse grained grey sandstone are alternated, overlain

with limestones and andesites.

(b) In the north of Guarabuqui:

There are coffee-colored or purplish red tuffaceous shale, sandstone, welded tuff and andesitic tuff, with stratification of the interval of 0.5 to 1 m developed well.

(c) Trojas area:

The beds are composed of conglomerate (colored reddish, with quartzite pebbles) with insertions of sandstone and shale, overlying the metamorphic rocks with unconformity.

(d) Perico area:

Overlying the metamorphic rocks and the intrusive rocks, beds are composed of conglomerate, sandstone and shale. Quartzite is main component of the conglomerate, which contain pebbles of older rocks as schists and granite. The matrix is medium grained reddish sandstone. In the upper part of the sequence, alternation of reddish brown medium grained sandstone and shale is accumulated with conglomerate bed bearing limestone pebbles.

(e) Jocon area:

There are conglomerate beds carrying quartzite pebbles with those of schists and granites. The conglomerate beds are alternated with reddish brown platy shale and sandstone.

(C) Agglomerates and andesites are distributed as the upper part of the Valle de Angeles Formation. Agglomerates are found at the western side and andesites are at the eastern side of the eastern area of the road from La Union to Salama. In the north of Valle de Guarabuqui, in the southwestern part of the survey area, they are extensively developed, including the andesite dykes which intruded the beds of Yojoa Group.

Meanwhile, in the Perico area in the northern part of the area, they are

distributed as the uppermost part of the Valle de Angeles Formation, dark greyish purple in color, accompanying pyroxene andesite and partly as clastic rocks.

In the north of Guarabuque are distributed massive hard rocks with variation of reddish color to purplish black, composed of brown dacite, pyroxene andesite, propylite and dark green hornblende andesite.

In the east of the area between La Union and Salama, there are massive rocks, reddish brown, brownish black, greyish black and greenish grey in color variation, composed of volcanic rocks are hornblende andesite, pyroxene andesite and dacite, which overlie the beds of the Valle de Angeles Formation and are partly covered with limestone.

(D) Upper conglomerates: In the lowland from the village of Guayape along Guayape River to Valle de Guarabuqui, are distributed brownish purple conglomerate beds with limestone pebbles. The conglomerate contains rounded or subangular pebbles, 2 to 20 cm in sizes, of grey limestone, brown chalcedonic rock, andesitic porphyry and quartzite. It does not contain any of schists. The conglomerate found around Suyapita contains chiefly pebbles of quartzite 1 to 20 cm and average 3 cm in diameter with minor pebbles of sandstone, black shale and green andesitic porphyry. They are distributed around Guarabuqui, around Guayape and around San Jose, along the both sides of the River, in an area of 4 km in width and 7 to 8 km in length. It is possible to regard it as conglomerate accumulated in comparatively younger age. However, here in this report, this conglomerate is included in this formation.

(E) By Mills et al. (1967), Valle de Angeles Formation is found in whole of the Olancho area, covering Atima Formation, but the typical succession of this formation is observed near Maria de Real (out of the area). Also, Williams and Mc-Birney (1969) stated that, although the beds of the formation

are well stratified and well sorted, they are deltaic and shallow-water sediments, partly showing characteristics of the accumulation along margin of geosyncline.

2-2-6 Esquias Formation

The Esquias Formation is distributed around the peaks in the area to the west of Mangulile northwestward from the north of Valle de Ulua, in the Pena mountain mass in the north of Ulua, in the area east of La Union in the central part of the survey area, in the area north of Mangulile, in Jocon area and in Zanja de Leon area, showing topographically particular characteristics as rounded peaks and hill tops with very steep mountain sides.

The Esquias Formation is composed mainly of limestone which is dark grey, massive and microcrystalline, containing few calcite veins, with less amount of greyish white to reddish-colored part. The thickness reaches over 500 m in places. Overlying the andesites and the Valle de Angeles Formation, this limestone is correlated at least to the upper part of the Valle de Angeles Formation or to younger formation. The limestone of this formation is distinguished from the limestone of Atima Formation by such characteristics as the former is dark grey in color, micrograined and with few calcite veins, but there is no other way to identify it firmly than to determine fossils contained.

In Zanja de Leon area in the northern part of the survey area, coffee-colored calcareous rocks are there overlain by limestone bed, with quartz sands and micritic materials.

The Pena mountain at the south of Salama shows steep cliff of relative height of 200 m, and is composed of massive, dark grey and compact limestone accompanied by sandy limestone in its lower part. It is on the quartzitic conglomerate.

Several Fragments of Acroporella and some fragments of Conodont are found in the limestone (Sample No. H013) collected along the road about 5 km south of Salama. Determination of age was not possible owing to incomplete figures, but as a whole it is thought that the age of the limestone would be late Cretaceous.

It is thought that this formation would be correlated at least to late Cretaceous to Eocene Esquias Formation, as the formation covers the Valle de Angeles Formation. But viewing from the point that the formation is stratigraphically above the andesites, it is possible to take it younger than the Esquias Formation, which requires further consideration.

2-2-7 Matagalpa Formation

In an area of 5 km by 3 km around the village of Pedernales about 7 km north of Concordia, are distributed pyroclastic rocks covering the Paleozoic rocks and the intrusive rocks as well as El Plan Formation. They are composed of intermediate andesitic tuff, hornblende dacite, purplish grey tuff breccia, purple hornblende andesite and welded tuff. They are thought to be comparatively young and it would be more appropriate to include them in the Matagalpa Formation rather than to correlate them to the upper part of the Valle de Angeles Formation.

At the peak of the mountain at the southwestern end of the survey area, pyroclastic rocks composed mainly of welded tuff and white tuff are distributed, which are correlated to Tertiary system.

2-2-8 Quaternary Sediments

Owing to sudden change of topography in east-west direction between mountainous land and river-erosion level, development of talus can be seen in the plain along Aguan River in the northern part of the survey area. Eluvial deposits are accumulated partly with the thickness of more than 100 m on the basement of Valle de Angeles Formation or of the Paleozoic

formation.

In the southern part of the area, alluvial plains, as Orica basin and Valle de Lepaguare plain constituted with sands and pebbles of eluvial deposits, are developed in a narrow zone in the direction of north and south, within an area where the Paleozoic formation is distributed. Around Ulua, an alluvial plain in east-west direction or in northeast-southwest direction is developed. Around Salama, a plain with eluvial sediments of the thickness of less than 10 m is developed.

In the central part of the survey area, thin layer of sands and gravels is deposited on the land dissected like a platform at La Union, while eluvial sediments are developed near Mangulile.

2-3 Geological Structure (Refer to PL. III-3)

2-3-1 Outline of the Structure

In the southern part of the survey area the metamorphic rocks accompanied by the intrusive rocks are distributed with the boundary approximately in east-west direction. In the central to northern part, the metamorphic rocks are distributed roughly in east and west. These metamorphic rocks are the basement, thus, it can be said that the geological structure in this survey area is predominantly based on the east-west direction. It is assumed that a large fault in the direction of east and west is present along Aguan River, at the northern end of the area.

In the area between the metamorphic rocks in the southern part and those in the central part, sedimentary rocks mainly of the Mesozoic Group are distributed. There, the closer to the metamorphic rocks, the older formation is distributed, and the far is the location the younger beds are there. As a whole, they reveal a large geosynclinal structure, dominated

by the tectonic lineation in east and west.

There are small basins, where Mesozoic sedimentary rocks are accumulated, partly in the area occupied by the basement of the metamorphic rocks in the central and northern area. Around Mangulile or around Zanja de Leon, they are developed in bay-like part of the basement metamorphic rocks, while a small basin is recognized around Jocon or around Perico. The older rocks are dominated by the tectonic elements in the direction of east and west, and the younger the formation are, the directions of the predominant tectonic elements are varied in the order of northwest-southeast, northeast-southwest and north-south.

2-3-2 Metamorphic Rocks

The metamorphic rocks in the southern part of the area are remarkably folded and drag folds are recognized partly. The directions of the trends are mainly in east-west, but occasionally they are northeast-southwest and north-south. According to the variation of the dips, the plunges of the axes of the foldings are gently to the east or rather steeply to the northeast in some areas, but the geological structure has not been distinctly confirmed. As a whole, the formations are trending east and west, and are dipping to the north in most of the cases. At the southern end of the area, where marble is distributed, an anticline is expected to be present with the axis of east-west. In the east side of the southern area, parts of the metamorphic rocks with the intrusive rocks are stretching to the north, and the younger sedimentary rocks have a depression structure bounded by a fault in northwest-southeast direction, which was filled with sedimentary rocks and intrusive rocks. However, essential character of the geological structure could not be comprehended without further detailed geological survey.

In the northern part of the survey area, although the limit of the distribution of strata is mainly east and west, remarkable foldings are

recognized and the trend of the beds are mainly northwest-southeast with the dip of north or south in Jocon area and are east-west or northeast-southwest around Perico in the eastern part. From Jocon to Zanja de Leon, a fault like structure in the direction of northwest-southeast is recognized, which is thought to be a branch of the Aguan fault. Mangulile-La Union area is recognized to be dislocated in some distance by the faults in the directions of northeast-southwest and north-south.

2-3-3 Sedimentary Rocks

The El Plan Formation in the southern part of the survey area is distributed in the north of the metamorphic rocks. The beds of this formation are recognized to be accumulated gently in basins in east and west or in east-north-east and west-south-west around Valle de Ulua. Between the metamorphic rocks and this El Plan Formation, there is Todos Santos Formation in the eastern side, bounded by a fault which is represented by topographical features in northeast and southwest. The beds of the Todos Santos Formation are observed to have stratification in the direction of northeast and southwest.

Furthermore, in the west side of the southern part of the survey area, El Plan Formation is distributed around Valle de Guarabuqui, and in the area between this part occupied by the Formation and the part where eastern El Plan Formation is developed, the sedimentary rocks of Yojoa Group containing limestone are distributed in northwest and southeast. In the north of this area, Valle de Angeles Formation and Esquias Formation are found to occupy hill tops. The Valle de Angeles Formation is composed of conglomerate trending east and west and of limestones of Esquias Formation distributed in northwest and southeast.

Along the southern margin of the metamorphic rocks in the central part of the survey area, although small exposures of El Plan Formation are

recognized partly, Valle de Angeles Formation is distributed, extending to the southern part. The Valle de Angeles Formation shows main trend of east and west near the metamorphic rocks, but in far distance the trend varies to northwest-southeast or northeast-southwest. Also it reveals various dips. In the area occupied by this formation, there are small exposures as the inlier formation of the calcareous sedimentary rocks belonging to Yojoa Group, dominated by tectonic elements in the direction of north-south or northeast-southwest. In the east side of the central part, andesites including agglomerates are found to occupy vast area. They show the trend of northeast-southwest or north-south. These andesites and the andesites distributed around La Flor range in the southwestern part of the area with younger Esquias limestone beds, are recognized to occupy the area between the metamorphic rocks in the central part and those in the southern part. There, the further the distance from the metamorphic rocks is, the younger the beds located are. It is thought that a large geosynclinal sedimentary structure is shown there with the axis in the direction of east and west.

In the central and northern part of the survey area, there are several exposures of small basin sediments including beds of Valle de Angeles Formation and limestone overlying it. They are dominated by tectonic elements in the direction of east-west or northeast-southwest. Especially, the sedimentary rocks in Perico area are found to show basin-like sedimentary structure in the direction of east and west.

2-3-4 Fault

In the southern part of the survey area, intrusive rocks are seen predominantly in the direction of west-north-west and east-south-east. There are many faults parallel to this trend. In the north, conglomerate beds are in this direction, while in the southern area many faults are observed to be in this direction. Also, along the boundary between Todos

Santos Formation and El Plan Formation, a fault of northeast-southwest is recognized.

In the central part of the survey area, faults in the directions of northeast-southwest and of north-south are predominant, while there are many faults in the direction of northwest and southeast in Jocon area in the north. As a whole, there are many faults in the direction of north and south, in the zone of north and south, through La Union. The distribution of the intrusive rocks is limited in the east side of this north-south zone. Small exposures of basin-like calcareous sediments as well as the distribution of andesites are restricted in the east side of the above mentioned zone. The irregular stretching of the metamorphic rocks to the north in the southern part of the survey area is situated close to this north-south zone. Also, this zone corresponds with the bending point of Aguan River, which flows in east and west direction in the west side of this zone, while the direction of this river is northeast and southwest in the east side of the zone. Viewing from the above-stated evidence, it can be said that there might be a covered large tectonic line in the direction of north and south, through La Union.

2-4 Igneous Activity

1) In the north of the area occupied by the metamorphic rocks in the southern part of the survey area, there is an igneous body composed of diorite porphyry and granodiorites, 3 to 8 km in width and 35 km in extension, distributed in the direction of west-north-west and east-south-east. (hereinafter referred to southern igneous body.) This igneous body has various lithofacies being mainly intermediate character as diorite, diorite porphyry, quartz diorite, granodiorite, gabbro, andesitic porphyry, quartz porphyry and so on. The igneous body is recognized to have intruded the mica schist which belongs to the metamorphic rocks, and to be covered with El Plan

Formation, the limestones of Yojoa Group and the conglomerate of Valle de Angeles Formation. The distribution of this igneous body is limited to the marginal zone of the metamorphic rocks and no isolated distribution of this body in the sedimentary rocks has been found. Therefore, the age of the intrusion of this igneous rock is thought to be in the middle of the ages of the metamorphic rocks and the sedimentary rocks.

2) In the northern part of the survey area, there is an intrusive rock which is composed of granodiorite and partly of granite in the vicinity of Carrizal. This igneous rock is found to have intruded the metamorphic rocks and to be covered with limestones. Also, in the Perico area, are distributed igneous rocks constituted mainly by granite, granodiorite and partly quartz prophyry, around the margin of the metamorphic rocks. They are overlain by the beds of the Valle de Angeles Formation.

3) In the La Conce area of the southern part, ore distributed the stock like fine grained acidic rocks which consist of quartz porphyry, aplite, felsitic porphyry and so on. These rocks subjected the intense alteration, and distributed near the skarn body, as a stock or dyke intruding into sandstone, shale, conglomerate of the El Plan Formation. These rocks showed a distribution as if intruded into the surrounding diorite porphyries, so can be correlated the later stage. And by the case which produced some skarn minerals around the rocks, it is assumed these might be igneous rocks related to mineralization.

As the other dyke rocks, are distributed the andesitic porphyry dyke which had comparatively basic composition, and had two or three m in width and intrude the sandstone, shale alternative beds in the El Plan near Jutiapa. Furthermore, in the andesite beds of the east of La Union, are distributed six or seven hornblende andesite dykes which are comparatively acidic and intruded into the andesite, and these dikes showed one to three m in width, but

poor extension.

4) The southern igneous body, distributed in the southern part of the survey area, is composed of the combination of various lithofacies as follows;

Dioritic porphyry: This rock is characteristically rich in phenocrysts of feldspar, greyish green, greyish blue and dark grey in color, containing phenocrysts of hornblende and plagioclase. Magnetite is contained. Around Concordia, additional phenocrysts of anorthitic plagioclase are found, although they are subjected to saussuritization and sericitization. Magnetite, sphene, apatite are contained in this rock as accessary minerals.

Diorite: This rock is coarse grained and dark blackish grey to grey in color, with many phenocrysts of hornblende and plagioclase. There are some areas where this rock contains pyroxene. Xenoliths of basic rock and pegmatites 5 cm in width are recognized to be contained in this rock, at points about 7 km northeast of Orica.

Gabbro: Exhibiting gabbroic lithofacies, this rock is distributed in the diorite in xenolith-like form. It is subjected to chloritization and serpentinization, and the boundary with diorite is not distinctly observed.

Granodiorite: This is coarse grained homogeneous hornblende-quartz-feldspar rock, grey and greyish white in color, composed of fledspar, perthite, quartz and hornblende with accessory minerals of magnetite, sphene and apatite.

The boundary between this rock and the dioritic porphyry has not been confirmed. In the south of Guayape, the rock contains abundant micas and it shows variation of lithofacies to a certain degree.

The intrusive rocks, found in Perico area in the northern part of the survey area, are as follows;

Granodioritic porphyry: This is grey to greyish white medium grained rock, composed mainly of perthite, plagioclase, quartz and hornblende with magnetite. It undergoes chloritization and epidotization partly.

Quartz diorite: This rock is composed mainly of plagioclase, quartz, biotite and hornblende as well as apatite and iron minerals.

Quartz porphyry: This rock is composed mainly of anorthitic plagioclase, quartz, perthite chlorite (after hornblende) in association with zircon and magnetite.

In the southern part of the survey area, the following porphyritic are found in La Conce area;

Quartz porphyry: This is greyish white fine grained rock, with phenocrysts of crimson-grey corroded quartz and feldspar contained in the matrix of fine grained felsic crystals. It is subjected to remarkable kaolinization, and partly to silicification. It is pretty difficult to distinguish some of them from the granodiorite.

Aplite: This is greyish white to reddish brown stained and fine grained rock, which is subjected to intense hematitization and also to remarkable silicification and argillization. Therefore, original minerals contained in this rock are uncertain.

Chemical analysis was performed with the samples of these igneous rocks --- 3 samples collected in the southern part of the survey area and 2 samples taken in the northern part. The results of the chemical analysis are shown in the Appendices A. III-4. By the standard of the classification of felsic plutonic rocks based on the values of norm calculation from the results of the chemical analysis, these rocks are classified as shown in the following table; (Refer to Fig. III-5A)

	Sample No.	Area	Locality X	Locality Y	Classification of Igneous Rocks
1	Sample H012	Concordia	35.3	19.5	quartz diorite
2	" H036	Conce	24.8	26.8	altered quartz porphyry
3	" H037	Conce	25.8	27.4	quartz diorite
4	" 73001	Calpules	38.6	99.8	granodiorite
5	" 73104	Qda. Negra	39.6	87.8	granodiorite
6	" 80102	Esquipulas del Norte	49.2	91.7	quartz porphyry

On the basis of the values obtained from the norm calculation, percentages of each component of normative feldspars are plotted in the triangle diagram of orthoclase -- albite -- anorthite, as shown in Fig. III-5B. Taking the sum of the quantity of each component of normative feldspars to be 100, the results of the calculation with the components of each sample are as follows;

1 Or_3 Ab_{77} An_{20}

2 Or_4 Ab_{93} An_3

3 Or_3 Ab_{60} An_{37}

4 Or_{24} Ab_{50} An_{26}

5 Or_{12} Ab_{53} An_{35}

6 Or_{65} Ab_{33} An_2

The followings can be said from the above facts. As a whole, they are poor in anorthitic component. The sample 2 contains many quartz veinlets and is subjected to intense silicification and albitization. It is thought that the rock represented by this sample might have relation to mineralization in this area.

5) In the southern igneous body various lithofacies of diorite to granodiorite are included. As far as observed, along the boundaries of the rocks of different lithofacies, no distinct marginal zone is recognized or boundaries are not clear. In the south of Guayape, granite porphyry (white dake-like rock poor in hornblende) is recognized in the granodiorite. The marginal facies of this rock are not clearly observed, either. Lateral extension of this rock is rather small.

Accordingly, although various lithofacies are recognized in these rocks, the ages of the formation of these rocks would not be so much different. It is thought that they would have been formed through a series of granitic magma's differentiation. The intrusive rocks in the northern part of the survey area are mainly granodiorite and are rather acidic, compared to those in the southern part, but it is thought that the ages of the activities of these two igneous bodies would not be so much different chronologically. As to the age of the activities of these rocks, isotopic age determination of the northern igneous body has been carried out by K-Ar method with the result of $89 \pm 4 \times 10^6$ m.y., by which it is presumed that the age of the formation of this igneous body would be late Cretaceous or older.

It is necessary to investigate whether acidic stocks composed of quartz porphyry and aplite distributed around Conce are representing some marginal facies of the surrounding dioritic rocks or are rather younger rocks by all means different from the dioritic rocks, but in this report it is thought that the formation of these stocks would be of Cretaceous age, taking they are related to the mineralization suggested by the skarnization of some parts of El Plan Formation.

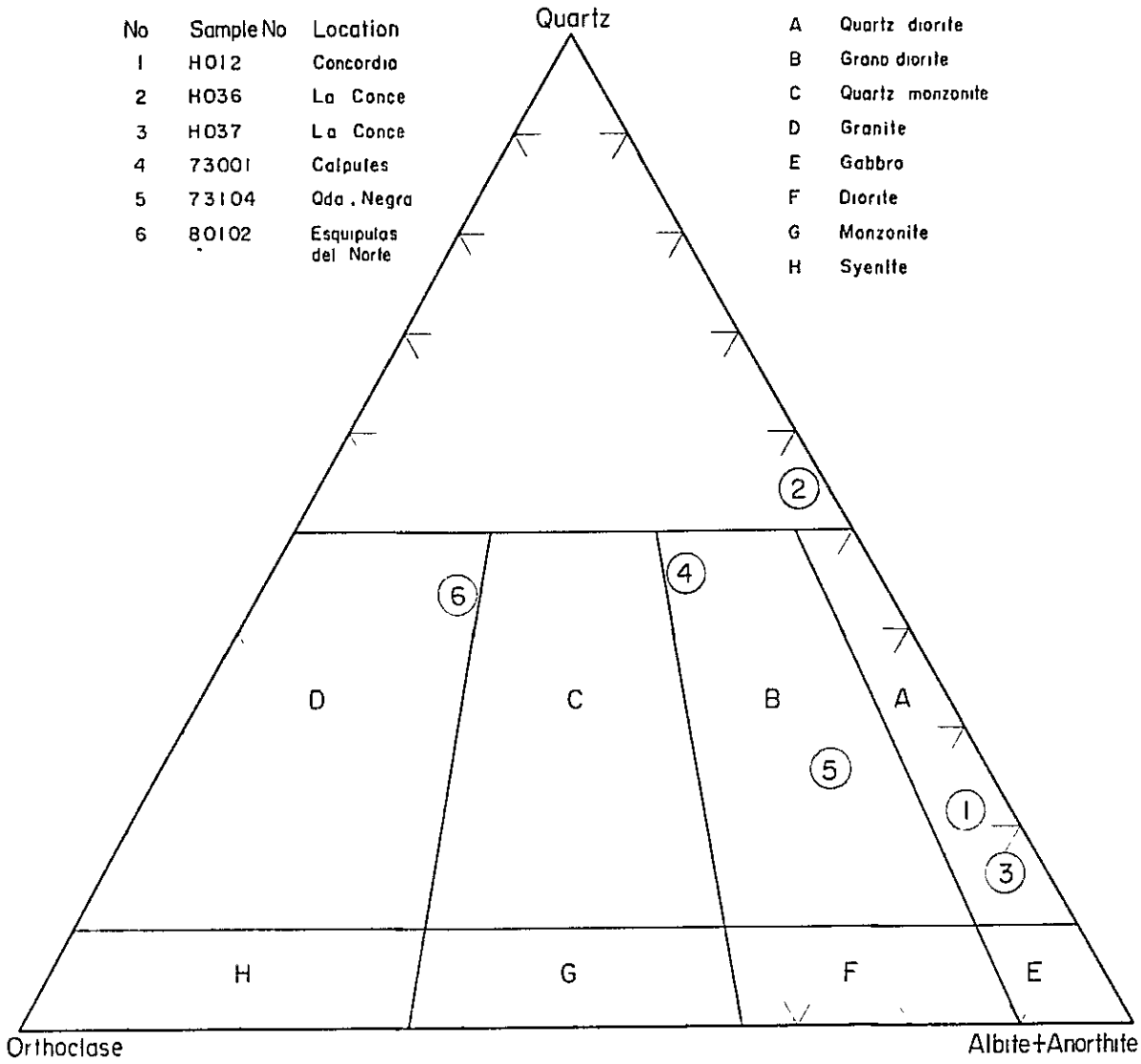


Fig Ⅲ-5 Diagram of Chemical Data of Rocks

A Classification of Igneous Rocks by Normative Quartz and Feldspars

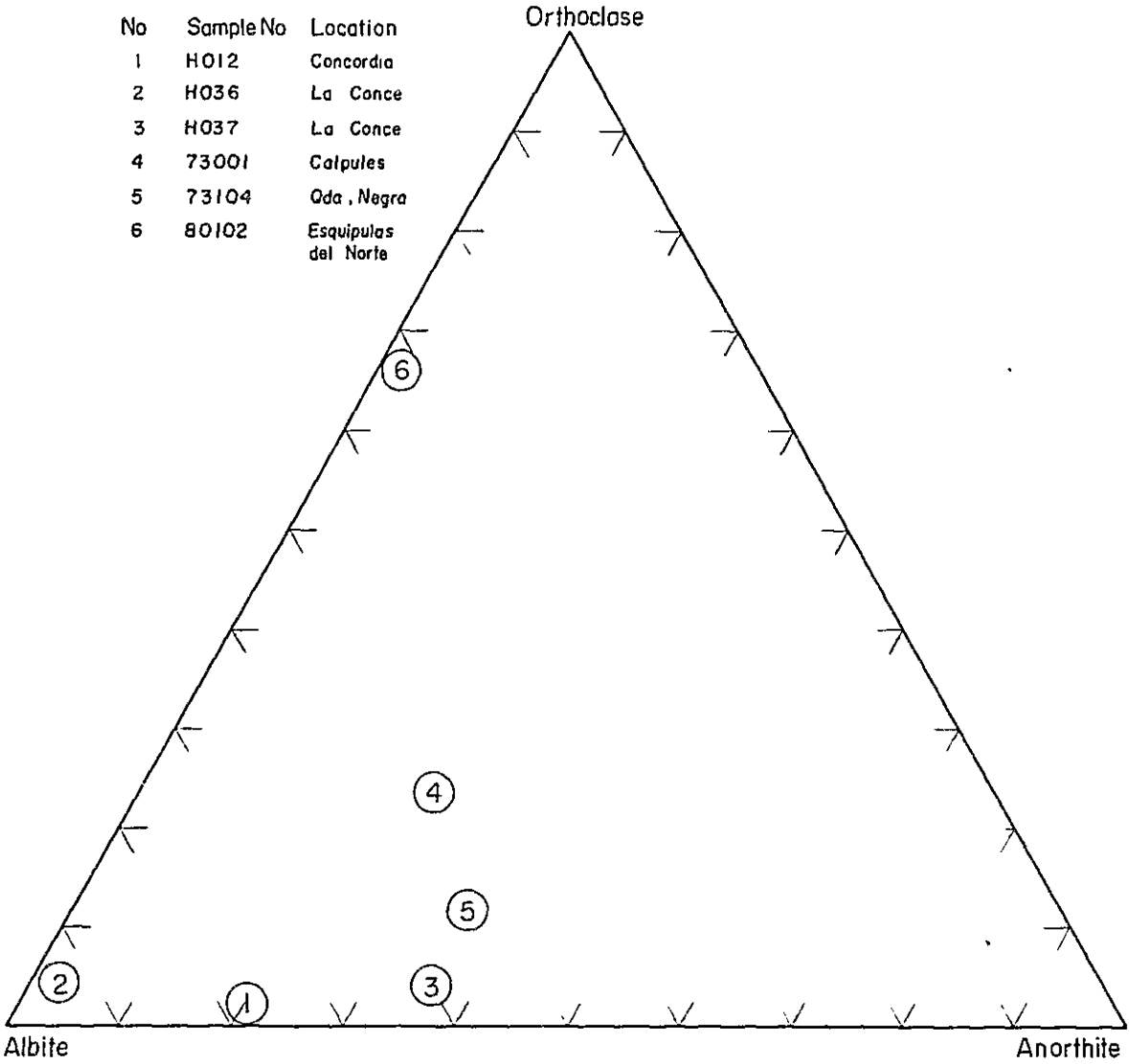


Fig. Ⅲ-5 Diagram of Chemical Data of Rocks

B. Classification by Feldspars

2-5 Mineralization (Refer to Table III-1.)

2-5-1 Distribution of Indications of Mineralization

Yhe known indications of mineralization and the indications confirmed through the informations obtained in the present survey are as shown in the separated table.

In the southern part of the survey area, there are 6 known indications of copper and iron mineralization as Conce, Suyapita, Concordia South, Portillo, Llano Mejia and Talanqueras. In the central part of the survey area, there are 5 known indications of mineralization of antimony, gold etc. as Tata Angel (Sb), Chica Leona (Cu), Playas de Arena (Au) La Lola (Au) and Lupe California (Au). There is no known indication of mineralization in the northern part of the survey area, although intrusive rocks are recognized.

As to the indications of mineralization found in the southern part of the survey area, those at Conce and at Suyapita are of the type of skarn ore deposits with such minerals as garnet and actinolite. Other three indications of mineralization are of vein type and disseimination type in the intrusive rocks, which represents genetic types of moderate to high temperature. However, the indication of mineralization at Talanqueras should be treated in separated way, as it is of the type of copper vein found in the andesite. The indications of mineralization in the central part of the survey area are of the vein type of antimony and gold, which reveals characteristics of epithermal mineralization. The country rocks of these indications are tuffaceous sandstone, andesite of Valle de Angeles Formation or Paleozoic mica schist.

These indications of mineralization found in the southern part and in the central part are distributed along the marginal zones of the Paleozoic metamorphic rocks and the intrusive rocks. Even those found in the andesite are distributed within 5 km of the above rocks. (The indications of

Table Ⅲ-1 List of Mineralized Zone in the Olancho Area

Area	Name of Mineralized zone	Location	Host rock	Metal	Type of Mineralization	Exploration & Development
Conce	Conce	9km SE of Guayape	Quartz porphyry, Limestone Sandstone, Conglomerate	Cu , Fe	Skarn	Under the detailed survey by DGMH, large outcrop consists of garnet, actinolite
	Suyopito	2km North of Guayape	Shale, Sandstone, Limestone, Diorite porphyry	Cu , Au	Skarn	Garnet skarn etc, silicified, like manto
	Concordia South	0.2km South of Concordia	Quartzdiorite	Cu	Dissemination	2 short drillings carried out in the silicified, argillized zones by United Nations
	Portillo	5km East of Concordia	Diorite porphyry	Cu , Fe	Vein	Some trenches
	Llano Mejia	3km West of Concordia	Diorite porphyry	Cu	Vein	3 old openings
	Talanqueras	10km NNW of Guayape	Andesite	Cu	Vein	Only outcrop
Union	Tata Angel	7km NW of La Union	Tuff, Tuffaceous sandstone	Sb	Vein	Temporary mining 3 old openings 200 meter in length
	Chica Leona	5km SE of La Union	Andesite	Cu	Dissemination	Outcrop and old openings
	Playas de Arena	7km North of Mangulile	Sericite schist	Au	Vein	No accessable old openings
	La Lola	6km North of Mangulile	Sericite schist	Au	Vein	More than 3 old openings Quartz vein
	Lupe California	5km North of Mangulile	Sericite schist	Au	Vein	2 old openings Quartz vein

mineralization found in the andesite have been confirmed to comprise merely green copper minerals.)

2-5-2 Character of Mineralization

The indications found at Conce and at Suyapita are of the typical skarn type mineralization of magnetite and copper sulphides with such skarn minerals as garnet, actinolite, epidote, etc. Those found at the south of Conce and at Concordia South are possibly of the type of what is called porphyry copper, as they are represented by copper dissemination in the granodioritic or quartz dioritic rocks. However, in each case, sulphide minerals are only slightly confirmed and it is difficult to assume amount of sulphide minerals supposedly contained at depth. The indications of mineralization found at Portillo and at Llano Mejia are ore veins contained in the diorite porphyry. Copper sulphide minerals are recognized to be present but systematic exploration works have not been carried out in other areas than Conce.

There is an antimony mine at Tata Angel in the central part of the area, where ore veins are confirmed in tunnels worked at present. There, main ore minerals are stibnite and its oxidation products, which reveal the mineralization to be of low temperature type.

2-5-3 Period of Mineralization

The period of mineralization of the skarn type and of ore vein type in the intrusive rocks in the southern part of the survey area is after the activity of the intrusive rocks. If the acidic stocks found at Conce are related to the mineralization, the period of the mineralization would be later. The limestone in Conce area is skarnized and the limestone is thought to belong to Yojoa Group. Therefore, the period of the skarnization in this Conce area would be after the sedimentation of Yojoa group, that is to say, in the middle Cretaceous period.

It is thought that the period of the mineralization of gold ore veins contained in the metamorphic rocks in the central part of the survey area would be after the Paleozoic Era. As the antimony ore veins at Tata Angel are emplaced in the tuffaceous sandstone of Valle de Angeles Formation, which means that the mineralization would be later than the accumulation of middle part of the Valle de Angeles Formation, the period of the mineralization of these antimony ore veins would be at the end of Cretaceous period. The mineral indication at Chica Leona is ore vein in the andesite. It is after the activity of the andesite, and so the period of this mineralization would be at the end of Cretaceous period or in Tertiary period.

Based on the above-stated evidences, it is thought that there would have been two periods of the mineralization in this area; in middle Cretaceous period and at the end of Cretaceous period, or that the period of the mineralization would be only once --- at the end of Cretaceous age.

It is important to consider over the period of the mineralization in this area as well as the age of the activities of the igneous rocks.

2-5-4 Indications of Mineralization

(1) Indications of mineralization at Conce (Refer to PL. III-5, III-6, III-7)

(A) The indications are found in the mountainous land next in the west to the village of San Jose, which is located about 20 km east of Guayape in the southern part of the survey area.

(B) DGMH of the Republic of Honduras carried out the regional geochemical exploration, in the term from May, 1974 to December 1975, in the Olancho area, and recommended La Conce area in the first place as a geologically favorable area and geochemically highly anomalous area. La Conce area was divided into 5 blocks and detailed geochemical survey and magnetic survey have been conducted, which is nearly finished at present. The outline of the results of the surveys are as follows;

In this area, sedimentary rocks as quartzite, shale, sandstone, arkose sandstone, conglomerate and limestones are distributed with the trend of north and south and with the dip to the west. Remarkable silicification and hematitization are recognized. There are skarnized portions partly. As the intrusive rocks, there are acidic to intermediate intrusive rocks such as felsitic porphyry, dioritic porphyry and granodiorite, and very fine grained rocks as aplite and quartz porphyry.

Strong anomalies of copper, silver and zinc detected by the geochemical survey are recognized along the boundary between the limestones and the intrusive rocks. In the northern part of the area, malachite and azurite representing copper mineralization are contained, while in the southern part pyrite and chalcopyrite are found in the quartz-felsitic porphyry along the contact zone with granodiorite.

Copper anomalies detected by the geochemical survey are found around the limestones in the northern part and also near skarnized portion in the southern part of the area, while zinc anomalies are recognized in the limestone zone in the northern area. Silver anomalies are found in the sandstone along the contact zone with the intrusive rocks. By the results of the above-stated, it was recommended to carry out magnetic exploration, pilot drilling and persuit of the mineralized zones to the northern part and to the southern part of the survey area.

(C) The results of the survey are described hereafter, referring to the reports by DGMH.

In this area, quartzite, sandstone, arkose sandstone and metamorphosed breccia rock which are thought to belong to El Plan Formation are distributed eastward from the western side, with the trend of north and south, and with the dip to the east. In the northern part of this area, limestone belonging to Atima Formation is inserted in lenticular form, and in the eastern

side, conglomerate bearing pebbles of limestone and quartzite is recognized to cover them. It is said that this conglomerate would be a member of Valle de Angeles Formation, but identification of this conglomerate is not certain as it is subjected to intense alteration.

In this area, there is a zone 200 to 500 m in width, in the approximate direction of north and south, where rocks are subjected to intense alteration as iron-oxidation and silicification and identification of lithologic characters of the rocks is quite difficult. Skarnized portions are found to be inserted in the altered beds in this zone. Skarn minerals are mainly garnet (andradite), epidote, chlorite and actinolite with minor sphene, talc and chlorite. In this alteration zone and in the southern part of this area, exposures of quartzose-felsitic porphyry are scattered in the stock-like form. These exposures are distributed in the remarkable alteration zone, and it is difficult to identify lithofacies of these rocks. It is necessary to confirm whether they are the scattered stocks or the dykes. In further south, granodiorite is extensively exposed in the southeastern side, where disseminated sulphide minerals are recognized and the rocks are subjected to argillization.

(D) Problems in this area

It is most important to confirm the forms of alteration and skarnization with limestone, because the beds are not identified clearly as this area is underlain mainly by the metamorphic rocks.

As to quartzose-felsitic porphyry, the problem is its relation to intermediate intrusive rocks distributed with aplite in the southern part of this area. It is necessary to confirm forms of the rock and to make clear the relation to mineralization in this area.

As for mineralization, fine grained copper minerals are recognized in the skarnized portions and in the intrusive rocks. It is thought that

sulphide minerals disseminated in the altered rocks and in the skarnized portions have been leached out through the weathering on the surface. It is necessary to confirm concentration or dissemination at depth, as well as to consider over the geological environment of such mineralization.

(E) Accordingly, it is necessary to carry out further detailed geological survey in this area, and to bring light to the above-mentioned problems. The following investigation works are recommended;

Detailed geological survey accompanied by trenching and diamond drilling, in order to obtain informations on the mutual relation of the geological units.

Diamond drilling and Detailed IP survey in the skarnized zone and in the alteration zone, to obtain infromations on the forms of sulphide minerals and the size of mineralized zones at depth.

For the information on the relation of the mineralization to the intrusive rocks, geochemical survey by rock samples isotopic age determination of rocks, study on the alteration, and on the skarn and ore minerals.

(2) Indications of mineralization at Portillo

The indications are found along the road between Concordia and Campamento on the hill about 5 km east of Concordia. There are three trenches within 200 m remained in the forest of pine trees of relative height of 60 m along the hillside. (The approximate altitude is 760 m above sea level).

In this area, DGMH conducted magnetic survey and detailed geochemical exploration with the elements of Cu, Pb, Zn, Ag and Au. It is reported that anomalies detected by each method are distributed along the above trenches. There are coarse grained granodiorite, hornblende granodiorite etc. Around trenches, diorite porphyry and granodiorite are distributed

and a fracture zone in the direction of N 70°E, dipping 70° to the north is found with varied width of 50 to 80 cm. Along this fractured zone is recognized sericitization, in both sides of which hematitization is seen with such parts where vesicular quartz are contained. As ore minerals, chalcopyrite, hematite, magnetite and malachite are recognized. There are portions rich in epidote and quartz, as well as those rich in chlorite and hematite. Emplacement of copper gold ore veins would be expected in this area.

(3) Indications of Mineralization at Llano Mejia

Indications of copper mineralization have been known on the hills about 3 km west of Concordia. Three old workings are confirmed, which are the tunnel of lower level (730 m above sea level), that of middle level and that of upper level (770 m above sea level).

In the tunnel of lower level, quartz-magnetite ore vein is found in the milky diorite porphyry, with the strike of N60°E, dipping 60° to the south although there are some milky green colored parts due to chloritization, intense silicification and hematitization are recognized around the tunnel of lower level. Dissemination of malachite is found around the ore vein. The width of the ore vein varies from several cm to over 10 cm.

The tunnel of upper level is located on the hillsides about 300 m west of the tunnel of lower level. There is a tunnel oriented to the north. (From the amount of the waste, the length of the tunnel is estimated to be more than 30 m.) The indication of mineralization is chloritized ore vein contained in the coarse grained diorite. There azurite, malachite and pyrite are recognized.

The tunnel of middle level is located between the above two tunnels, and merely old trenches are confirmed there.

In this area, emplacement of copper ore veins in the intrusive rocks would be expected.

(4) Indications of Mineralization at Suyapita

On the hill about 100 m north of the village of Suyapita, there is a tank for service water to the village. Near on the top of the hill with gentle slope, skarnized portion is found within an area about 40 m in diameter. The skarnized portion is about 5 m in thickness, and contains yellowish grey garnet (andradite, as fine grained as 0.5 to 0.1 mm.), hematite and partly magnetite (about 0.1 mm in diameter). Malachite and azurite are recognized in vein-like form. The confirmed skarnized portion is about 40 m, but a farm land is there in the north side and the extension is uncertain. Underlying this skarnized portion, there lies a black shale bed rich in magnetite and fractuared a little, with the thickness of 8 to 10 m. In the farm land in the east side, dioritic porphyry is distributed, but the relation of this rock to the mineralization is uncertain.

The skarnized portion found in this area is represented by the skarnization of calcareous part of the Yojoa Group. Further exploration for the skarn type mineralization would be warranted in this area through investigations of conditions of occurrences of ore minerals and species of intrusive rocks in relation to mineralization.

(5) Indications of Mineralization at Concordia South

There is a hill named Cerro Cobre as high as 15 m, in the neighbouring area in the south of the village of Concordia. The hill is composed of granodiorite, 40 m in north and south, and 110 m in east and west. It is reported that in 1974 DGMH completed diamond drilling of a hole of approximate depth of 50 m in the northern hillfoot, and that of a hole about 100 m in depth in the plain part in the west side of the hill. (Location not confirmed)

The hill is constituted by medium grained granodiorite containing transparent quartz. An old trench is found on the western hillside with

the length of 20 m, where green copper minerals are recognized spread. The granodiorite contains mica and hornblende, and is subjected to sericitization in the westside and to comparatively intense silicification in the eastside, in addition to partly observed chloritization. The location of a hole completed by DGMH corresponds with the northern extension of the part comparatively intensely sericitized.

In this area, emplacement of copper mineralization of dissemination type would be expected.

(6) Indications of mineralization at Talanqueras

It is said that the indications are malachite-azurite ore vein, partly dissemination, contained in the andesite bélonging to Valle de Angeles Formation. (The vein is as thick as 20 cm and the confirmed length is about 2 m). The surrounding alteration zone is as extensive as 1 km^2, and it is said that pyrite gossans are recognized along the Gutiapa River in the northeast of the ore vein. The present field investigation did not include this area.

(7) Indications of Mineralization at Playas de Arena

Entrances of two old tunnels have been confirmed in the quartz-mica schist around Playas de Arena in the middle stream of Quebrada del Oro (valley of gold). They are collapsed and it is impossible to enter into the tunnels. It is presumed that the indications are gold ore veins in the directions of east-north-east and west-south-west and of north-north-west and south-south-east.

(8) Indications of Mineralization at La Lola

More than three old gold workings are found along the ridge near El Olingo about 1 km southwest of Playas de Arena. The ore veins are white and milky drusy quartz veins with maximum width of 50 cm. The mica schist is subjected to silicification and argillization. The directions of the

ore veins seem to be northeast-southwest and north-south. It is said that the ore veins were worked by Mr. Mateo Vasquez who lived in the village of Tierra Blanca. Crushing by stone mill, gold were said to be recovered by amalgamation process. The assay result of a sample collected from the quartz vein is 0.1 g/t of Au.

(9) Indications of Mineralization at Lupe California

The two old workings are known in the mica schist, though submerged, at about 1 km west of the village of Buena Vista which is located about 2 km south-south-west of the indications of mineralization at La Lola. The gold ore veins are quartz veins as wide as about 50 cm. The strike of Lupe vein is N65°W and vertical, while that of California vein is N50°E with the dip of 50° to the southeast. However, no value of gold was detected in the two samples collected there.

(10) Indications of Mineralization at Chica Leona

There are more than three remains of old workings and trenches at the southeastern hillfoot of the hill called Chica Leona about 3 km southeast of La Union. Silicification and weak gossans are scatteringly distributed there. This alteration zone is as wide as about 30 m, and about 50 m in length, in the direction of northeast and southwest. Dissemination of malachite in film-like form has been recognized along small cracks of andesite lava and partly of andesitic tuff breccia.

(11) Tata Angel Antimony Mine (Refer to Fig. III-6)

This mine is located about 3 km northwest of the village of La Union. It is in the forest of pine trees on the hill along the road between La Union and Mangulile, with the relative height of about 280 m. There is no other way than footpass to the mine from the road.

The mine was operated from about 1945 to 1963. It is said that it is worked intermittently at present by a small scaled underground digging with

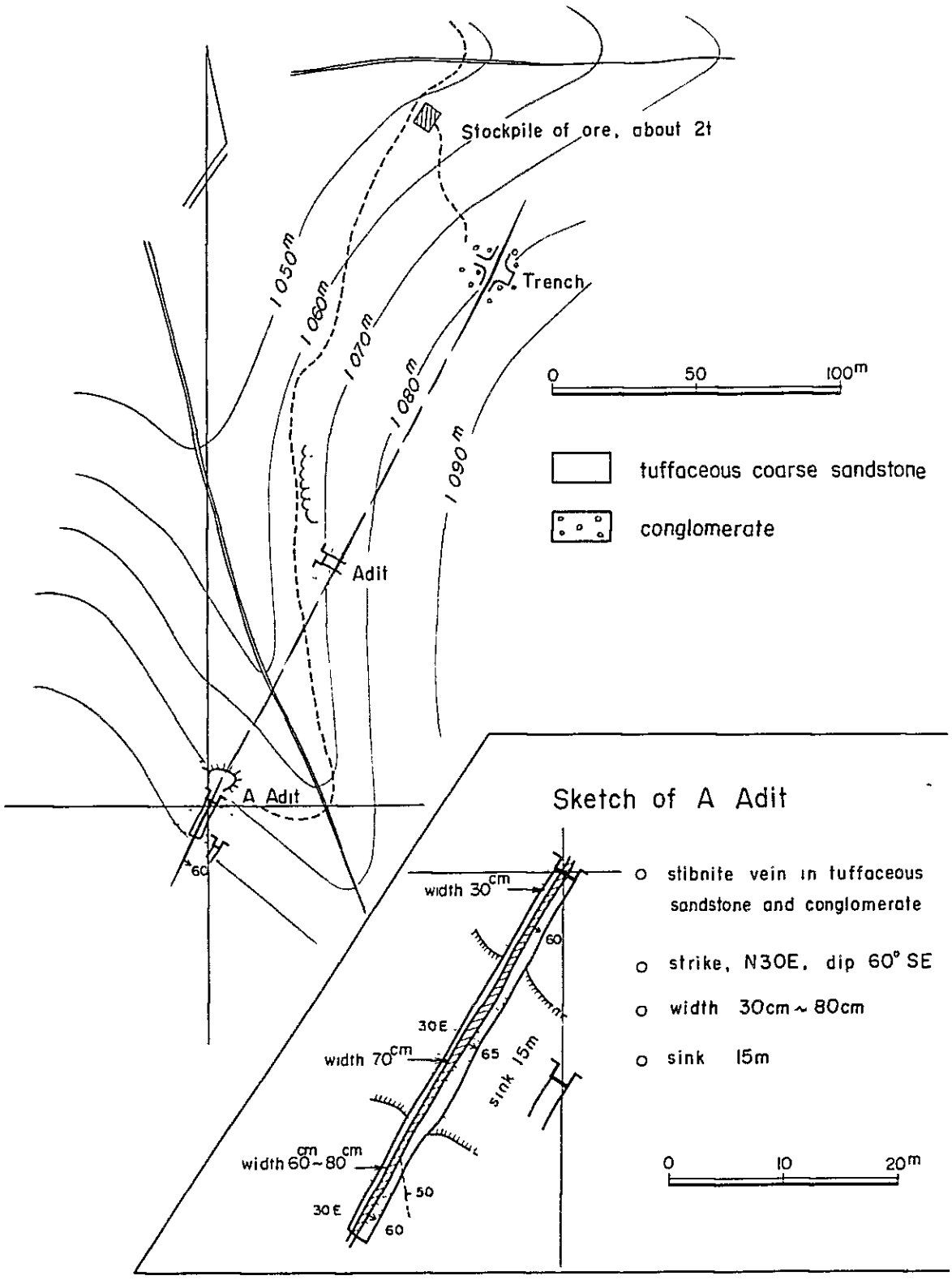
hand picking by Mr. Valgas who lives in the village of La Union.

The area is underlain by andesitic tuff, tuffaceous sandstone and fine conglomerate of the Valle de Angeles Formation, the strike of which is generally east and west with gentle dipping to the north, while around the mine the strike of the beds is mostly north and south with gentle dipping to the west. In the north of the mine, Paleozoic mica schists are distributed beyond the boundary line in the direction of east and west.

The ore deposit is of the type of ore vein in the tuffaceous sandstone, trending in the direction of N20°E dipping 65° to the east. There are three old workings and many old trenches at the level of 1,060 m above sea level. Among them, the south tunnel is about 40 m in length, with a down-shaft of 15 m and a shaft to the surface. The width of ore vein is 60 to 80 cm. The concentrated parts of antimony ore minerals is recognized as thick as 15 cm along the hanging side of this vein, and about 5 cm in thickness along the foot side of the vein. Around the vein, kaolinization, silicification and fractuation are recognized. The middle tunnel is located at the same level as the south tunnel, and is a drift in north and south, although it is submerged. In the southern area, old trenches are found and there fractured zone is observed in the conglomerate.

Ore minerals are mainly stibnite about 1 cm in diameter, and the space amidst the grains of the stibnite is recognized to be filled with grey cervantite. There are about 2 tons of ore stockpiles, including ores in bags.

Fig. Ⅲ-6 Sketch Map of Tata Angel Mine



Chapter 3 Conclusion of the Survey

3-1 Geology

3-1-1 Abstruct of the Survey Area

The rainy season in the subject survey area is generally from June to September. In many places vehicles can not afford rivers in the rainy season. Especially, access to the areas of Mangulile and La Union is very difficult. Therefore, the favorable season for the survey is the dry weather during December to March, and the access condition become better.

In the northern mountainous part of the survey area, where the roads are not well developed, as Carrizal or Perico area, the survey was conducted on horse or on foot, staying in camps. It is necessary for the survey in this area that the survey programs should be carefully prepared in addition to that the period of the survey should be selected carefully.

3-1-2 Geological structure

A) The Paleozoic metamorphic rocks are distributed mainly in the direction of east and west. The northern boundary of the northern geological unit, the southern margin of the central geological unit and the southern boundary of the geological unit of Perico area are all controlled by the tectonic elements in the direction of east and west. As to the inner structures, it is impossible to describe details of the geological structure as well as the stratigraphy more than the fact that they are controlled by tectonic elements in east-west direction, without further detailed geological survey. Especially, in the southern geological unit, probably there is an anticline with the axis in east and west, near the limestone zone, and also it is necessary to elucidate the significance of the structure in the northeastern part of Concordia, where the metamorphic rocks are distributed, partly stretching to the north.

In the northern and the central geological units, there would have been bay-like depressions, as seen at Mangulile, in the area occupied by the metamorphic rocks, where sedimentary basins around Jocon and Zanja de Leon were formed. It is important to comprehend mechanism of the formation of such basin structure.

B) Among the Mesozoic sedimentary rocks, the El Plan Formation constitutes the geology in the area from the Valle de Ulica basin to Jutiapa, where geosynclinal sedimentation with the axis in east-west direction is exhibited. it is necessary to consider the basement structure at the period of sedimentation of the formation, by the study of the features of the sediments. In the middle of the areas occupied by the El Plan Formation between near Llano de Guarabuqui and at Jutiapa to the east, there is a covering of younger sediments, and the mechanism of the sedimentation in the north side of the metamorphic rocks is an interesting problem to be discussed. Partly along the southern periphery of the area where the metamorphic rocks are distributed, in the central part of the survey area, the El Plan Formation is developed in quite a small area. The form stated as above is notable in the evolutional history of the geological structure, and it would be necessary to elucidate the sedimentary environment in the early Mesozoic Era, regarding such points as the El Plan Formation has greater thickness in the south while it is merely scatteringly distributed in the north.

C) The Valle de Angeles Formation is well developed in the central to the northern part of the survey area. The formation is accompanied by occasional insertions of limestone in the upper part. It would be necessary to make clear the geological structure and the sedimentary environment at the period of the sedimentation of the Valle de Angeles Formation, in addition to the study of the confirmation of the geological structure of the metamorphic rocks underlying the formation.

D) The andesites belonging to the upper part of the Valle de Angeles Formation are distributed extensively from the north of Salama to the east of La Union. There are agglomerates in the west side, where fracture structure in the direction of north-south or northeast-southwest is developed. It is necessary to confirm the mechanism of extrusion of the andesites. Small exposures of the Yojoa Group as the inlier form are found in the area occupied by the Valle de Angeles Formation and the above andesites, and it is required to presume geological structure of the basement rocks, giving consideration to forms and features of the distribution of these basin-like sediments.

E) As is described in the preceeding chapter, a fault zone is developed through La Union, in the north-south direction. Bounded by this fault zone, distributions of the intrusive rocks and the andesites are restricted, and also the orientations of geological structures are different in each side of the fault zone --- that is, the tectonic elements developed there are in the direction of west-north-west and east-south-east in addition to that of east and west in the west side of the fault zone, while the elements of northeast and southwest are well recognized in the east side. Thus this fault zone forms a line where tectonic elements are changed in both sides. A covered large tectonic line is thought to be present in this zone. The analysis of this structure is quite an interesting problem.

3-1-3 Stratigraphy

A) Outline of the stratigraphy in this area is as follows;

The basement rocks in this area are the Paleozoic metamorphic rocks composed mainly of mica schists. In the southern part and the central part of the survey area, alteration of sandstone and shale with occasional conglomerate belonging to the El Plan Formation, which is thought to be lower Jurassic, is found to overlie the above basement rock, with unconformity.

At the southeastern end of the area, alteration of red brown sandstone, shale and conglomerate, belonging to middle Jurassic Todos Santos Formation is found to cover the metamorphic rocks and the intrusive rocks, showing a sequence of shallow water sediments, followed by the middle Cretaceous Yojoa Group, composed mainly of calcareous sediments and limestone, which is distributed chiefly in the southern part of the survey area. In the late Cretaceous period, sedimentation of shallow water sediments such as red quartzite, conglomerate and alteration of shale and sandstone of the Valle de Angeles Formation is recognized followed by the extensively distributed red beds accompanying pyroclastic rocks as tuff etc. At the end of the Cretaceous period or in early Tertiary period, extrusion of andesites are recognized is succession to the above. The limestone beds in correspondence with the Esquias Formation are accumulated overlying those layers. In the north of Concordia and in the southwestern end of the survey area, Tertiary pyroclastic rocks of the Matagalpa Formation are found to overlie them, partly.

B) Age determination by pollen was attempted as to part of the sedimentary rocks in this area, but, except for the fossils collected in the limestone, no fossil has been found to be able to determine the age in the present survey. Accordingly, the beds from El Plan Formation to Matagalpa Formation are identified in lithological correlation with the formations distributed in the other areas. Especially, it is difficult to distinguish Todos Santos Formation from Valle de Angeles Formation, and the presence of this formation is admitted on the basis of the description and the reports in the past. Therefore, it would be necessary to make clear the age of the formations, by the confirmation of the relation of the beds as well as by the discovery of the fossils. Especially the following points are important.

Possibility of the presence of Todos Santos Formation.

Age of Matagalpa Formation in the north of Concordia.

Age of Yojoa Group exposed in a small scale in the area occupied by the Valle de Angeles Formation.

Correlation of the andesites and relation to Valle de Angeles Formation.

Stratigraphy and classification of the metamorphic rocks.

Correlation of various formations distributed in the northern part and in the central part of the survey area.

C) There are two groups of limestone in this area ----- one is the limestone belonging to Yojoa Group, distributed in northeast-southwest direction from Conce, and the other is that belonging to Esquias Formation, distributed in La Flor mountainous land and in the northern part of the survey area. This grouping is attempted only partly by fossils but mostly by color and amounts of quartz veinlets. It would be necessary to study these limestones by fossile more in detail. Especially viewing from the fact that Esquias Formation is essentially the formation underlying the volcanic layers, it is fossiles to be a problem to regard such limestones covering the andesites to belong to Esquias Formation. Therefore, it is necessary to make clear the age relation as to this formation.

3-1-4 Igneous Activity

A) The large igneous body, 35 km in extension and 3 to 8 km in width, which is composed of diorite porphyry and granodiorite, distributed in the southern part of the survey area, has various lithofacies. It would be necessary to confirm ages and the order of the intrusion, making clear the form and the mutual relation of these various lithofacies after classification and petrological study of each of the rocks. It is important to determine the ages of the rocks of different lithofacies in relation to the sedimentary rocks, in addition to the age determination by isotopic measurement of K/Ar method or Rb/Sr method.

B) Detailed observation is necessary on the relation of these rocks to the age of the fault movement, forming depression-like structure around Concordia, and on the reason why these igneous rocks are distributed limitedly along the peripheral zone of the metamorphic rocks, in addition to the observation of the relation to the sedimentary rocks.

C) It is necessary to determine age of the igneous body composed mainly of granite and granodiorites, distributed in the northeastern part of the survey area, as stated above, but especially the igneous body found at Carrizal is quite peculiar as the rocks no accompanying sedimentary rocks, and it is interestint to solve the problem why they are exposed only in the northeastern part of the survey area.

D) As to the acidic igneous rocks composed of quartz porphyry and aplite, distributed around Conce, it is necessary to confirm whether they are of the same age as that of the diorite porphyry by the age determination, in addition to the study of the relation to the sedimentary rocks and to the diorite porphyry.

E) Andesite dyke has been found near Jutiapa, which cuts the beds of El Plan Formation, and there are dykes of andesitic variation, such as andesite dyke near Jutiapa which cuts the beds of El Plan Formation and the dyke found in the andesite in the east of La Union. It is desirable to confirm the relation of these dykes to the Valle de Angeles Formation.

3-1-5 Mineralization

A) The above-stated acidic igneous body found near Conce is recognized to have intruded the alteration zone including the skarnized portion, and it is thought that this igneous body would have had a role for the mineralization in this area. Meanwhile, around the skarnization zone at Suyapita, the only igneous rock is the diorite porphyry in the east side and no other acidic intrusive body has been recognized there. Therefore,

it is most important to confirm how these igneous bodies would have related to the mineralization in the area.

B) There are problems to clarify on the formation of skarn minerals such as garnet, actinolite, epidote, etc., on the alteration as silicification, hematitization, kaolinitization, etc., and on the distribution of the sulphide minerals. Almost no sulphide minerals have been recognized in Conce area and in Suyapita area. It is quite an important problem to ascertain the features of distribution of sulphide minerals at depth.

C) Generally garnet (andradite) is associated with copper and iron in many cases, while actinolite is with copper, lead, zinc and iron. Viewing from indications found in this area, it is expected that there would be mineralization mainly of copper and iron with occasional lead and zinc.

There are variations of scale and character of the mineralization in the area where indications are distributed, owing to intense folds and remarkable alteration. It is necessary to carry out detailed and precise investigation and to give deep consideration on it.

D) It is necessary to clarify in the area around Concordia, where indications of mineralization of dissemination type and ore vein type are distributed, are on the classification of the country rocks, on the difference, the intensity and the area of the alteration, on the observation and the analysis of the vein patterns and on the variation of ore minerals.

E) As to epithermal antimony ore veins, it is necessary to make detailed observation of the features of the known ore veins, and to analyse the intensity of the mineralization in every part of the ore veins, the alteration of wall rocks, features of the distribution of ore minerals, in order to estimate the potentiality for further ore reserves and to ascertain the variation of ore grade in such transitional part as from oxidation zone to sulphide zone.

F) As to the period of the mineralization, it can be said that the mineralization in such zone as includes Conce area in the southern part of the survey area would possibly be at the end of Cretaceous period, comparing the periods of the end of Cretaceous and the end of Paleozoic. (However, the mineralization found in the andesites in the northwestern end of the survey area would have been at the end of Cretaceous period or in Tertiary period, because it is evident that the mineralization was after the sedimentation of the Valle de Angeles Formation.)

In the area including La Union and Mangulile, as it is recognized that the mineralization would have been after the sedimentation of the Valle de Angeles Formation, the period of the mineralization would be in the Tertiary or at the end of the Cretaceous. Therefore, the period of the mineralization in whole of this area would have been at the end of the Cretaceous age or in the Tertiary period. It is an important problem to be solved whether the mineralization was once or twice.

G) In the central part of the survey area, the indications are of the ore vein type of antimony, gold and copper, representing epithermal mineralization, while in the southern part of the area, there are indications of skarn type mineralization, representing hydrothermal mineralization of high to moderate temperature. It would be necessary to confirm the differences of the temperature of mineralization in the central part and that in the southern part, by means of the studies on the mineral association and on the variation of alterations.

3-2 Extraction of the Favorable Areas

3-2-1 Reasons for extraction

The known indications of metal ore mineralization are distributed mostly in the peripheral zones within 5 km of the areas occupied by the

Paleozoic metamorphic rocks and the intrusive rocks contained. Three of such peripheral zones of the metamorphic rocks are found in the north of Jocon, Zanja de Leon and Perico, which are facing to the Aguan River, in the northern end of the survey area. But in these areas, there is no indication of mineralization ever found. In Perico area, especially, the conditions that small basin-like sedimentary structure are present and that the acidic intrusive rocks are there are satisfied, but no indication has been known in this area. It is thought that the potentiality of mineralization would be low by other conditions such as the scale of sedimentary basin, the geological age, the kinds of intrusive igneous rocks, characters of metamorphic rocks, etc. might be necessary.

The period of mineralization, which is thought to be possible, would be later Cretaceous or Tertiary, after middle part of the Valle de Angeles Formation. At least it is after the sedimentation of the Yojoa Group. However, the limestone bed at Peña mountain at the south of Salama, the limestone bed at Flor mountainous land and the limestone bed from the central part to the northern part of the area, all of which are grouped into the Esquias Formation, tentatively, are found overlying the andesites of upper part of the Valle de Angeles Formation, and the mineralization is restricted to the underlying beds to the andesite. Thus as these limestones are thought to have been accumulated after mineralization, they are not included in the subject target.

According to the above-mentioned evidences, the main reasons for the extraction of favorable areas for the emplacement of ore deposits are as follows;

a) that known indications of mineralization are present in the subject area.

b) that the subject area is in the peripheral zone within about 5 km of

the area occupied by the metamorphic rocks including the intrusive rocks.

c) that the subject area is in a zone near unconformity of El Plan Formation, where the conditions for the accumulation of the sedimentary beds would have been unstable.

d) that fissures and faults in the directions of north-south or northwest-southeast are developed well in the subject area.

e) that there are some areas where alterations such as skarnization, silicification, chloritization and hematitization are recognized.

f) that there are geochemical anomalies of such elements as Cu, Pb and Zn detected by the geochemical survey carried out by DGMH.

3-2-2 The Extracted Favorable Areas (Refer to Fig. III-7, III-8)

Two favorable areas have been extracted in the present survey area through the above-mentioned reasons.

A) Conce-Concordia Area

Including indications of mineralization of two skarnized portions at Conce and at Suyapita, of copper dissemination type at Concordia south, of copper vein type at Portillo and Llano Mejia, and of Talanqueras copper ore veins in the andesite, in this area, the tectonic lines in the direction of northwest-southeast are well developed, and the sedimentary rocks are complicatedly distributed in addition to the presence of the intrusive rocks and the intense alteration. In this area, hydrothermal mineralization of high to moderate temperature would be expected.

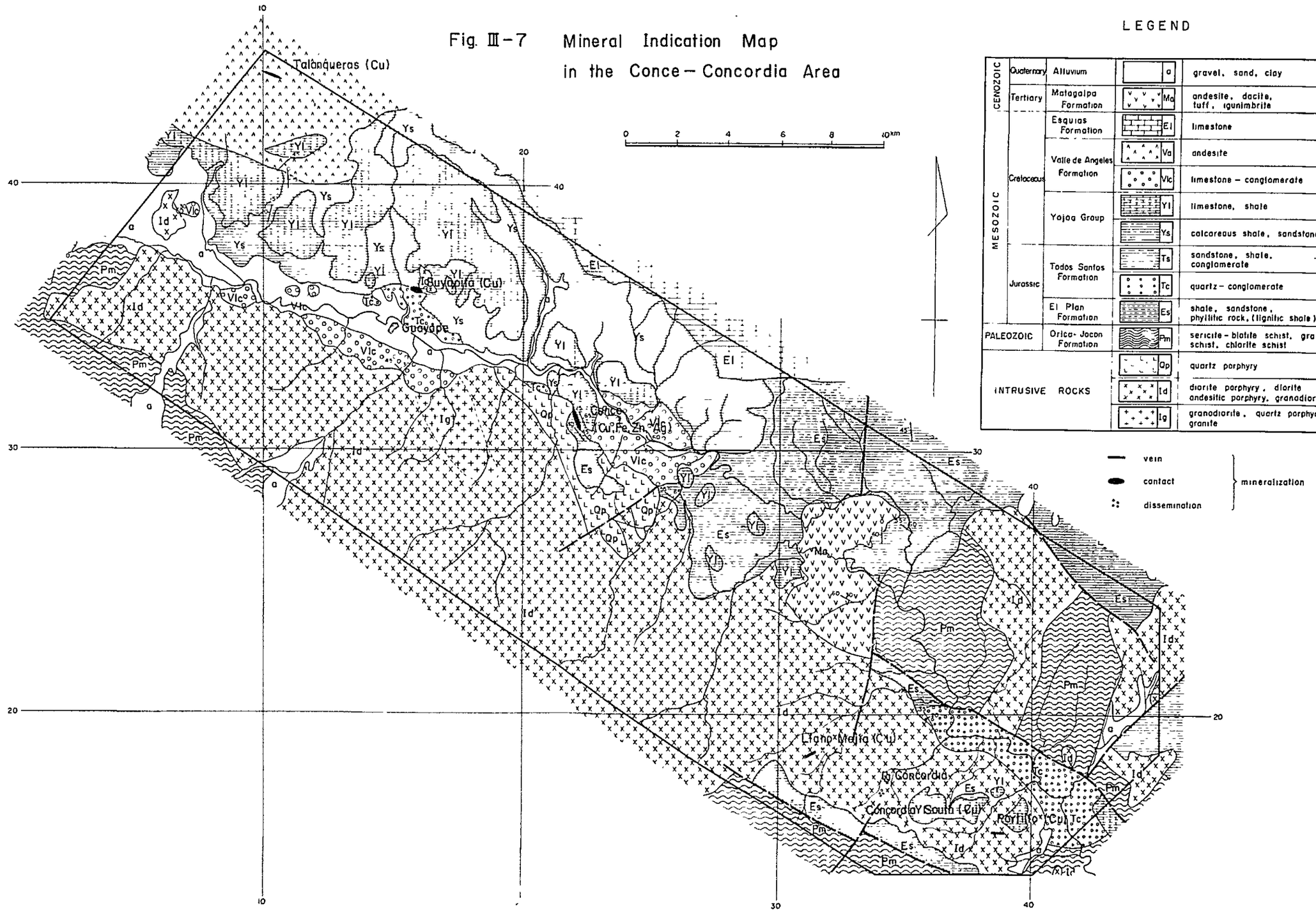
The area of 590 km^2, 13 km in width and 45 km in length, where the above-stated indications of mineralization and the intrusive rocks are included, has been extracted as Conce-Concordia area. This area is pretty convenient as it is accessible from Guaymaca to Conce through Orica, and also from Campamento to Concordia.

B) La Union---Mangulile Area

An area of 250 km^2, 8 km in north-south and 25 km in east-west, has been extracted as favorable area. In this area, Tata Angel antimony mine near La Union, indication of copper mineralization in the andesites at Chica Leona and three indications of gold mineralization at the north of Mangulile are included. The only access to this area is by the road from Las Cruces to La Union. This road is passable by jeep generally, but in the rainy season, vehicle can not afford rivers by occasional floods. The road between La Union and Mangulile is under construction at present.

In this area, boundary zone between the sedimentary rocks and the blocked metamorphic rocks is included, and the fissures and faults in the directions of northeast-southwest and north-south are well developed. But no intrusive acidic igneous rock has been found in this area.

Fig. Ⅲ-7 Mineral Indication Map in the Conce – Concordia Area

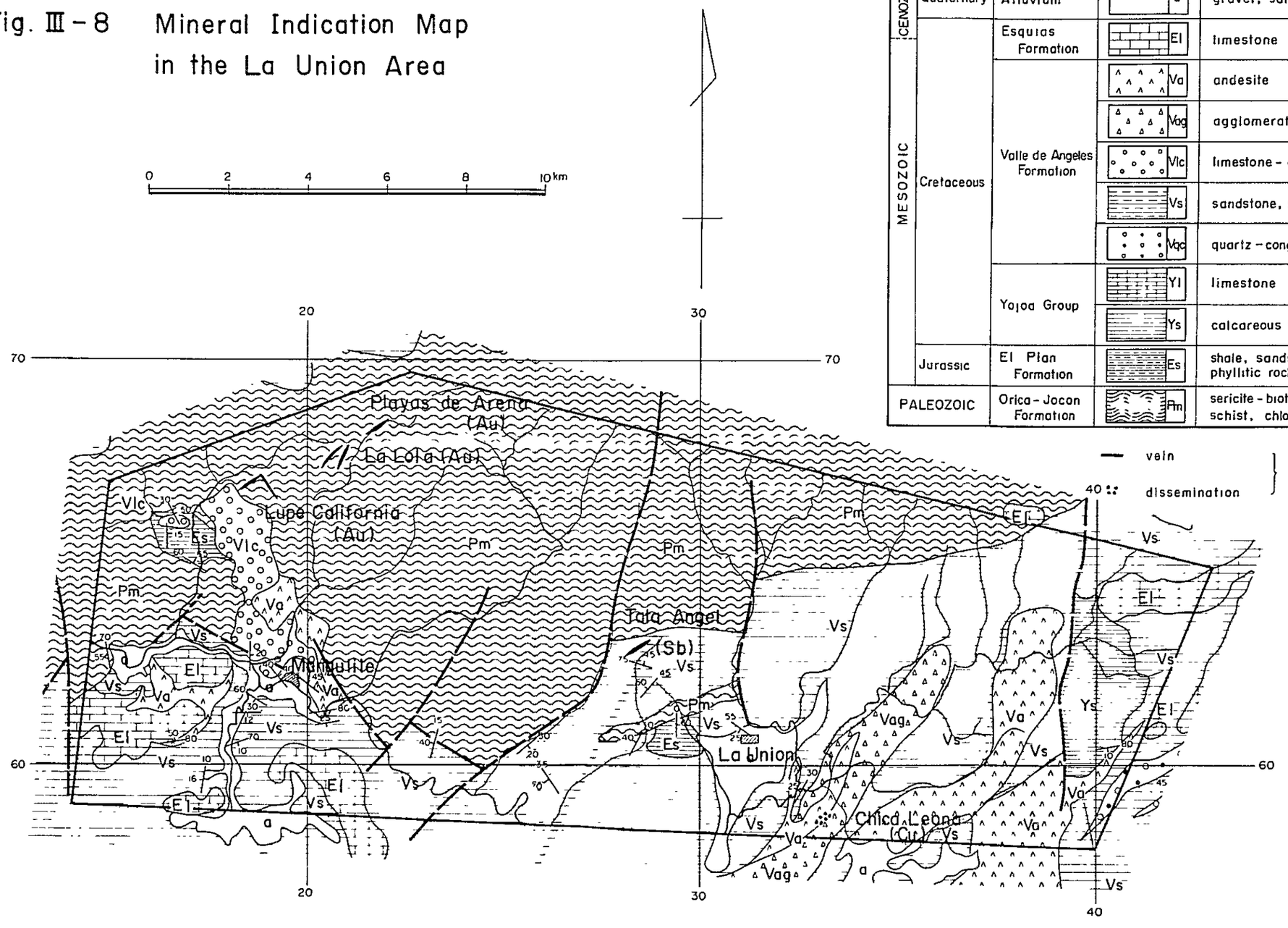


LEGEND

CENOZOIC	Quaternary	Alluvium	a	gravel, sand, clay
	Tertiary	Matagalpa Formation	Ma	andesite, dacite, tuff, igunimbrite
MESOZOIC	Cretaceous	Esquias Formation	El	limestone
		Valle de Angeles Formation	Va	andesite
			Vlc	limestone – conglomerate
		Yojoa Group	Yl	limestone, shale
			Ys	calcareous shale, sandstone
	Jurassic	Todos Santos Formation	Ts	sandstone, shale, conglomerate
			Tc	quartz – conglomerate
		El Plan Formation	Es	shale, sandstone, phyllitic rock, (lignitic shale)
PALEOZOIC		Orica-Jocon Formation	Pm	sericite – biotite schist, graphite – schist, chlorite schist
INTRUSIVE ROCKS			Qp	quartz porphyry
			Id	diorite porphyry, diorite andesitic porphyry, granodiorite
			Ig	granodiorite, quartz porphyry granite

vein
contact
dissemination
} mineralization

Fig. Ⅲ-8 Mineral Indication Map in the La Union Area



LEGEND

CENOZOIC	Quaternary	Alluvium	a	gravel, sand, clay
MESOZOIC	Cretaceous	Esquias Formation	El	limestone
		Valle de Angeles Formation	Va	andesite
			Vag	agglomerate
			Vlc	limestone - conglomerate
			Vs	sandstone, shale, tuff
			Vqc	quartz - conglomerate
		Yojoa Group	Yl	limestone
			Ys	calcareous shale, sandstone
	Jurassic	El Pian Formation	Es	shale, sandstone phyllitic rock, (lignitic shale)
PALEOZOIC		Orica - Jocon Formation	Pm	sericite - biotite schist, graphite - schist, chlorite schist

— vein
:: dissemination
} mineralization

APPENDICES

A. Ⅲ—1 List of Rock Samples

Sample No.	Location			Rock Name	Thin Section	Polished Section	Chemical Analysis of Ore							Chemical Analysis of Whole Rock	X-ray	Fossil	Pollen	K-Ar Dating
	X	Y	Name of Map				Au	Ag	Cu	Pb	Zn	Sb	As					
H001	16.8	66.3	Mangulile	Epidote hornblende rock	( )													
H002	20.7	61.7	Mangulile	Rhyolite	○													
H003	20.8	61.7	Mangulile	Tuff breccia	○													
H004	28.3	63.1	La Union	Sandstone	( )													
H006	28.3	63.1	La Union	Stibnite vein		○		○	○			○	○					
H007	20.8	67.6	Mangulile	Channel sample of quartz vein	○		○	○										
H008	17.0	60.7	Mangulile	Dacitic coarse tuff	( )													
H009	17.3	61.2	Mangulile	Altered tuff breccia	○													
H010	38.2	15.8	Campamento	Diorite∿Diorite porphyry	( )													
H011	38.3	17.0	Campamento	Quartzite	○													
H012	35.3	19.5	Campamento	Granodiorite or quartz diorite	○									○				○
H013	44.2	34.7	Salama	Limestone												○		
H015	34.2	17.2	Campamento	Malachite and other Cu-oxides in granodiorite		○			○									
H016	33.1	58.8	La Union	Malachite and other Cu-oxides in silicified andesite					○									
H017	20.8	67.8	Mangulile	Quartz vein			○	○										
H018	18.5	67.0	Mangulile	Quartz vein			○	○										

Sample No.	Location X	Location Y	Location Name of Map	Rock Name	Thin Section	Polished Section	Chemical Analysis of Ore Au	Ag	Cu	Pb	Zn	Sb	As	Chemical Analysis of Whole Rock	X-ray	Fossil	Pollen	K-Ar Dating
H019	18.9	67.1	Mangulile	Quartz vein			○	○										
H020	38.8	41.9	Yocon	Andesite	○													
H021	38.3	41.6	Yocon	Dacite with pyrite disseminate	○													
H022	22.5	31.4	Orica-Guayape	Skarn minerals											○			
H023	22.5	30.9	Orica-Guayape	Malachite and other Cu-oxides in altered rock		○			○									
H024	22.5	31.3	Orica-Guayape	Limestone												○		
H025	22.4	30.9	Orica-Guayape	Garnet-actinolite skarn	○				○									
H026	22.6	30.7	Orica-Guayape	Silicified, limonitized quartz porphyry			○	○	○	○	○							
H027	22.3	30.2	Orica-Guayape	Quartz porphyry	○													
H028	22.3	30.6	Orica-Guayape	Epidote actinolite rock	○													
H031	22.5	29.8	Orica-Guayape	Conglomeratic silicaous rock			○	○	○	○	○							
H032	22.5	29.9	Orica-Guayape	Limonitized quartzite			○	○	○	○	○							
H036	24.8	26.8	Orica-Guayape	Granodiorite with quartz vein	○									○				
H037	25.3	27.4	Orica-Guayape	Meta granodiorite	○									○				
H038	25.8	28.3	Orica-Guayape	Fine sandstone	○													
H040	15.8	35.5	Orica-Guayape	Silicified sandstone	○													

Sample No.	Location			Rock Name	Thin Section	Polished Section	Chemical Analysis of Ore							Chemical Analysis of Whole Rock	X-ray	Fossil	Pollen	K-Ar Dating
	X	Y	Name of Map				Au	Ag	Cu	Pb	Zn	Sb	As					
H041	16.0	36.2	Orica-Guayape	Malachite and other Cu-oxides in skarn					○									
H043	16.0	36.2	Orica-Guayape	High grade Cu-ore		○			○									
S100	38.6	15.7	Campamento	Malachite and other Cu-oxides		○												
S101	38.6	15.7	Campamento	Malachite and other Cu-oxides		○												
S102	31.6	18.7	Campamento	Azurite and other Cu-oxides		○												
S104	28.3	63.1	La Union	Stibnite vein		○									○			
T8156	3.6	43.0	Montana de la Flor	Andesite	○													
T8168	32.9	26.2	Salama	Shale													○	
T8159	10.7	40.4	Montana de la Flor	Porphyrite	○													
T81513	10.8	18.4	Guaimaca	Biotite muscovite quartz schist	○													
T8282	16.3	36.3	Orica-Guayape	Diorite porphyry	○													
72901	30.5	95.5	Esquipulas del Norte	Sandstone (or siltstone)	○													
72902	29.5	94.0	Esquipulas del Norte	Conglomerate (with quartz)	○													
72903	29.8	93.0	Esquipulas del Norte	Limestone	○													
72904	29.7	92.4	Esquipulas del Norte	Quartz conglomerate	○													
73001	38.6	99.8	Olanchito	Granodiorite	○									○				○
73002	43.9	03.2	Olanchito	Quartz porphyry	○													

Sample No.	Location			Rock Name	Thin Section	Polished Section	Chemical Analysis of Ore							Chemical Analysis of Whole Rock	X-ray	Fossil	Pollen	K-Ar Dating
	X	Y	Name of Map				Au	Ag	Cu	Pb	Zn	Sb	As					
73003	46.5	00.5	Olanchito	Granodiorite porphyry	○													
73102	40.0	89.5	Esquipulas del Norte	Muscovite schist	○													
73104	39.6	87.8	Esquipulas del Norte	Granodiorite	○									○				
80101	48.9	93.5	Esquipulas del Norte	Conglomerate	○													
80102	49.2	91.7	Esquipulas del Norte	Quartz porphyry	○									○				
80104A	49.1	91.3	Esquipulas del Norte	Granodiorite	○													
80104B	49.1	91.6	Esquipulas del Norte	Meta limestone (Marble)	○													
80104C	49.1	91.4	Esquipulas del Norte	Fe oxides in altered rock					○									
80106	47.2	95.8	Olanchito	Andesite	○													
80108	47.1	99.6	Olanchito	Sandstone	○													
80204	19.2	98.9	Arenal	Sericite graphite schist	○													
80205	21.0	97.4	Arenal	Muscovite biotite schist	○													
80401	08.3	90.0	Jocon	Quartz conglomerate	○													
80403	08.2	89.9	Jocon	Limestone	○													
80404	08.1	89.6	Jocon	Dolomitic limestone	○													
80406	05.8	88.3	Jocon	Limestone												○		
80603	01.5	90.1	Jocon	Limestone (fossiliferous)												○		
80604	04.4	92.8	Jocon	Quartzite	○													

A. III—2 Microscopic Observations (Thin Sections, Polished Sections)

Sample No.	Location	Rock Name	Microscopic Observation
H001	Mangulile	Epidote hornblende rock	Major constituent minerals are epidote, hornblende and albite (subhedral, less than 0.5 x 0.4 mm). Epidote is rounded and subhedral and shows zonal structure (less than 0.3 x 0.2 mm). Hornblende is tabular or prismatic (less than 1 x 0.3 mm) and shows weak pleochroism (Z = pale bruish green). Chlorite occurs at the boundary between epidote and hornblende and is partly altered to vermiculite. Minor constituents are sphene and opaque minerals.
H002	Mangulile	Rhyolite?	In thin section (as well as the rock sample), where the contact can be seen, the base of the upper volcanic unit conforms to the undulatory top of the lower black shale. Some volcanic rock fragments and clots or veinlets of chalcedony and calcite are present in the slightly metamorphosed shale. Volcanic rock shows aphiric texture with a well-marked flow structure and composed mainly of plagioclase lath, quartz, chlorite, and carbonate. Iron oxide or ferruginous materials are concentrated along carbonate grain's boundaries.
H003	Mangulile	Carbonaceous tuff breccia	Fragments of lava are separated by streaks of carbonaceous, argillaceous material and patches of carbonate. Fragments are mostly composed of intermediate to acidic extrusives such as andesite, dacite, and quartz latite. Plagioclase phenocrysts are predominated through the fragments, and some ferromagnesian phenocrysts (chlorite and ore, pseudomorph after hornblende, or flakes of much resorbed biotite) are also present. The groundmass are microcrystalline (pilotaxitic), or may be glassy with crystallite, although having devitrified.
H004	La Union	Lithic graywacke sandstone	Subangular and subrounded grains of less than 0.5 cm in size are set in a matrix containing much microcrystalline quartz, little chlorite, and sericite. Grains are largely quartz, quartzite, mica-quartz schist, and an aggregate of microcrystalline quartz (chert). There are few metadacite fragments and mica flakes.

Sample No.	Location	Rock Name	Microscopic Observation
H008	Mangulile	Dacitic coarse tuff	Fragments of andesitic and dacitic lava and chips of quartz and plagioclase occur in a carbonatized altered glassy matrix with lesser amounts of leucoxene and magnetite. Fragments of metamorphic rocks such as quartz-sericite schist (quartz with undulatory extinction, muscovite, with accessory magnetite? and apatite), and quartzite (a little muscovite) are also present.
H009	Mangulile	Altered tuff breccia	Fragments of intensely altered andesite and dacite, and broken crystals of feldspars and mafic minerals lie in an intensely altered matrix of quartz, carbonates, chlorite, and opaque dusty materials. Mafic minerals are completely altered into an aggregate of carbonates, chlorite, and opaque minerals.
H010	Concordia	Meta-porphyrite	Main constituents are green hornblende and plagioclase. Some of phenocrysts of calcic plagioclase and smaller grains of the same minerals are represented by recrystallized sodic plagioclase mixed with hornblende to varying degrees. Other phenocrysts of zoned plagioclase are rather fresh with slightly saussuritized and sericitized core. Aggregate of anhedral crystals of hornblende is not uncommon in a matrix of plagioclase and hornblende. Small amounts of magnetite, sphene, and apatite are also observed in the matrix.
H011	Concordia	Quartzite	Subangular quartz grains, less than 1.5 mm in diameter, are strained, and welded together to form a quartzite by secondary growth. There is also a very little interstitial chlorite, altered feldspar, zircon, and opaque minerals.
H012	Concordia	Granodiorite	Crystals and grains of saussuritized plagioclase are surrounded by chains of epidote, quartz, and chlorite. Mafic minerals appear to be completely altered to chlorite and other secondary minerals. There is also a little magnetite and ferruginous materials in and around chlorite flakes. Quartz is fairly abundant not only interstitial to the plagioclase, but also present as veins with lesser amounts of epidote and albite.

Sample No.	Location	Rock Name	Microscopic Observation
H020	Talgua	Meta-andesite	Phenocrysts of plagioclase (subhedral, less than 0.7 x 0.6 mm) and chlorite?, calcite and quartz after ferromagnesian prismatic crystals (euhedral, less than 1.8 x 1.2 mm) occur in a vitreous matrix containing plagioclase laths with chlorite patches, quartz, magnetite and carbonate. Some quartz or quartz-calcite veinlets are observed. Prevailing ore dust (hematite?) in a glassy matrix may causes brownish discoloration of the rock.
H021	Talgua	(pyrite disseminated) dacite	Phenocrysts of plagioclase lath (less than 0.4 x 0.2 mm, altered partly to sericite and calcite) are distributed through a matrix of chlorite, plagioclase, sericite, quartz and ferruginous materials. The rock bears many vesicules filled with layer of quartz, calcite and chalcedony. Euhedral pyrite grains and iron ores are only found in these vesidules. A concentric colloform layers of chalcedony with a calcite ring (which have been deposited on the fine quartz aggregate) is observed.
H025	La Conce	Garnet-actinolite skarn	The main constituent minerals are equant crystals of garnet of 0.1 to 0.2 mm across and elongated crystals of actinolite up to 2 cm long. Garnet is of andradite-glossular series. Fine-grained talc? less than 0.1 mm in size is also present.
H027	La Conce	Quartz porphyry	The rock is pink grey and contains phenocrysts of corroded quartz and euhedral large feldspar (perfectly altered) in a very fine-grained microcrystalline felsic matrix. The color at naked eyes appear to be mainly due to clay minerals (kaolinite) which replace large feldspars.
H028	La Conce	Epidote actinolite rock	The rock shows weak schistosity and has banded structure consisting of epidote-rich and actinolite-rich layers. The main constituent minerals are epidote and actinolite. Epidote is subhedral and shows zonal structure (less than 0.05 x 1.2 mm). Actinolite is fine grained (0.05 - 0.15 mm in length) and shows acicular form (Z = pale bluish green). Sphene, chlorite, vermiculite and quartz occur as minor constituents.

Sample No.	Location	Rock Name	Microscopic Observation
H036	La Conce	Quartz porphyry with quartz vein	The rock, veined by quartz, mafic minerals (biotite?) are completely altered to chlorite, muscovite and iron ore. Intermediate plagioclase, slightly altered, encloses roundish to irregular small grains of quartz. There is a little interstitial K-feldspar.
H037	La Conce	Meta-granodiorite	The rock is typical granodiorite and is composed mainly of plagioclase (euhedral to subhedral, less than 2.5 x 2.0 mm, highly saussuritized), interstitial quartz, perthite (micropegmatite), and rather abundant hornblende (euhedral to subhedral, less than 2.2 x 1.0 mm, Z = pale greenish yellow, X = light greenish yellow). Some large cystals of plagioclase have many inclusions of hornblende and uralite. Plagioclases are enclosed poikilitically in large phenocrysts of hornblende. Accessory minerals are apatite, sphene, and magnetite.
H038	La Conce	Fine sandstone	The rock is argillaceous sandstone with volcanic glass? patches. Angular chips of quartz (and very little feldspar), less than 0.5 mm in size, are in a matrix of chlorite, clay, with accessory zircon, titan-mineral, and opaque minerals. Many fragments of chlorite (up to 1 x 1 mm) may be altered volcanic glass.
H040	Suyapita	Silicified lithic sandstone	Fragments less than 1 mm in size composed almost entirely of coarser (0.1 - 0.5 mm) quartz crystals with brown to black staining are scattered in a matrix of microcrystalline quartz.
T8156	Guarabuqui	Andesite (Andesite Porphyry)	Phenocrysts of plagioclase (less than 2.2 x 2.0 mm, subhedral, partly altered to sericite and saussurite) and clinopyroxene (less than 2.0 x 0.8 mm, euhedral prismatic crystals, mostly altered to chlorite, epidote, quartz and calcite) are distributed through a matrix of chlorite, plagioclase (feldspar), and epidote. Accessory minerals are rather abundant leucoxene and apatite.

Sample No.	Location	Rock Name	Microscopic Observation
T8159	Convento Mt. Flor	Meta-dacite (or welded tuff)	The rock, highly carbonatized and silicified, shows traces of a fragmental character and may be a tuffaceous flow. Phenocrysts and chips of plagioclase (less than 2.2 x 1.4 mm, highly altered to the fine mixture of sericite, calcite and epidote), rounded quartz, and chips of lava fragments are located in a fine-grained quartzofeldspathic matrix. A little prismatic phenocrysts of ferromagnesians (aggregate of chlorite and magnetite) are also present.
T81513	Orica South	Biotite muscovite quartz schists	The rock is typical metamorphosed sediment and is composed mainly of quartz (anhedral, 0.2 x 0.1 mm), biotite (subhedral, Z = green or greenish brown, less than 0.2 mm in length) and muscovite. Small albite spot (about 0.2 x 0.1 mm) is also observed. Minor constituents are chlorite (subhedral), tourmaline and rutile. Vermiculite replaces biotite.
T8282	Suyapita	Diorite porphyry	Plagioclase (andesine to labradorite) and pyroxene (augite and hypersthene) of 0.5 to 2 mm in size are set in a fine-grained groundmass of feldspar laths, quartz, sericite, and opaque dusty materials. The plagioclase is partly altered to sericite and pyroxenes are completely altered into an aggregate of tremolite, chlorite, and quartz. Reddish brown coloration is conspicuous.
72901	Zanja de Leon	Carbonaceous sandstone (or siltstone)	The rock ranges in color from light brownish grey to dense reddish brown with white (calcite) veinlets. The reddish color may be due to the concentration of ferruginous material. Small chips of calcite, quartz and a little flakes of chlorite and muscovite are enclosed in an argillaceous carbonate matrix of very fine grain. Some patches of silt or argillite are also observed.
72902	Zanja de Leon	Conglomerate (Quartz conglomerate)	Subrounded grains and pebbles of quartz, chert and quartzite and flakes of (highly altered, bent and deformed) muscovite and a little magnetite, are cemented by fine-grained quartz and micaceous clay. Micaceous minerals are stained brown by ferruginous materials.

Sample No.	Location	Rock Name	Microscopic Observation
72903	Zanja de Leon	Limestone	Angular calcite chips and well-rounded calcite grains are embedded in a very fine-grained carbonate matrix. Some calcite clots and veinlets are much coarser grained than the matrix of the rock. Only carbonate is present in this rock section.
72904	Zanja de Leon	Quartz Conglomerate	Subangular quartz grains, some quartzite, quartz-sericite-actinolite schist, chert and aggregates of altered feldspar are cemented by fine-grained quartz, white mica and clay. Boundaries of grains are indicated by a fine dust of hematite (?). Most of rock fragments, quartzites, are composed of rounded strained quartz (some showing Boehm lamellae) with interlocking sutured boundaries, or welded together by secondary overgrowth (being in optical continuity with original grains).
73001	Perico	Granodiorite	Subhedral crystals and grains of zoned andesine-oligoclase (less than 4 x 2 mm, somewhat sericitized and saussuritized) with quartz, biotite, green hornblende, and a little interstitial microcline make up this rock. Some chloritization of biotite flakes is seen. Accessories are magnetite, ilmenite, and apatite.
73002	Perico	Quartz feldspar porphyry	The major constituents are saussurite and albite replacing calcic plagioclase, quartz, perthite, and chlorite (pseudomorph after hornblende?). Large euhedral to subhedral forms of the plagioclase (less than 5 x 2 mm), corroded irregular form of quartz are surrounded by a mosaic of quartz, plagioclase and perthite. Accessories are sphene, zircon and magnetite.
73003	Perico	Granodiorite porphyry	The principal minerals are perthite, oligoclase (subhedral less than 1.0 x 0.5 cm, somewhat sericitized and saussuritized), irregular forms of quartz, and hornblende (euhedral, less than 1.0 x 0.5 cm, X = pale greenish yellow, Z = light brownish green). The large crystals of hornblende with many inclusions of plagioclase and magnetite, oligoclase and quartz are surrounded by a web of micropegmatite. Secondary chlorite, epidote, and magnetite have locally produced (pseudomorph after biotite).

Sample No.	Location	Rock Name	Microscopic Observation
73102	Perico	Muscovite schist	Main constituent minerals are quartz (less than 0.5 x 0.3 mm, anhedral and shows wavy extinction), muscovite (subhedral) and albite. Muscovite is partly altered to vermiculite. Minor constituents are apatite, tourmaline, sphene and opaque minerals.
73104	Perico	Quartz diorite	The rock is typical diorite. Zoned andesine-oligoclase, quartz, biotite, hornblende (Z = deep olive green, X = yellowish brown) and K-feldspar are the essential minerals. Accessory minerals are rather abundant apatite and iron ore. There is a little secondary chlorite, sericite and hematite.
80101	Perico	Polymictic conglomerate	Subangular rock fragments (chiefly granodiorite and coarser quartz rock), chert, sericite's aggregate, quartz, perthite, K-feldspar and plagioclase grains are cemented by interstitial fine-grained quartz and micaceous clay. Most of fragments and grains are rimmed with (iron) ores. K-feldspar is strongly kaolinized in general, while albite is relatively fresh.
80102	Perico	Altered quartz porphyry	The rock is composed largely of fine-grained, recrystallized ground-mass of quartz, chlorite, and opaque dusty materials. Coarse-grained pseudomorphs after feldspar about 0.5 mm in size are occasionally present. Rare pyroxene? relicts less than 0.5 mm are altered into an aggregate of chlorite, amphiboles, and magnetite.
80104A	Perico	Grancdiorite	Main constituent minerals are plagioclase, quartz and biotite. Plagioclase (subhedral, less than 2 x 4 mm) is partly altered to sericite or saussurite. Quartz (rounded and anhedral, 0.1 - 0.5 mm in diameter) shows wavy extinction. Biotite (Z = brown) includes zircon surrounded by intense radio-active halo. K-feldspar also occurs as anhedral form. Minor constituents are chlorite, muscovite, actinolite and apatite. Chlorite and actinolite replace biotite.

Sample No.	Location	Rock Name	Microscopic Observation
80104B	Perico	Meta limestone (Marble)	Main constituent mineral is calcite. Aggregates of fine-grained quartz (0.02 - 0.2 mm) are observed at the boundary among calcite grains. Diopside (rounded and subhedral, less than 2.0 x 1.2 mm), tremolite (0.1 mm in length) and opaque minerals also occur as minor constituents.
80106	Perico	Meta andesite	The rock is highly altered andesite. Phenocrysts of plagioclase (subhedral, less than 2.5 x 0.8 mm) are partly or completely altered to calcite and chlorite. Groundmass is also altered and composed of chlorite, sericite, calcite, albite, quartz, vermiculite, opaque minerals and microphenocryst of plagioclase (less than 0.1 x 0.05 mm).
80108	Perico	Silty sandstone	The principal clastic grains (less than 0.3 x 0.2 mm) are angular to subrounded quartz and grains of argillite, with clastic flakes of muscovite and chlorite. The mica flakes are bent and deformed by compaction of the sediment. The cement appears to be iron oxide, with interstitial clay. Some streaks of ferruginous argillaceous material are also present.
80204	Qda los Urracos	Pelitic schist	The rock shows typical schistosity and is composed mainly of quartz (anhedral, less than 0.3 x 0.8 mm), graphite (anhedral and lenticular), muscovite (subhedral) and chlorite. Garnet and plagioclase are completely altered to chlorite and saussurite, respectively. Minor constituent minerals are albite, actinolite, apatite, biotite, tourmaline and vermiculite. Vermiculite is observed around chlorite.
80205	Qda.los Urracos	Muscovite biotite schist	The rock shows typical schistosity and is composed mainly of quartz (anhedral, less than 0.25 x 0.2 mm), muscovite and biotite (subhedral, Z = greenish brown). Minor constituents are apatite, rutile and sphene. Chlorite is rarely observed.

Sample No.	Location	Rock Name	Microscopic Observation
80401	Jocon	Quartz conglomerate	Rounded quartz grains and quartz-rock fragments of varying textures are cemented by a argillaceous matrix with a little flakes of muscovite, ferruginous materials, and zircon. Pebbles and grains of quartz often show undulatory extinction and have a Boehm lamellae due to strong deformation. "Quartz rock fragments" are subdivided into quartzite (strained quartz with interlocking sutured boundaries), quartz-sericite schist and chert.
80403	Jocon	Pelleted (argillaceous) limestone	The rock is porous, and mostly made up of very fine-grained (unidentified) carbonate. Pellets of varying size (up to about .2 mm in diameter) and shape are locally fringed by (barely detectable size under microscope) carbonate. A little chlorite occupy irregular interspace. Quartz grains are rarely included in some pellets.
80404	Jocon	Dolomite limestone	Well-rounded spherules of carbonate grains, 0.25 mm or less in diameter, are embedded in a fine-grained carbonate matrix. Carbonate in monomineralic veinlets may be dolomite, having glid twinning on (0221). Chips of quartz, muscovite, and opaque minerals are rarely observed.
80604	Jocon	Quartz muscovite schist	Very fine-grained quartz (anhedral form, less than 0.1 mm in size), muscovite and/or sericite and a little ore dust with a distinct schistosity. Rather large grains of quartz and iron oxide made up some fine veinlets (0.2 mm or less in width). Crystals of ferruginous? carbonate occur in or around a quartz veinlet.

A. III—2 Microscopic Observations (Polished Sections)

Sample No.	Location			Types of Mineralization	Microscopic Observation
	X	Y	Name of Map		
H006	28.3	63.1	La Union (Tata Angel)	Stibnite vein	Stibnite is predominant in the rock and is the only observable opaque mineral. It always shows well-developed polysynthetic twinning.
H015	34.2	17.2	Campamento (Concordia)	Malachite in Granodiorite	Opaque mineral cannot be observed. Rutile and sphene are disseminated in the rock.
H023	22.5	30.9	Orica-Guayape (La Conce)	Malachite in altered rock	Pyrite is the only sulfide mineral and forms discrete grains measuring 0.2 to 2 millimeters across. It is always replaced by Fe(?) hydro-oxides. Hematite is sparsely disseminated in the rock and may be a second clay product.
H043	16.0	36.2	Orica-Guayape (Suyapita)	High grade Cu-ore	Hematite is the most aboundant mineral and is disseminated with rock. It shows prismatic crystals and often form thin aggregates. Hematite is always associated with sphene and may be an alteration product of titanomagnetite. A trace of chalcopyrite and pyrite occurs in disseminated grain. Chalcopyrite and covelline are rarely observed as weathering products.

Sample No.	Location			Types of Mineralization	Microscopic Observation
	X	Y	Name of Map		
S100	38.6	15.7	Campamento (Portillo)	Malachite and other Cu-oxides	Chalcopyrite is a predominant sulfide mineral and form a part of a sulfide-rich vein occuring in the sample. Pyrite is also present in the vein and is largely replaced by secondary Fe(?) - hydro-oxide minerals. Chalcocite and covelline replace chalcopyrite as secondary products.
S101	38.6	15.7	Campamento (Portillo)	Malachite and other Cu-oxides	Sulfide minerals are present only in small amounts in the rock. Chalcopyrite and pyrite occure in disseminated minute grain. Covelline sometimes with a trace amount of chalcocite forms small inclusions in the cores malachite(?). The other minerals observed are hematite and Fe(?)- hydro oxides produced by weathering.
S102	31.6	18.7	Campamento (Llano Mejia)	Azurite and other Cu-oxides	Pyrite and chalcopyrite are disseminated in the rock. Pyrite exhibits euhedral crystals ranging a 1 to 0.3 millimeters in size. Chalcopyrite measures a 1 to 0.3 millimeters across and fills some interstices among the silicate minerals and pyrite. It also forms hair-line thin veinlets in the rock.

Sample No.	Location			Types of Mineralization	Microscopic Observation
	X	Y	Name of Map		
S104	28.3	63.1	La Union (Tata Angel)	Stibnite vein	Stibnite forms some part of veins. It may have originally formed euhedral crystals and now its margin is replaced by transfer minerals. In the wall rock opaque minerals cannot be observed.