Chapter 4 Vueltas del Rio Sector

4-1 Outline of the Area

The area extracted as the most favorable area for further detailed investigation by the surveys carried out in the first year was the Chamelecon area including this Vueltas del Rio area. The Chamelecon area is next to the southern part of the town of Sula, and occupied an area of 35 km^2, 10 km in east-west and 2 to 5 km in north-south. The area is accessible by vehicles along the unsealed road southward from the town of Sula, which is located along the highway from San Pedro Sula to Copan, or along the recently-constructed roads from the village of Chiquila through El Coyol to this Vueltas del Rio area.

The area is situated in the hilly land of the altitude of 200 to 600 m above sea level, with relative height of 200 to 400 m. Topographically the land is ragged and rock exposures are extremely poor due to thick vegetation. In the southernmost part of the area, Chamelecon river flows eastward from the west, forming partially meandering features by deep dissection. Talus sediments are found along the rivers and river terraces are developed with the height of 5 to 12 m along the river in the plain part.

By the past various surveys conducted by UNDP such as the detailed geological survey, the geochemical survey, the geophysical prospecting and diamond drilling, the followings have been confirmed.

- Gold mineralization and secondary copper mineralization in the altered rocks near the surface.
- Primary gold and copper mineralization in fracture zones or in quartz veins.
- Geochemical anomalies of gold, copper and zinc.

Also, estimation of ore reserves was performed as to the porphyry

copper type indications of copper and gold mineralization found in the form of veinlets and dissemination, which are distributed in an area of 1.8 km by 0.8 km in the metamorphosed pyroclastic rocks in the Vueltas del Rio area. The ore reserves estimated are as follows;

Probable ore reserves -----	Gold	7,500,000^t	(Au 1.3 g/t)
	Copper	4,500,000^t	(Cu 0.67%)
Possible ore reserves -----	Gold	10,000,000^t	(Au 0.95 g/t)
	Copper	6,400,000^t	(Cu 0.45%)

The area was developed as San Martin mine in those days, and there are many remains of old workings and old trenches in this area.

In the first year, geochemical survey, geophysical survey (IP method) and diamond drilling were carried out in addition to the detailed geological survey in Vueltas del Rio area. By the results of these surveys, further favorable areas were extracted, and in the second year detailed geological survey accompanying trenches by bulldozers as well as diamond drilling were carried out in the central part of the Vueltas del Rio area, through which indications of gold, copper and zinc mineralization were confirmed. Furthermore, a synclinorium with axis of east and west has been recognized as an important characteristics of the geological structure in the area, by the general analysis of the informations obtained through the diamond drilling and the various surveys especially through the precise division of the lithofacies. Also, considering the combination of alteration and mineralization, favorable areas for the possibility of emplacement of mineral deposits were extracted.

In the third year, by the detailed geological survey accompanying bulldozer trenches, behavior of gold near the surface was confirmed and by the diamond drilling informations on clearer geological structure and additional indications of mineralization were obtained. Two holes of diamond

drilling

eastern e

were carried out to confirm the geology, in the eastern plain where
xtension of the Vueltas del Rio Formation would be expected to be
Consequently, the distribution of the Vueltas del Rio Formation
rmed and additional indications of mineralization was caught by
ing.

logy (Refer to PL. III-I-1, III-I-5)
the main part of this area, Vueltas del Rio Formation of unknown
stributed, and it extends to Laguna Seca sector in the west mainly
rection of east and west, with the width of 1 to 2.5 km north-south.
rthern side of the area, Paleozoic mica schists are distributed
ounded by a fault of east and west with the limestones of Atima
belonging to Cretaceous Yojoa Group, which are distributed in the
side of the area.
Vueltas del Rio Formation is composed mainly of basic to acidic
to liparitic pyroclastic rocks with occasional insertions of shale,
, conglomerate and andesitic volcanic layers. They are subjected
rphism, and schistose foliation is developed well, with fine drag
s the alteration is remarkable, recognized as silicification,
zation and argillization, identification of original rocks is
difficult. These beds are seen intruded by dykes of diabase,
porphyry, quartz porphyry and andesite.
ese beds comprise metamorphosed sedimentary rocks mainly of pyroclastic
nd viewing from this fact that the beds are to have undergone meta-
, it would be possible to take them to be Paleozoic. It is impossible

loes
lown

These beds are generally trending in east-north-east and west-south-west, although they are in east and west in the northern part. As a whole it is recognized that they are tightly folded and form a synclinorium with the axis in the direction of east-north-east and west-south-west, which is composed of two synclines and an anticline. In the apparent order upwards from the lower part, schalstein, metamorphosed tuff, tuff breccia and metamorphosed andesite are observed repeatedly alternated. The axes of the folds are gently plunging 5° or 10° to the east. Remarkable alteration is recognized on the surface as sericitization, silicification and argillization while chloritization is observed at depth. The form of this alteration is thought to be in good harmony with the above-stated geological structure, and the alteration zone is also plunging gently to the east.

Many indications of gold and copper mineralization are found on the surface, and also many indications of copper, gold and zinc mineralization are recognized in the drill holes. However, the relation of mineralization to the dykes or to the geological structure has not been clarified, and igneous rock related to mineralization, if any, is uncertain.

4-3 Geochemical Survey (Refer to Fig. 6, 7, 8, 9, and Table 6-11 and PL. III-1-18)

The geochemical survey by soil and rock samples was carried out in this area by UNDP. This survey employed very dense methods as line-spacing was 50m and interval of the sampling points was 20 m, with the indicative elements of Cu, Pb, Zn and Au.

For the appreciation of the results of the above geochemical survey by UNDP and for the supplement of the results of the geological survey, geochemical survey by soil sampling was carried out in the first year. The area was divided into blocks of each area of 1 km^2, and about 10 sampling points were planned in every block. Soils were collected at the depth of

30 cm, and after plant roots were removed, each sample of about 1 kg was packed into numbered vinyl bags. The collected samples reached as many as 305. (8.7 samples/km^2)

The analysis was performed in ppm order by atomic absorption method, although the analysis of Au was by mean of wet chemical method in 0.1 ppm order, in Japan and by the DGMH of the Republic of Honduras. The assay results were statistically treated by electronic computer, and through the determination of the thresholds, anomalies were detected. These anomalies were correlated with those by UNDP.

Cu anomaly over 167 ppm was detected roughly in the form of parallelogram about 1 km in north-south and about 1.5 km in east-west, in a zone with remarkable alteration and with many intrusive rocks in an area occupied by the Vueltas del Rio Formation. Pb anomaly is in the south side of the Cu anomaly, occupying rather narrower zone than Cu anomaly. Zn anomaly is distributed along the hillside in the southeastern part, to the southeast of Cu anomaly. The results of the geochemical survey by UNDP are well corresponded with the results of this geochemical survey. As a whole, lead and zinc anomalies are distributed in the surrounding area of the copper and gold anomalies. This pattern of the distribution of anomalies would show large mobility of zinc, and it is thought that the Zn anomaly would have spread southward out of the originally anomalous area, on the slope inclining to the south.

4-4 Comparison with UNDP Survey

4-4-1 Laguna Seca II

Laguna Seca II is a block of 0.16 km^2 at the western end of the detailed survey area. The block is underlain by the Paleozoic mica schists and Atima limestone. The mica schists, containing crystalline limestones,

are trending ENE-WSW with the dip to the south. The boundary between the mica schist and Atima limestone is made by Pueblo Nuevo Fault.

Through the survey works by UNDP, though 5 separated geochemical anomalies as for Cu, Pb, Zn contents were obtained by 126 soil samples, indications of mineralization were not confirmed. Through the present survey, no geophysical exploration work was carried out, and the result of geochemical exploration does not show the block to be favorable for mineralization.

Accordingly, it can be said that the block is of less importance for further exploration, checking up with results of the present survey.

4-4-2 Laguna Seca I

Laguna Seca I is a small block of 0.64 km^2 located at the north of the Laguna Seca village. In this block, mica schists group (mica schists and crystalline limestone) and limestone of Atima Formation are in contact by Pueblo Nuevo Fault, and diorite is seen to have intruded into the limestone. Dominant trend of bedding is E-W. The Pueblo Nuevo Fault runs in E-W or in ENE-WSW. As for geochemical exploration, through the chemical analysis of Cu, Pb, Zn, Ag and Mo contents of 451 soil samples, Cu and Zn anomalies extending in NW-SE are obtained in the central part of this block. The anomalous zone corresponds to the area occupied by limestones where exposure are very poor, located near the ridge. The results of the geophysical exploration by Turam method, though some discussion on several points was left behind, caught the orientation of ENE-WSW in the southern part and E-W in the northern part which is parallel to the trend of the Pueblo Nuevo Fault.

With comparison to the results of the present survey in this block, have correlated with the deep surface soil covers though the geochemical anomalies are high. The results of the detailed geological survey including

trenching are described in another chapter.

4-4-3 Ojo de Agua I

Located at the northern end of the detailed survey area, Ojo de Agua I block occupies an area of 0.64 km^2, where mica schists are distributed in the north and Vueltas del Rio Formation is in the south, both trending east-west. The boundary between the mica schist and the Formation is constituted by the Pueblo Nuevo Fault. There are diorites and andesites intruding the above rocks. The result of the geochemical exploration carried out by UNDP did not show any marked anomaly in this block through the chemical analysis of Cu, Pb, Zn, Ag and Mo contents of 471 soil samples. Also, the result of the geophysical exploration by Turam method indicate the orientation obtained is oblique to the strikes of beddings. UNDP report concluded this block is not favorable for the emplacement of mineral deposits. By the present survey as well, which did not reveal any anomaly, further exploration is not recommended in this block.

4-4-4 Ojo de Agua II

Located about 1.5 km southeast of Chiquila, Ojo de Agua II block occupies an area of 0.4 km^2, where a schistose part of Vueltas del Rio Formation is distributed with the extension of E-W, intruded by diabasic rock in the central part.

UNDP analysed on Cu, Pb, Zn, Mo and Ag contents of 286 soil samples and found a slightly anomalous zone in the eastern end of the block. This anomalous zone is recognized to be at the southern margin of the diabase intrusive body, through the present survey. The surface soil of the anomalous zone is so deep that it was impossible to define the cause of the anomaly through the present survey. The result of the geophysical survey by Turam method show the orientation of NW-SE.

UNDP concluded further exploration work to be extended to the southern

part and the southeastern part of this block, though less important because of scarce mineral indication.

By the present survey it can be said that the margin of the igneous rock is worth further examination as well as eastern part, as the exploration around the igneous intrusive body is necessary, though no direct indication of mineralization has been found.

4-4-5 Zapotal I-II

Located in the northern side of Chamelecon River in the central part of the detailed survey area, Zapotal I and II blocks occupy an area of about 1 km^2. In the northern part schistose member of Vueltas del Rio Formation is distributed, which is intruded by diabase, extending east and west. To the south of it, diorite is distributed in east-west, intruding the Atima Formation limestone located along its southside.

By the chemical analysis of Cu, Pb, Zn, Mo, Ag and Au contents of 723 soil samples, UNDP has shown the geochemical anomalies of Cu as well as Zn, extending east and west in the southwestern part of the block. The anomalies are controlled by the distribution of limestone beds. The result of geophysical exploration by Turam method reveals the structure of NE-SW, which corresponds to the direction of geochemical anomalies.

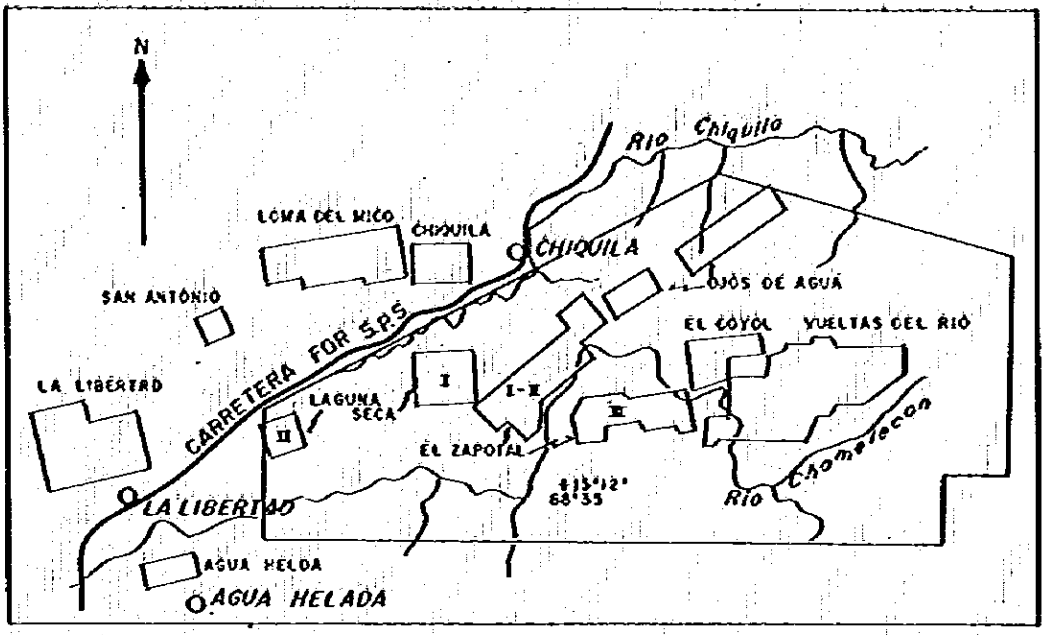
Through the present survey, it has been recognized that the location of Cu and Zn anomalies corresponds mainly to the boundary area between limestones and diorite dykes, but the Cu anomalies found in the area occupied by diabase are not elucidated well with corresponding geological features. There is no notable anomaly along the NW-SE fault and the NNE-SSE fault supposed in the north. The southern part of this block is worth general examination including Zapotal III area.

4-4-6 El Coyol

El Coyol block is located in the northern side of Chamelecon River

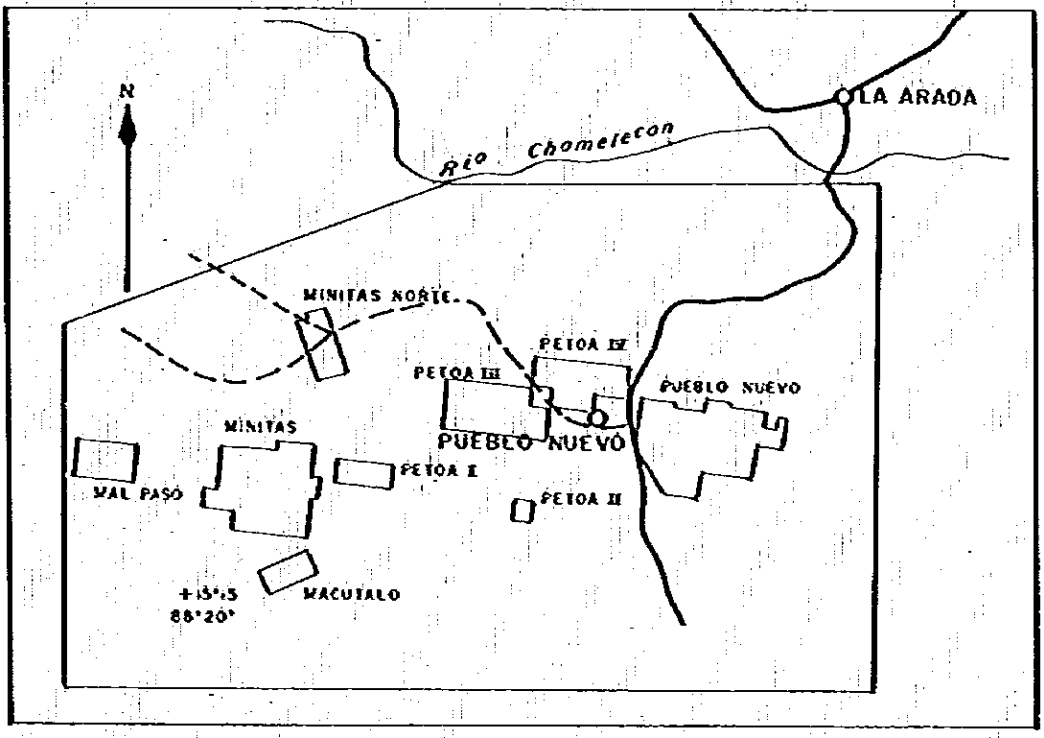
Fig. 6 Index Map of Explorated Sectors by UNDP.

Chamelecon and Chiquilo - La Libertad area



Scale
0 1 2km

Petoa area



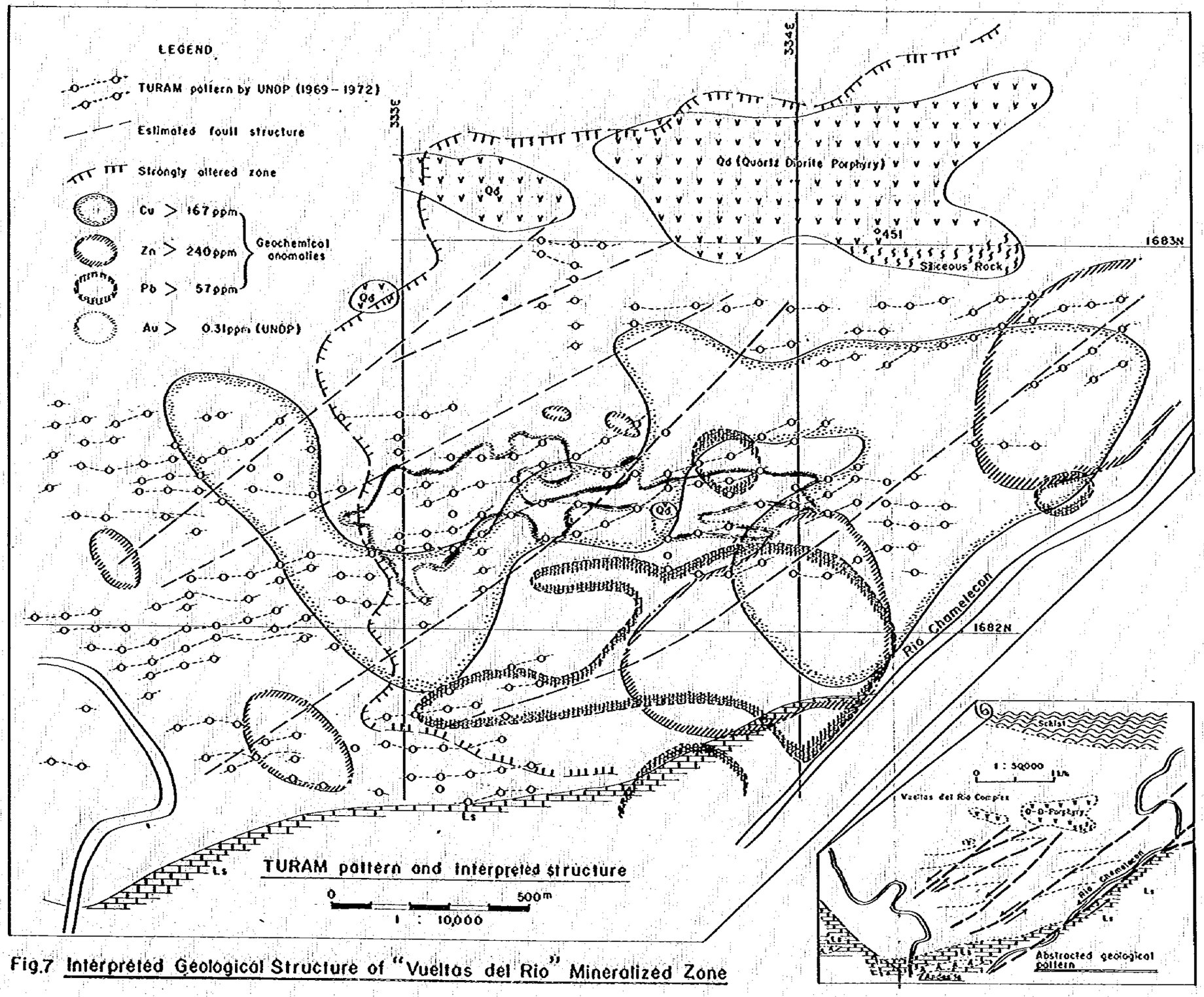
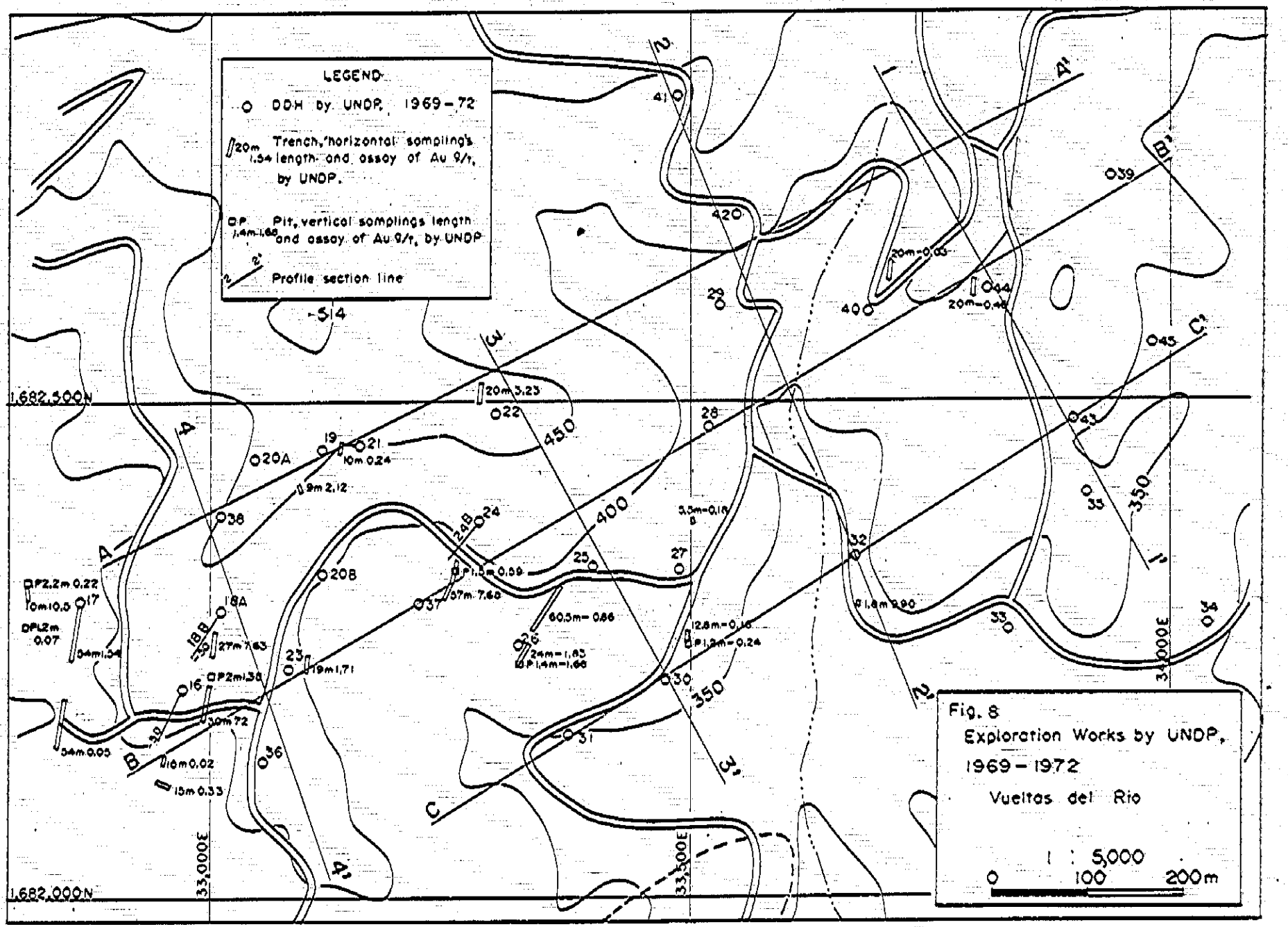


Fig.7 Interpreted Geological Structure of "Vueltas del Rio" Mineralized Zone


LEGEND
DDH by UNDP, 1969–72
20m 1.34 Trench, horizontal samplings length and assay of Au g/t, by UNDP.
DP 1.4m-1.66 Pit, vertical samplings length and assay of Au g/t, by UNDP
Profile section line
-514
1,682,500N
1,682,000N
33,000E
33,500E
34,000E
A
A'
B
B'
C
C'
1
2
2'
3
3'
4
4'
20m 3.23
9m 2.12
10m 0.24
DP2.2m 0.22
DP2m 0.07
54m 1.34
54m 0.05
16m 0.02
15m 0.33
27m 7.63
19m 1.71
37m 7.60
60.5m-0.86
24m-1.83
DP1.4m-1.66
DP1.5m 0.59
3.5m-0.16
12.8m-0.16
DP1.2m-0.24
DP1.8m 0.90
20m-0.03
20m-0.46
Fig. 8
Exploration Works by UNDP,
1969 – 1972
Vueltas del Rio
1 : 5,000
0 100 200m

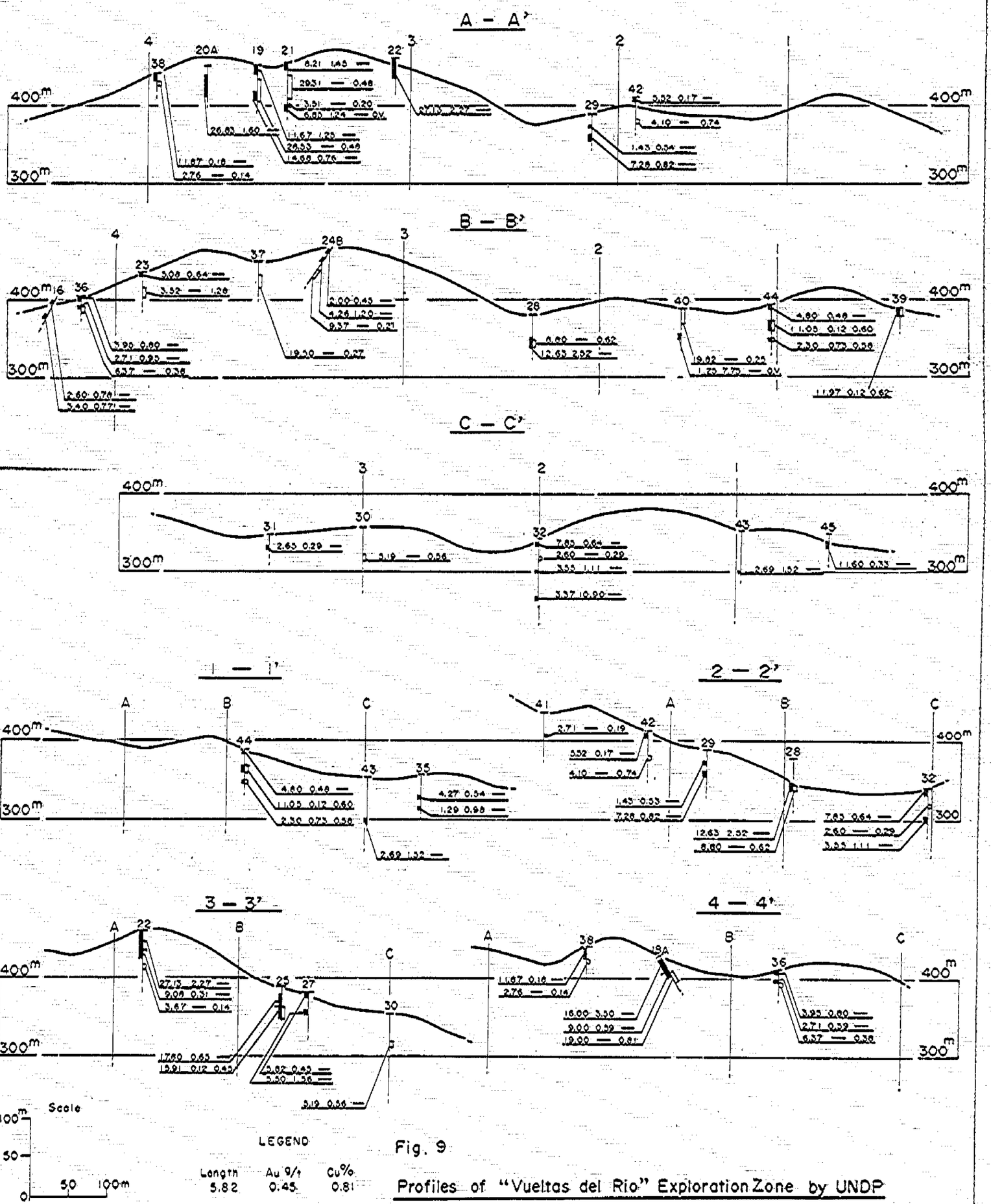


Fig. 9

Profiles of "Vueltas del Rio" Exploration Zone by UNDP

Table 6-11 Investigation by UNDP

* T : Turam , Mag : Magnetic survey, IP : Induced Polarization GS : Geoelectrical Soundings
** Rec = Recommendation

Chamelecon area

Sectors \ Exploration works	Geochemistry: Number of samples	Geochemistry: Interval of values (soil, ppm)	Geophysis *	Excavation & D.D.H: Trench, Pit, Holes; total (m)	Evaluation or Recommendation
Vueltas del Rio	stream sediment 6 soil 2,969 rock 159 total 3,133	Cu 4 ~ 4,851 Pb 1 ~ 2,140 Zn 1 ~ 4,800 Ag generally < 1 Mo 1 ~ 10 Au 0.01~17.10	T. Mag. IP. G.S. and E.M gun.	Trench 23 ; 545.5 Pit 11 : 20.2 Holes 33 ; 2402.0	Probable ore (t) / Possible ore (t) Au 7.5 x 10^6 (1.3 g/t) / 10 x 10^6 (0.95 g/t) Cu 4.5 x 10^6 (0.67%) / 6.4 x 10^6 (0.45 %) Rec** Mill test and feasibility study
EL Zapotal I - II	Soil 679	Cu 6 ~ 922 Pb 4 ~ 1,089 Zn 1 ~ 4,500 Ag 0.2under ~ 7 Mo 1under ~ 16 Au 0.01 ~ 91	T and Mag	Trench 2 ; 60 Pit 1 ; 22	Rec ; Furtner investigations
EL Zapotal III	Soil 679	Cu 8 ~ 1,413 Pb 2 ~ 4,500 Zn 20 ~ 9,600 Ag 0.02 ~ 22 Mo generally low Au 0.01under~2.26	T	Trench 16 ; 372.5 Pit 2 ; ?	massive sulfide mineralization at depth in a vein type deposit is indicated. Rec ; 1. additional subsurface exploration 2. preliminary metallurgical laboratory test 3. additional exploration inside and ajacent
Laguna Seca I	soil 495	Cu < 2,290 Pb < 61.4 Zn < 2,410 Ag < 5 Mo < 8 Au < 0.24	T	—	1. Insufficient geological data 2. The anomalies seem to continue the Laguna Seca II Rec; Detail geological results combined with an extended soil survey beyond the limits of this area accurate appraisal.
Laguna Seca II	soil 126	Cu < 23.1 Pb < 27.1 Zn < 1,860 Ag < 6 Mo < 1.7	—	—	Negative
El Coyol	soil 353	Cu 3 ~ 660 Pb 4 ~ 289 Zn 4 ~ 2,380 Ag generally low Mo Au 0.01under~0.73	T and EM.	—	Negative
Ojo de Agua I	soil 471	Cu 4 ~ 349 Pb 4 ~ 130 Zn 10 ~ 920 Ag 0.2 ~ 13 Mo < 7	T and Mag	—	EM anomalies are probably caused by clay zone Negative
Ojo de Agua II	soil 286	Cu 4 ~ 632 Pb 3 ~ 757 Zn 32 ~ 1,970 Ag < 1 Mo < 9	T	—	Insufficient geological data Rec; Detailed geological mapping and an extension of the geochemical soil survey towards south and southeast.
Aqua Helada	soil 250 ore 1	Cu < 150 Pb < 30 Zn generally<200 Ag < 4 Mo < 10	—	—	Negative

Petoa area

*** MM Mise-o-La-Masse

Pueblo Nuevo	soil 940	Cu < 120 Pb max ; 1000over Zn	T and Mag	Trench 4 ; 106.4 Pit 3 ; 6.1	Mineralization are shown in the 5 localities. Rec; Two drill holes in Santo Domingo and the line 5 of trench.
Macutalo	soil 512	Cu (2 main anomalies) Pb (no anomalies) Zn (Cu anomaly corrospond to) Mo (low anomalies)	T Mag MM*** and EM-Gun	Trench 4 ; 67.1 Pit 1 ; 7.00 Holes 5 ; 48.3.9	Min ; 0.6 X 10^6 t (Cu t:~20% in the value of chemical analysis) Rec ; One drill hole in the south western portion
Petoa I	soil 99	?	T and Mag	—	Negative
Petoa II	soil 40	?	T and Mag	—	Negative
Petoa III	soil 210	Cu 304	T and Mag	—	Negative
Petoa IV	soil 281	?	T and Mag	—	Negative
Minitas Norte	soil 179	Cu < 800	T and Mag	Holes 1 ; 73.1	Negative
Minitas	soil 1,660	Cu < 24,500 Zn < 14,700	T. Mag. EM-Gum and Sp.	Pit 12 ; 14.96 Holes 4 ; 402.11	The mineralized narrow stretches are caught by the four drill holes in skarn zones. Rec; Four drill holes for the detection of another mineralization.
Mal Paso	soil 341	Cu < 3,220 < 2,140 < 43,000	T	—	The mineralization is considered to be similar to Minitas Rec ; Two drill holes in the diffrent portion

Chiquila – La Libertad area

Loma del Mico	soil 1,100 stream sediment	Cu 2 ~ 1,770 Pb 5 ~ 3,620 Zn 14 ~ 5,700 Mo 1 ~ 60	T and Mag	Holes 3 ; 270.9	A great number of both Turam and giochemical anomalies, beside three holes, has not been trenched, or drilled.

EL Zapotal I - II	Soil 675	Zn 1 ~ 4,500 Ag 0.2under ~ 7 Mo 1under ~ 16 Au 0.01 ~ 91	T and Mag	Pit 1 ; 22	Rec ; Further investigations
EL Zapotal III	Soil 679	Cu 8 ~ 1,413 Pb 2 ~ 4,500 Zn 20 ~ 9,600 Ag 0.02 ~ 22 Mo generally low Au 0.01under~2.26	T	Trench 16 ; 372.5 Pit 2 ; ?	massive sulfide mineralization at depth in a vein type deposit is indicated Rec ; 1. additional subsurface exploration 2. preliminary metallurgical laboratory test 3. additional exploration inside and ajacent
Laguna Seca I	soil 495	Cu < 2,290 Pb < 614 Zn < 2,410 Ag < 5 Mo < 8 Au < 0.24	T	—	1. Insufficient geological data 2. The anomalies seem to continue the Laguna Seca II Rec; Detail geological results combined with on extended soil survey beyond the limits of this area accurate appraisal.
Laguna Seca II	soil 126	Cu < 231 Pb < 271 Zn < 1,860 Ag < 6 Mo < 17	—	—	Negative
El Coyol	soil 353	Cu 3 ~ 660 Pb 4 ~ 289 Zn 4 ~ 2,380 Ag generally Mo low Au 0.01under~0.73	T and EM.	—	Negative
Ojo de Agua I	soil 471	Cu 4 ~ 349 Pb 4 ~ 130 Zn 10 ~ 920 Ag 0.2 ~ 13 Mo < 7	T and Mag	—	EM anomalies are probably caused by clay zone Negative
Ojo de Agua II	soil 286	Cu 4 ~ 632 Pb 3 ~ 757 Zn 32 ~ 1,970 Ag < 1 Mo < 9	T	—	Insufficient geological data Rec; Detailed geological mapping and an extension of the geochemical soil survey towards south and southeast.
Aqua Helada	soil 250 ore 1	Cu < 150 Pb < 30 Zn generally<200 Ag < 4 Mo < 10	—	—	Negative

Petoa area

**** MM Mise-o-La-Masse

Pueblo Nuevo	soil 940	Cu < 120 Pb max ; 1000over Zn	T and Mag	Trench 4 ; 106.4 Pit 3 ; 6.1	Mineralization are shown in the 5 localities. Rec; Two drill holes in Santo Domingo and the line 5 of trench.
Macutalo	soil 512	Cu (2 main anomalies) Pb (no anomalies) Zn (correspond to Cu anomaly) Mo (low anomalies)	T Mag. MM and EM-Gun	Trench 4 ; 67.1 Pit 1 ; 700 Holes 5 ; 483.9	Min ; 0.6×10^6 t (Cu tr~20% in the value of chemical analysis) Rec ; One drill hole in the south western portion
Petoa I	soil 99	?	T and Mag	—	Negative
Petoa II	soil 40	?	T and Mag	—	Negative
Petoa III	soil 210	Cu 304	T and Mag	—	Negative
Petoa IV	soil 281	?	T and Mag	—	Negative
Minitas Norte	soil 179	Cu < 800	T and Mag	Holes 1 ; 73.1	Negative
Minitas	soil 1,660	Cu < 24.500 Zn < 14.700	T. Mag. EM-Gum and Sp.	Pit 12 ; 14.96 Holes 4 ; 402.11	The mineralized narrow stretches are caught by the four drill holes in skarn zones. Rec ; Four drill holes for the detection of onother mineralization.
Mal Paso	soil 341	Cu < 3,220 < 2,140 < 43.000	T	—	The mineralization is considered to be similar to Minitas Rec ; Two drill holes in the diffrent portion

Chiquila – La Libertad area

Loma del Mico	soil 1,100 stream sediment	Cu 2 ~ 1,770 Pb 5 ~ 3,620 Zn 14 ~ 5,700 Mo 1 ~ 60 Ag 0.2 ~ 21	T and Mag	Holes 3 ; 270.9	A great number of both Turam and giochemical anomalies, beside three holes, has not been trenched, or drilled. Rec ; Further investigation
Chiquila	soil 230	Cu 4 ~ 443 Pb 4 ~ 50 Zn 8 ~ 348 Mo.Ag ?	T	—	Negative
San Antonio	soil 126	Cu ? Pb 5 ~ 55 Zn 7 ~ 117 Mo < 5 Ag < 2	T	—	Unknown (Negative)
La Libertad	soil 1,005 stream sediment	Cu 2 ~ 1972 Pb 5 ~ 1700 Zn 9 ~ 3940 Mo.Ag Fe 4 ~ 11 (%) Mn 1 ~ 2 (%)	T and Mag	Trench 1 ; 36.0 Pit 6 ; up to 3m depth each Holes 3 ; 283.4	1. The most promising in the area. 2. Important to test the anomalies both in a southerly and easterly direction. Rec; 2 or 3 additional drill holes to a depth of at least 200 m.

running in the north of Zapotal. The block is occupied by Vultas del Rio Formation and diabase. The geological structure is not quite certain because of the local intense alteration and deep weathering to form thick surface soil. General trend of strata is E-W with steep dipping.

By the UNDP geochemical exploration, Cu, Pb, Zn, Mo, Ag and Au contents of 353 soil samples were analysed and moderate Cu and Zn anomalies were obtained. The Cu anomaly located on the slope in the north side of the Chamelecon River is in the area covered by deeply weathered soil. Cu-Zn anomaly zone near the limit of the block corresponds to the area are occupied by the quartz-diorite porphyry. The result of the geophysical exploration by Turam method shows a belt of high conductivity in the northeastern part of the block. The belt acrosses the contact zone between Vueltas del Rio Formation and the intrusive rocks.

However, the conclusion by UNDP was negative in this block as there was no mineral indication found on the surface. By the present survey, the result is same, without any addition of new discovery of mineralization.

4-4-7 East of El Manguito

Copper mineralization has been found in diorite outcropping along river-bank of Chamelecon River, at the east of El Manguito. The mineralization is seen at two locations at interval of 70 m, represented by malachite in the fractuated zone in diorite, 2 to several meters wide.

4-4-8 Vueltas del Rio and Zapotal III

Described in the later part.

4-5 Geophysical Survey (IP method)

In this IP survey, frequency domain method was employed, using dipole-dipole configuration. Total 13 survey lines were established with the line-spacing of 200 m and with the interval of survey points of 100 m. Total length of the survey line was 25.0 km and the total area surveyed was

as extensive as approximately 4.4 km^2.

The instruments supplied for the measurement were as follows;

IP transmitter

(1) Model CH-506 A, B — Chiba Electronic Laboratory made

Output voltage 20 - 800V

Output current 0.1 - 2.5 A

Frequency 0.1 - 0.3, 1.0, 3.0, 5, 10 Hz

Serial No. 5

(2) Model L-5202 A, B — Yokohama Electronic Laboratory made

Output voltage 40 - 800V

Output current 0.2 - 4A

Frequency 0.1, 0.3, 1.0, 1.25, 2.5, 5 Hz

0.03 - 20 second

Serial No. 06A, 06B

IP receiver

(1) Model YM-412 — Yokohama Electronic Laboratory made

Sensitivity	50 μV
Input impedance	10 MΩ
Frequency	DC, 0.1 - 10 Hz
Serial	No. 5

(2) Model 7505 U - S — Yokohama Electronic Laboratory made

Sensitivity	10 μV
Input impedance	2 MΩ
Frequency	0.1 - 5 Hz
Serial	No. 05

Generator

(1) Model 130232 TYPE DO 36 - 01 — Geotronics made

Output	2.0 KW
Generating	115 V, 17.3 A, 400 Hz

(2)	Model G - 50 D	Yanmer made
	Output	2.5 KW
	Generating	125 V 60 Hz
	Serial	No. S - 20155

The survey works were carried out by establishing survey lines of the length of 2.3 km in north and south with the line-spacing of 200 m over the area of the approximate width of 2 km in east-west. Survey points were determined every 100 m on these lines by the land survey. Topographical correlation with the results of property measurement of rock piece samples and simulation by electronic computer were carried out, after the measurement of apparent resistivity, FE and MP. Synthetic analysis was conducted with the informations obtained through various surveys as geological survey.

Survey Results (Refer to Fig. 10)

Apparent resistivity is high with the limestone while it is low with the metamorphosed tuff, sandstone and shale. The dacitic porphyry distributed in the northern side of the survey area exhibits high apparent resistivity. There is little difference of resistivity between the diabase and the rocks comprising the Vueltas del Rio Formation.

The FE anomalies are caught in good correspondence with alteration and mineralization zones. There is a tendency of weak anomalies extending eastward from near the V-3 survey line and northeastward from near the V-6 line. These weak anomalies are well corresponded with the geochemical anomalies. It is presumed that the FE anomalies would have been detected in extensive alteration zone.

Moderate grade FE anomalies are distributed in the north-east from near the V-6 survey line, which is thought to be indications shown by alteration as silicification caused by the dacite porphyry and it is thought that comparatively distinct response body would be present in shallow part

of the anomalous zone. Also, another moderate grade FE anomaly which is seen extending eastward from the V-6 survey line is caught on the V-12 line, too. It is inferred that this FE anomaly would possibly be extending to the further east.

4-6 Diamond Drilling Survey

4-6-1 Drill Works

In the first year, a survey member in charge of the drilling was sent in advance from Japan to the field of La Flecha on 21st of August in 1977, and did the construction and the repair of access roads for the machines and materials, and prepared the drillsites. According to the schedule of the delivery, at the port, of the materials and supplemental parts and tools which had been sent by boat from Japan, another 4 members arrived on 23rd of September. Two drill-machines of TGM-5A were used. (The capacity of drilling is 510 m in final NQ size and 660 m in final BQ size.) The machines were operated by wire-line method, and the drilling of 6 holes of the total length of 1,825.90 m was completed. The works were finished on 20th of December.

In the Vueltas del Rio area, 4 drill holes of the total length of 1,202.60 m were completed in the remarkably altered zone in the central part of the geochemical anomaly.

The survey members for the drill works were composed of 1 chief engineer, 4 survey members, 12 field assistants and 17 field workers. Two parties were prepared for the works, which comprise two shifts of 15 hours per day, each shift comprising 8 hours. The results of the core logging, which was conducted by geologist members, was compiled in the log of the scale 1 to 500. Cores were sampled continously down to the depth of 100 m, while below this depth only important parts were sampled or 1 to 2

samples were sampled every 10 m for the observation of the tendency with the grade of mineralization at depth.

In the second year, drilling of 5 holes of the total length of 2004.1 m was carried out in the geochemical copper anomalies and in the alteration zone. Advanced member arrived on 15th of May, for the preparation works. Another 6 members with a geologist arrived on 5th of June. Fieldworks were conducted over 4 months.

In the third year, drilling of 8 holes of the total length of 2102.70 m was completed in the surrounding area, as well as in the area of the extension to the east, of the indications of copper, gold and zinc mineralization confirmed by the previous drillings. As was the case in the previous year, one advanced member was sent from Japan for the preparation on 21st of May, and another 6 members arrived on 4th of June. Drillworks were carried out, by three shifts, each shift comprising 8 hours.

Length and core recovery of each hole in each year are shown in the Table 6-10.

4-6-2 Geology (Refer to Fig. 11)

The following geological facts have been confirmed by the information obtained by the diamond drilling.

It is difficult to correlate the beds in each drill hole lithologically, owing to remarkable alteration, but regarding the andesite to be a key bed, a synclinorium structure is ascertained with the axis of east and west, dipping gently toward the east.

Also, sheared fracture zones are remarkably recognized in the survey area, in the direction of east-north-east and west-south-west. Along many of the fissures in the directions of east-west and occasionally of north-south, branched from the above sheared fracture zones, limonitized quartz veinlets are contained. Therefore, the indications of copper mineralization

Table 6--10 Diamond Drilling Data in the Vueltas del Rio Sector

(First - Third (1977 - 1979))

Synthesize data by drilling work

Years	Drill holes No.	Type of Machine	Working Period			Drilling	Core		No. of drilling days and speed					
										Drilling			Total	
			Preparation	Drilling	Removing	Length	Length	Recovery	Preparation	Actual Days	Speed	Removing	Actual Days	Speed
First (1977)	No. 52-1	TCM-5A	22nd Aug '77~ 24th Oct '77	25th Oct '77~ 11th Nov '77	12th Nov '77~ 15th Nov '77	300.60	288.70	96.0	18	15	20.04	3	36	8.35
	No. 52-2	"	7th Sep '77~ 28th Sep '77	29th Sep '77~ 19th Oct '77	20th Oct '77~ 21st Oct '77	301.80	290.60	96.3	16	18	16.77	2	36	8.38
	No. 52-3	"	21st Aug '77~ 28th Sep '77	29th Sep '77~ 21st Oct '77	22nd Oct '77	300.00	290.50	96.8	13	20	15.00	1	34	8.82
	No. 52-4	"	20th Sep '77~ 25th Oct '77	26th Oct '77~ 18th Nov '77	19th Nov '77	300.20	282.60	94.1	19	20	15.01	1	40	7.51
	Sub total					1,202.60	1,152.40	95.8	66	73	16.47	7	146	8.24
Second (1978)	No. 53-1	TCM-5A	21st May '78~ 14th Jun '78	15th Jun '78~ 3rd Jul '78	4th Jul '78~ 5th Jul '78	401.00	384.25	95.8	21	17	23.59	1	39	10.28
	No. 53-2	"	21st May '78~ 14th Jun '78	15th Jun '78~ 26th Jun '78	26th Jul '78~ 27th Jul '78	301.00	292.90	97.3	21	9.5	31.68	1.5	32	9.41
	No. 53-3	"	25th May '78~ 7th Jul '78	8th Jul '78~ 22nd Jul '78	22nd Jul '78~ 24th Jul '78	400.80	385.90	96.3	11	12.5	32.06	1.5	25	16.03
	No. 53-4	"	30th May '78~ 30th Jun '78	31st Jun '78~ 27th Jul '78	28th Jul '78~ 2nd Aug '78	500.50	472.90	94.5	10	23	21.76	5	38	13.17
	No. 53-5	"	23rd Jul '78~ 26th Jul '78	27th Jul '78~ 18th Aug '78	18th Aug '78~ 26th Aug '78	400.80	341.90	95.3	3	19.5	20.55	7.5	30	13.36
	Sub total					2,004.10	1,877.85	93.7	66	81.5	24.59	16.5	164	12.22
Third (1979)	No. 54-1	TCM-5A	1st Jun '79~ 12th Jun '79	13th Jun '79~ 29th Jun '79	29th Jun '79	250.20	236.00	94.3	8	14	17.87	1	23	10.88
	No. 54-2	"	1st Jun '79~ 12th Jun '79	13th Jun '79~ 25th Jun '79	26th Jun '79~ 27th Jun '79	250.30	245.20	98.0	8	11	22.75	2	21	11.92
	No. 54-3	"	4th Jun '79~ 2nd Jul '79	3rd Jul '79~ 12th Jul '79	13th Jul '79~ 14th Jul '79	250.70	246.40	98.3	3	9	27.86	2	14	17.91
	No. 54-4	"	4th Jun '79~ 17th Jul '79	18th Jul '79~ 30th Jul '79	30th Jul '79~ 31st Jul '79	250.40	248.70	99.3	4	10.5	23.85	1.5	16	15.65
	No. 54-5	"	3rd Jun '79~ 17th Jul '79	18th Jul '79~ 31st Jul '79	31st Jul '79~ 1st Aug '79	250.30	241.10	96.3	3	11.5	21.77	1.5	16	15.64
	No. 54-6	"	2nd Jun '79~ 29th Jun '79	30th Jun '79~ 12th Jul '79	13th Jul '79~ 14th Jul '79	250.20	226.40	90.5	3	11	22.75	2	16	15.64
	No. 54-7	"	23rd Jul '79~ 4th Aug '79	5th Aug '79~ 18th Aug '79	19th Aug '79~ 28th Aug '79	300.20	279.60	93.1	6	12	25.02	8	26	11.55
	No. 54-8	"	25th Jul '79~ 4th Aug '79	5th Aug '79~ 17th Aug '79	18th Aug '79~ 28th Aug '79	300.40	272.10	90.6	5	11	27.31	9	25	12.02
	Sub total					2,102.70	1,995.50	94.9	40	90	23.36	27	157	13.39
Grand Total						5,309.40	5,025.75	94.7	172	244.5	21.72	50.5	467	11.37

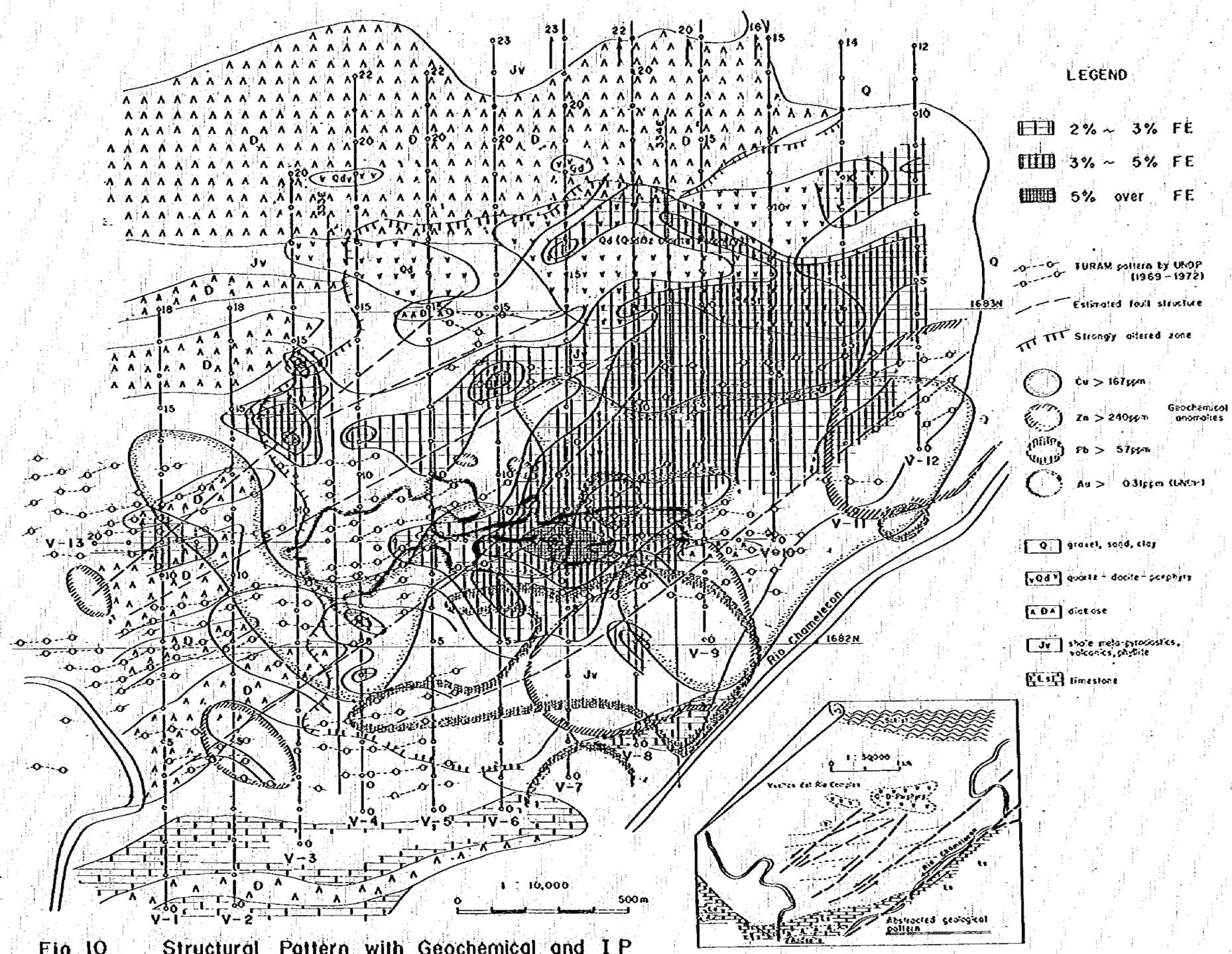
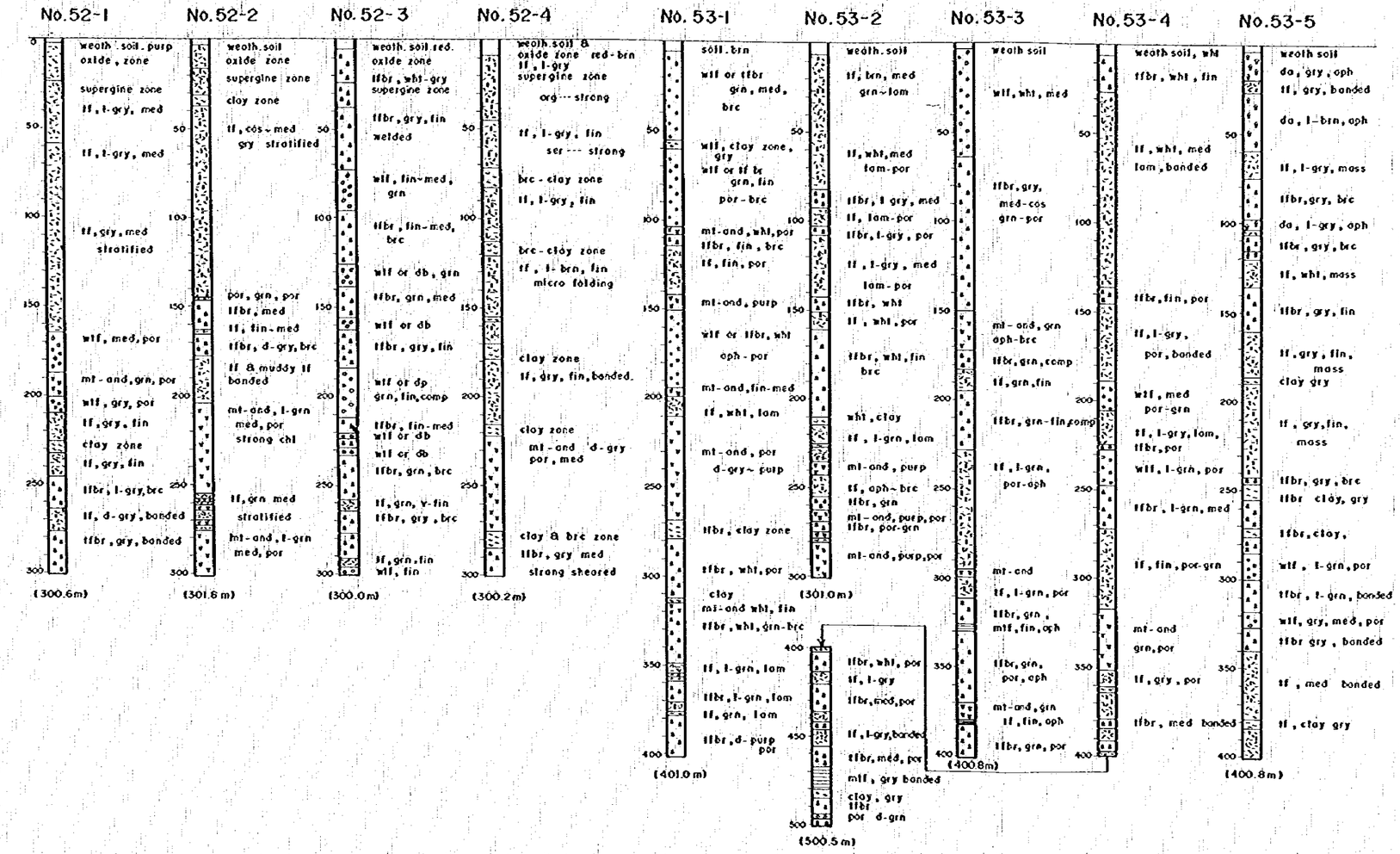


Fig. 10 Structural Pattern with Geochemical and I P Anomalies in The Vueltas del Rio Sector

Fig. 11 SUMMARY OF CORE LOG IN THE VUELTAS DEL RIO SECTOR

(No.52-1 ~ No.52-4)
1977 year

(No.53-1 ~ No.53-5)
1978 year



Symbol & Original Rock
soil
mf-and
lf
lfbr
wlf
chl
mlf
db
por
do

Texture
aph aphaniti
bond banded
brc breccia
grn granula
lam lamella
por porphyr

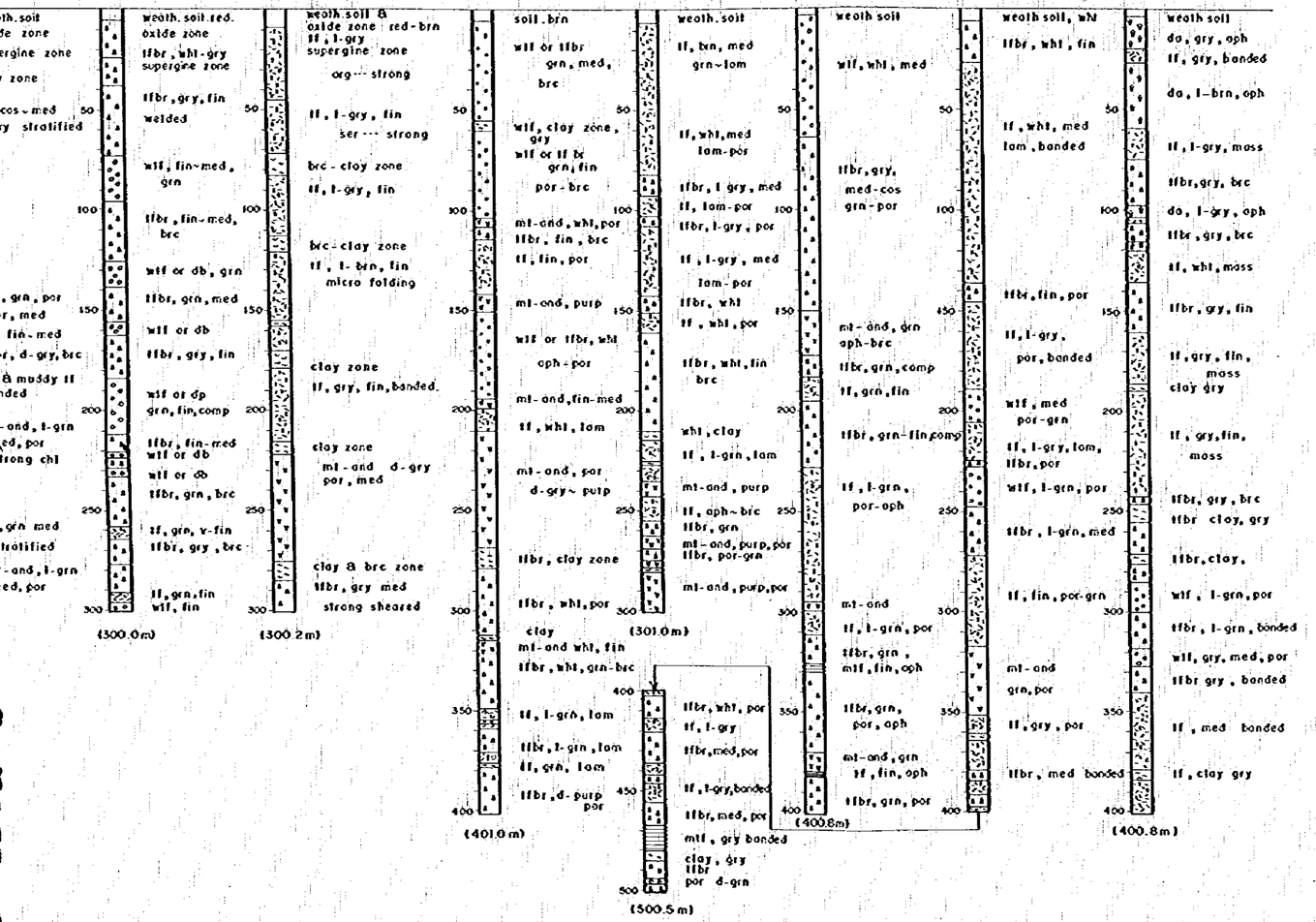
Grain size
v-fin very fi
fin fine
med medium
cos coarse

0 40

Fig. 11 SUMMARY OF CORE LOG IN THE VUELTAS DEL RIO SECTOR

(No.52-1 ~ No.52-4) 1977 year

(No.53-1 ~ No.53-5) 1978 year



INDEX

Symbol & Original Rock

soil	soil	
mt-and	meta andesite	
lf	tuff	
lfbr	tuffbreccia	
wlf	welded tuff	
chl mtf	chert & muddy tuff	
db	diobase	
por	porphyrite	
do	dacite porphyry	
	clay zone	

Phenocryst

cal	calcite
chl	chlorite
cly	clay
fd	feldspar
hb	hornblende
qz	quartz

Color

d	dark
l	light
blk	black
brn	brown
grn	green
gry	grey
purp	purple
whl	white
yel	yellow

Texture

aph	aphanitic
band	banded
brc	brecciated
grn	granular
lam	lamella
por	porphyritic

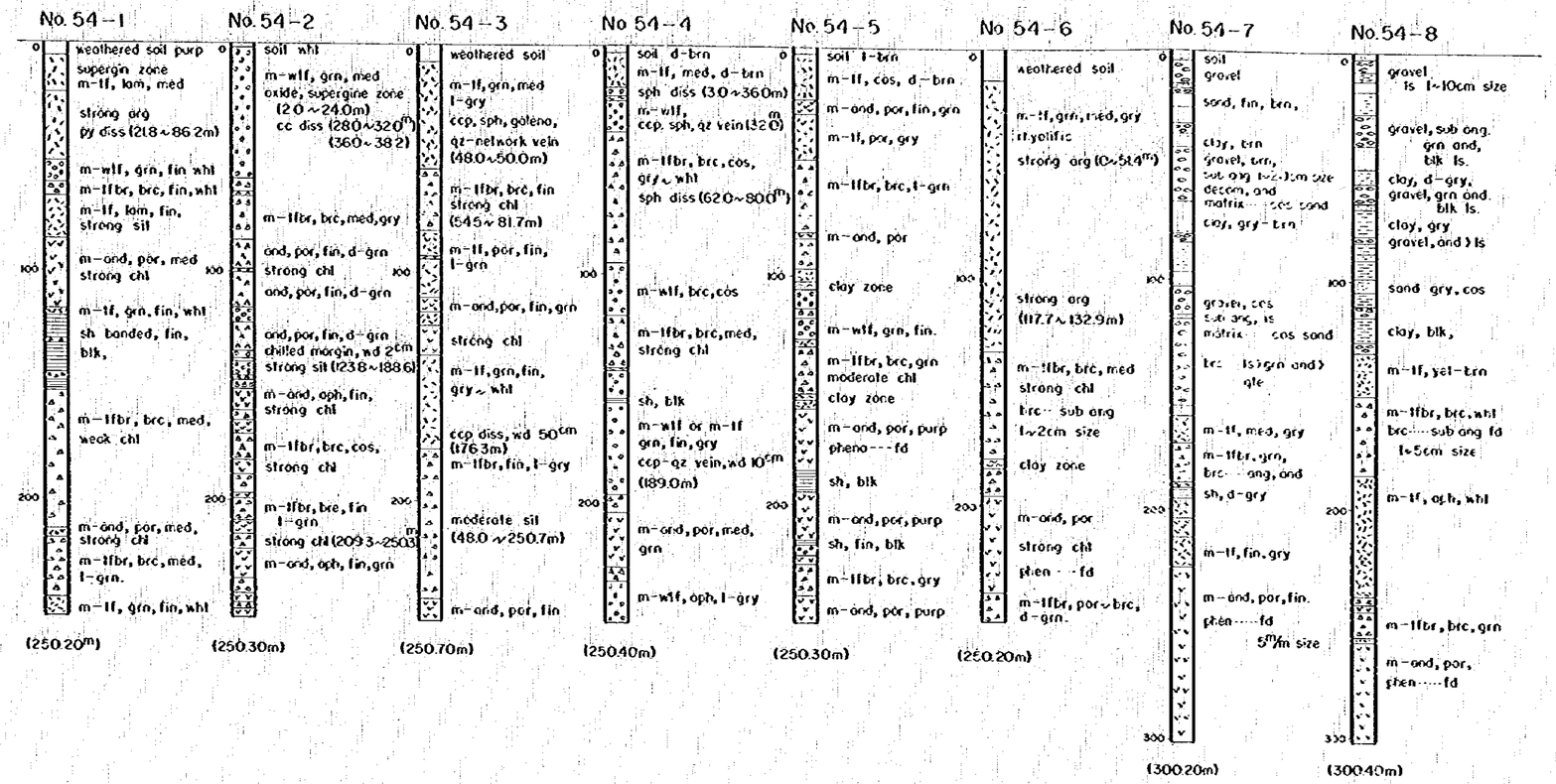
Grain size

v-fin	very fine
fin	fine
med	medium
cos	coarse

0 40 80 120 160 200m

Fig. 11 SUMMARY OF CORE LOG IN THE VUELTAS DEL RIO SECTOR

(No. 54-1 ~ No. 54-8) 1979 year



INDE

Symbol & Original Rock

soil soil
clay clay
gravel gravel
sand sand
m-lf. meta tuff
m-lfbr meta tuff
m-wlf. meta weld
sh. shale & m
mf-ond meta ande
por-ond porphyrite
clay zone

Texture

aph. --- aphonitic
brc. --- brecciated
grn. --- granular
lam. --- lamella
por. --- porphyritic

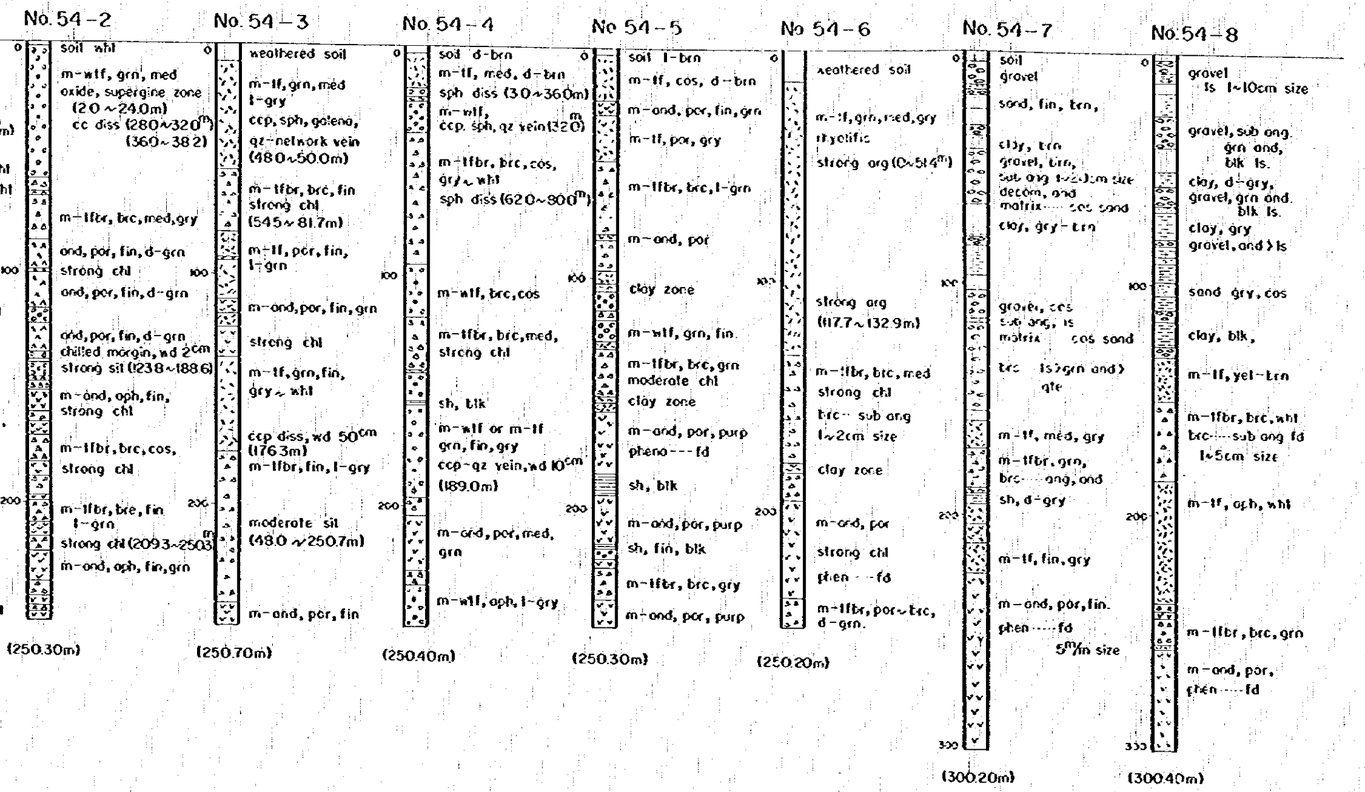
Grain Size

fin. --- fine grain
med --- medium grain
cos. --- coarse grain

0 50

Fig. 11 SUMMARY OF CORE LOG IN THE VUELTAS DEL RIO SECTOR

(No. 54-1 ~ No. 54-8) 1979 year



INDEX

Symbol & Original Rock

- soil — soil
- clay — clay
- gravel — gravel
- sand — sand
- m-lf. — meta tuff
- m-lfbr. — meta tuffbreccia
- m-wlf. — meta welded tuff
- sh. — shale & muddy tuff
- mt-and. — meta andesite
- por-and — porphyrite & andesite
- clay zone

Texture

- oph. --- ophanitic
- brc. --- brecciated
- grn. --- granular
- lam. --- lamella
- por. --- porphyritic

Grain Size

- fin. --- fine grain
- med --- medium grain
- cos. --- coarse grain

0 50 100 150 200m

Phenocryst

- cal. --- calcite
- chl. --- chlorite
- cly. --- clay
- fd --- feldspar
- hb. --- hornblende
- qz. --- quartz

Color

- d. --- dark
- l. --- light
- blk. --- black
- brn. --- brown
- grn --- green
- gry. --- grey
- purp. --- purple
- wht. --- white
- yel. --- yellow

caught at the depth of 104 m in the drill hole No. 53-3 and those of copper mineralization found at the depth of 109 m and 189 m are thought to be of the limonitized quartz veinlet type as mentioned above. Furthermore, between the surface and the depth of 150 to 200 m, alteration such as argillization, sericitization and carbonatization are recognized. Silicification is observed extensively but is weak. Chloritization is mostly found at depth, especially in the metamorphosed andesite.

4-7 Mineralization

The indications of copper, gold and zinc mineralization confirmed by the diamond drilling are shown in the Table 6-9 and the Table 6-8.

Most of these indications of mineralization are found in remarkable sericitization and argillization zone, in the metamorphosed tuff, in the metamorphosed tuff breccia and partly in the andesite in case of zinc, in a shallow part of the depth of less than 200 m, which corresponds with the secondary enrichment zone. Ore minerals are chalcopyrite, sphalerite, chalcocite, galena and electrum, associated with pyrite and hematite, occasionally with green copper mineral. Gangue minerals are quartz, calcite and sometimes clay minerals.

The dykes intruding the Vueltas del Rio Formation are subjected to alteration, but no positive data have been obtained in relation to the mineralization. Therefore, the role of the dykes to the mineralization and to the structural deformation is uncertain.

As for alteration and mineralization, it can be said that the indications of copper and gold mineralization are found in most cases in sericitization and silicification zones. Alteration zone is dipping gently to the east, in good harmony with the geological structure, but no concrete relation has been confirmed between such geological structure and the indications of

mineralization. Therefore, it can be said, as to the genesis of the mineralization, that the indications of mineralization found in the survey area are of epithermal to mesothermal fissure-filling type, related to the fissures in the predominant direction of east and west, considering no skarn mineral nor halogen mineral has been discovered.

Through the informations obtained by the detailed geological survey accompanying surface trenching, by the diamond drilling carried out in this series of surveys and by the diamond drilling performed by UNDP, 10 indications of gold mineralization have been confirmed in quartz-clay veins contained in the metamorphosed tuff. They are as wide as 0.5 to 3 m, with ore grade of 1.1 to 10 g/t, and many of them are found around San Martin old workings and Nelson trenches. Many of the soil samples collected in the area around this zone contain certain amount of gold, and such area where gold concentration is recognized is confirmed in a zone as extensive as 300 m in width of north-south and 1,200 m in length of east-west, where fracture are developed well. Grains of gold are usually 5 to 100 microns in size, forming electrum with silver, found in dot, prism, oval form and in irregular amoeba-like form. They are associated with galena. Also, they are found to have filled spaces amidst quartz grains, or spaces amidst the grains of oxide minerals of copper and iron. (Refer to Fig. 16, 17) Confining the area where the collected soil and ore vein samples reveal the content of more than 1 g/t of gold, and taking the depth down to 14 m with the density to be 2.4, ore reserves would be estimated to be in the order of several hundred thousand tons with the ore grade of 1.47 g/t in average. The above ore reserves of the gold ore deposits are thought to be worth consideration of the development. For the consideration, further detailed investigations such as trenching and precise sampling, followed by the shallow drilling in the grid system of the interval of 50 m are necessary to assure the accuracy

of the ore reserves by improving them to proved ore reserves. Furthermore, detailed study of the features of minerals concerning gold would be necessary to analyse mineral assemblage and grain sizes, for the consideration as to the methods of concentration. Also, concentration test would be required for the information on the recovery of gold. By the results of the above-stated investigations and tests, F/R should be prepared, considering mining, transportation, crushing, milling, market prices, concentration, watering and market conditions, before consideration to determine the development of the area.

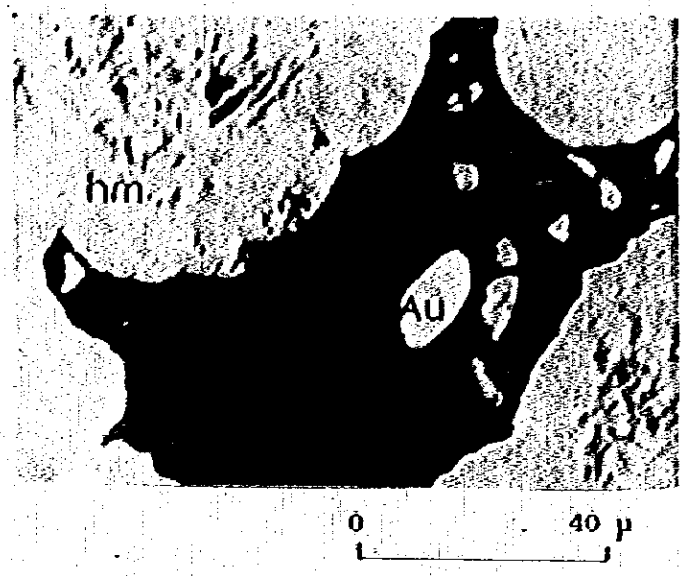
In case the results of these investigations and considerations are favorable, the following tests and research works would be required.

- Field climate, condition of location, environment for the construction of factories.
- Bulk treatment test including field test, and the test for the determination of flow sheet.

It is recommended to consider over the determination of the development besides proceeding with feasibility study including consideration of initial expenses and operation cost as well as income and expenditure, synthesizing the results of the above-mentioned tests and researches.

Fig. 16 Microscopic Observations and Photomicrographs of Gold Ores

Sample No.	Location	Formation	Ore Mineral	Microscopic Observations
N-88	82.55 33.70	Vueltas del Rio	Gold grain in a cavity among hematite mass	The specimen is composed of mainly iron oxide and iron hydroxide minerals. Hematite is the largest in quantity among them and it occurs as irregular shaped masses or network veins. Hematite masses have many pores or cavities in itself and the rim of the cavities show generally smooth spherical curve of colloidal forms. Among the cavities, fragments of magnetite and/or gauge mineral are sometime observed. Hematite also contains fine irregular formed darker phase but it could not be identified certainly. (goethite?) Near the one side edge of the specimen iron oxide veinlets fill up the crack or grain boundaries of quartz. These veinlets show beautiful colloform textures where symmetric and rhythmical banding structure and concetric spherulite texture formed by alternate precipitations of hematite and goethite are observed. By the EPMA experiments a small amount of copper is detected from goethite part. Gold grains less than 10 microns could seen, but they a are not many and usually very small in size.
TSA-1303	83.35 33.80	Vueltas del Rio	Gold grain in a small cavity	Under the microscope, irregular shaped dirty iron hydroxide masses, probably mixture of goethite and other, in various size are observed. Small spharulite and atoll shaped masses of goethite are found and some of the spherulite consist of hematite core and goethite crust. Gold grains, 3-10 microns in size are recognized mainly in small cavities.
W-120	83.52 34.48	Vueltas del Rio	Small gold grain	The specimen is schistosed reddish brown rock in which quartz lenses arrange in parallel. Under the microscope, small round hematite grains, less than 200 microns in size, are observed scatteredly and also very thin hematite veinlets of 2-15 microns in width are seen along fine cracks and around quartz crystals. Tiny gold grains are recognised but it is very hard to find them because of their small number and size.

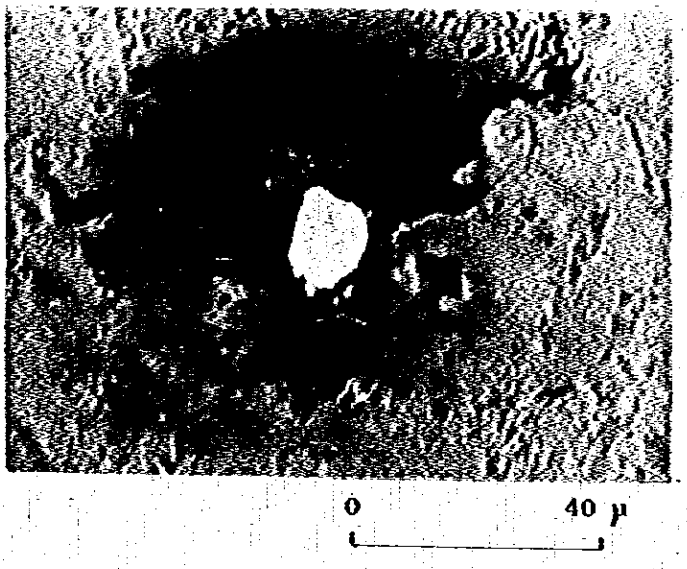


Sample N-88

Gold grain in a cavity among hematite mass.

Au : gold

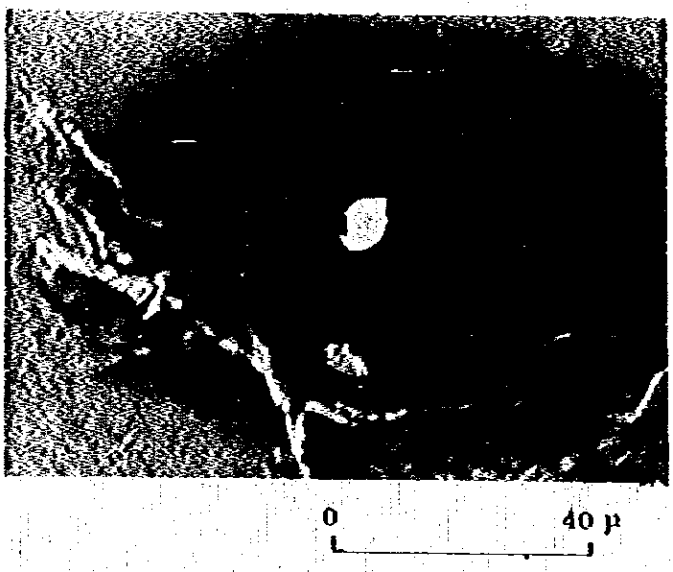
hm : hematite



Sample TSA-1303

Gold grain in a small cavity.

Au : gold



Sample W-120

Small gold grain

Au : gold

Fig. 17 Results and photomicrographs of EPMA

Sample No. : 3148

Location : Vueltas del Rio Sector

No. 53-3 Depth 148m

Formation : Vueltas del Rio

Ore minerals : electrum, chalcopyrite, galena and pyrite

Mieroscopic observation :

In megascopically, pyrite and galena occur as wide band on the polished specimen.

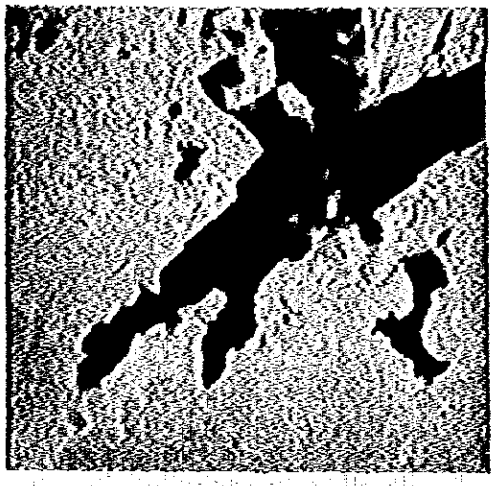
Under the microscope, it is mainly composed of pyrite, galena, sphalerite and chalcopyrite. Pyrite is most abundant on the polished surface and it is idiomorphic crystals, 400 to 100 microns in general size.

Galena is closely associated with aggregated masses of pyrite.

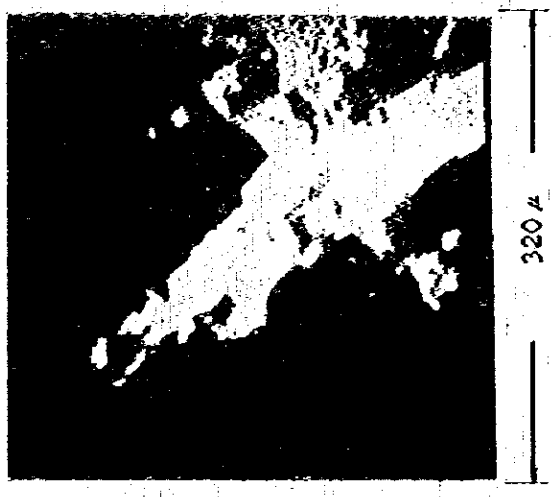
Sphalerite which mostly coexists with galena contains many small drops of chalcopyrite.

A small amount of bright yellow grains like native gold is observed, and it coexists with only galena in this specimen. It was determined by E.P.M.A. that these bright yellow grains were electrum, about Au 60%.

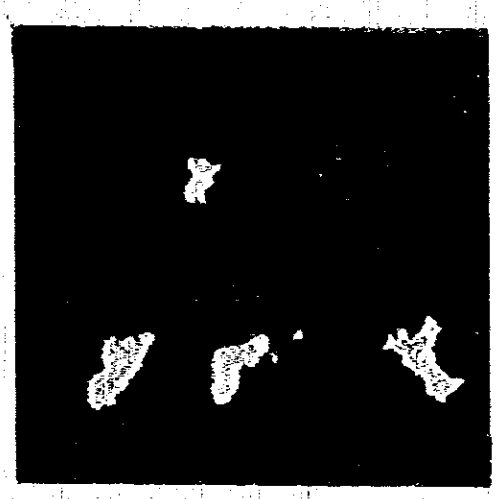
In reflecting color, electrum shows brighter yellowish tint than chalcopyrite and occurs as rounded and stretched shape crystals of 200 to 50 microns in size.



Absorbed electron image



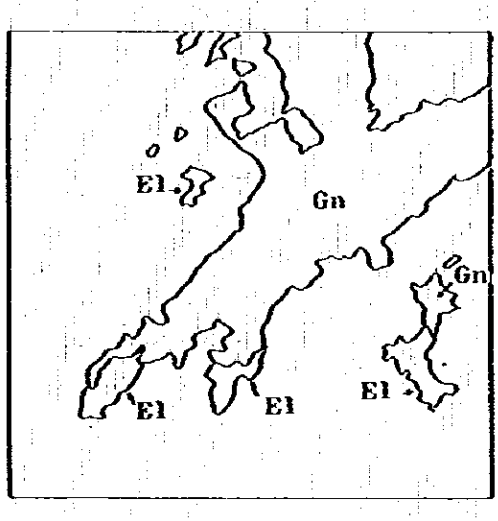
Pb X-ray image



Au X-ray image

Ag X-ray image

El: electrum
Gn: galena



Sample No. 3148
Accelerating voltage: 25KV
Absorbed electron current: 0.2μA
Magnification: X300

Chapter 5 Laguna Seca Sector

5-1 Detailed Geological Survey

This sector occupies an area of about 4 km^2, 2 km in north and south and 2.5 km in east and west, and comprises sheer hilly land of the altitude of 300 m to 550 m above sea level. The land is utilized as pasture with the vegetation of pine trees and other miscellaneous trees. In this area, as the high anomalies of copper, lead and zinc were detected by the geochemical survey along the Chamelecon fault, detailed geological survey accompanied by trenching has been carried out in the second phase to confirm the features of mineralization in relation to the geology.

5-1-1 Geology (Refer to Pl. III-1-2, III-1-6)

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

(1) Crystalline schists

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

easily. Fine drag folds are observed and weathering is recognized by the argillization.

(2) Vueltas del Rio Formation

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

(3) Atima Limestone beds

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

(4) Liparite

The liparite is grey compact dyke rock with the width of approximately

100 meters developed along the Chamelecon fault. Sometimes it is dark green in color and phenocrysts of mica can be observed, but phenocrysts of feldspar are very rare in this rock.

(5) Andesite

The andesite is black colored compact basaltic pyroxene andesite. Five dykes have been observed intruding the Atima Formation and the metamorphosed andesites, in the direction of northeast and southwest.

5-2 Geological Structure

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

5-3 Mineralization

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

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

Chapter 6 Zapotal III Sector

6-1 Detailed Geological Survey

6-1-1 Outline .

Located at about 3 km south-south-east of Chiquila village, this sector occupies an area of 0.8 km (N-S) by 2.0 km (E-W), corresponding to Zapotal III and a part of El Coyol, defined by UNDP survey. There is an access way to reach the suspension bridge on Chamelecon River, along a new bulldozed road after taking an existing road from Chiquila to Ojo de Agua. Other than the above, access is nothing but by small lanes. This detailed survey sector comprises relatively gentle slope toward north, which is cultivated with maiz and trigo, and rock exposure is very poor.

The easterly flowing Chamelecon River changes the direction to northward along the western limit of the block, where steep cliffs are formed facing west with abundant large rolling-stones of limestone. The northeastern part of the block is underlain by Vueltas del Rio Formation composed of metamorphosed volcanitic pyroclastics, but by the intense weathering it is difficult to give entire picture of this part except for the evidence of silicification with bleaching alteration.

Bounded by fault with Vueltas del Rio Formation, Cantarranas Formation is distributed extending east-west in an area 500 m long and 250 m wide at the south of Zapotal Village. The Cantarranas Formation is composed of well-bedded limestone, shale and sandstone. In the southern part of the sector, massive limestone of Atima Formation is distributed. Intrusive bodies of quartz-diorite porphyry and andesite are there extending east-west between Atima Formation and Cantarranas Formation. UNDP carried out trenching at 16 localities in addition to geochemical and geophysical exploration, but no marked indications were found in this sector.

Through the present survey, copper-mineralization has been found in a quartz vein contained in quartz-diorite porphyry on the slope at the southside of Zapotal village.

6-1-2 Igneous Rock and Alteration

Diabase; Intruding Vueltas del Rio Formation as dykes, the diabase is pale green to green fine-grained hollocrystalline rock partly with porphyritic texture. Fresh specimen shows character of hard compact rock, while pale green to pale brown fragile properties as phyllitic rock are observed with onion-structure where weathered. Fine feldspar and pyroxene with some hornblende are the main constituent minerals. The dykes are several meters to several ten meters in thickness, mostly extending east-west.

Andesite; Distributed in east-west in the southwestern part of the block. The largest width so far observed is 250 m. The rock shows fine-grained porphyritic texture, with the phenocrysts of argillized yellowish brown feldspar. Contamination of hematite is notable, which is thought to tiled brown color where weathered.

Quartz-dioritic porphyry; In the western area of the sector, the rock develops with width of up to 500 m, extending about 1.5 km. The quartz-diorite porphyry shows white, fine to medium-grained porphyritic texture, with phenocrysts mainly of feldspar of 1 to 2 m/m and small amount of quartz. Intensely silicified, the texture often disappears through the replacement of minerals by quartz and sericite. Local pyritizations are observed, but mostly they are limonitized.

Diorite; Distributed in the west beyond the limit of the sector, the diorite is bounded by a NNE-SSW fault. The diorite is green fine-grained hollocrystalline rock with occasional porphyritic texture, bearing hornblende, pyroxene, plagioclase and small amount of quartz.

Among the above igneous rocks, quartz-dioritic porphyry is intensely silicified and associated with mineralization, but any mineralization or alteration is observed in the neighbouring limestones affected by this porphyry. The rocks of the Vueltas del Rio Formation, distributed in the northeastern side of the NW-SE fault, are intensely silicified as a whole. But, little silicification is recognized in the rocks of Cantarranas Formation at the south of Zapotal village. It is recognized that diabase is weakly silicified locally.

6-1-3 Mineral Indications

The copper-indications found in the present survey are at three adjacent localities.

A) Fissure-filling quartz vein in quartz-dioritic porphyry.
(at the point of 430 m above sea level)

B) Same as above. (at the point of 410 m above sea level)

C) Same as above. (at the west side of A.)

Irregularly gathered copper minerals such as malachite, azurite and chalcopyrite are observed with pyrite and limonite.

	Location	Au g/t	Ag g/t	Cu %	Pb %	Zn %	S %
A)	1681.73m -- 331.02 m	0.1	nil	4.08	0.02	0.78	-
B)	1681.83m -- 331.00 m	0.5	33	2.16	0.01	0.74	0.05

The trend of B in the outcrop is N80°W with the dip of 80°S.

C) is located at the west side of A) and has revealed the assay result of Au: 0.1 g/t Ag: nil Pb: 0.30% and Zn: 0.14%.

Skarnization is not observed. The yellowish brown mineral like garnet has been determined as the contaminated product of oxidized iron minerals in calcites.

6-1-4 Comparison with UNDP Survey Results

In Zapotal III of the area of 0.9 km^2 defined by UNDP, 679 soil samples

were collected and intense Zn anomaly and moderate to weak Cu, Pb anomalies were detected. Also, the geophysical exploration by Turam method has revealed strong anomalies in the southwestern part and in the southeastern part. In the geochemical anomalies, pitting at two localities and trenching at 16 localities totalling 372.5 m were carried out and the assay results of Cu: 11.39% (Trench 1), Zn: 25.8% (Trench 4A) and Au: 17.7 g/t (Trench 4A) were obtained. Geochemically, intense Zn anomaly and weak anomalies of Au, Cu, Zn and Pb were detected in most of the sector, and secondary copper and zinc minerals with gold-silver mineralization are recognized in a zone extending 500 m.

6-2 Geophysical Survey (IP method)

6-2-1 Outline of the Survey (Refer to Fig. 12)

For the purpose to obtain informations on the possibility of emplacement of mineral resources around the anomalous area detected by the geochemical survey, geophysical survey by IP method was carried out in the period from June to August of 1977. Electrode configuration was dipole-dipole with the electrode-separation of 100 m, and the measurement was conducted to the electrode separation factor N=4. The approximate subject area was 3.3 km^2, with 9 survey lines and with the line-spacing of 200 to 300 m. The total length of the survey lines was 13.4 km. The survey lines were composed of 8 lines in north and south, located from the westernmost part to the eastern part of the village of Zapotal and 1 line linking the above 8 lines in the direction of east and west.

6-2-2 Results of the Survey

Summarizing the information on the geological structure presumed from the indications of apparent resistivity, the followings can be said.

. The limestone belonging to the Yojoa Group shows moderate apparent resistivity and high resistivity, by the results of the measurement.

This limestone is thick along the survey lines in the central part and is thinner toward both sides.

. Metamorphosed tuffs, sandstone and shale belonging to the Vueltas del Rio Formation reveal low apparent resistivity.

Also, the geological structure presumed from the FE anomalies is follows:

. FE anomalies of 2% to 5% are detected near the contact zone between the quartz dioritic porphyry and the limestone of Atima Formation. They are in good correspondence with fault zone in the direction of north and south. The indications coincide with the geochemical anomalies, and it is thought that they would have been caused by the alteration and the dissemination of sulphide minerals, but viewing from the indications, it is presumed that there would be no large response body there.

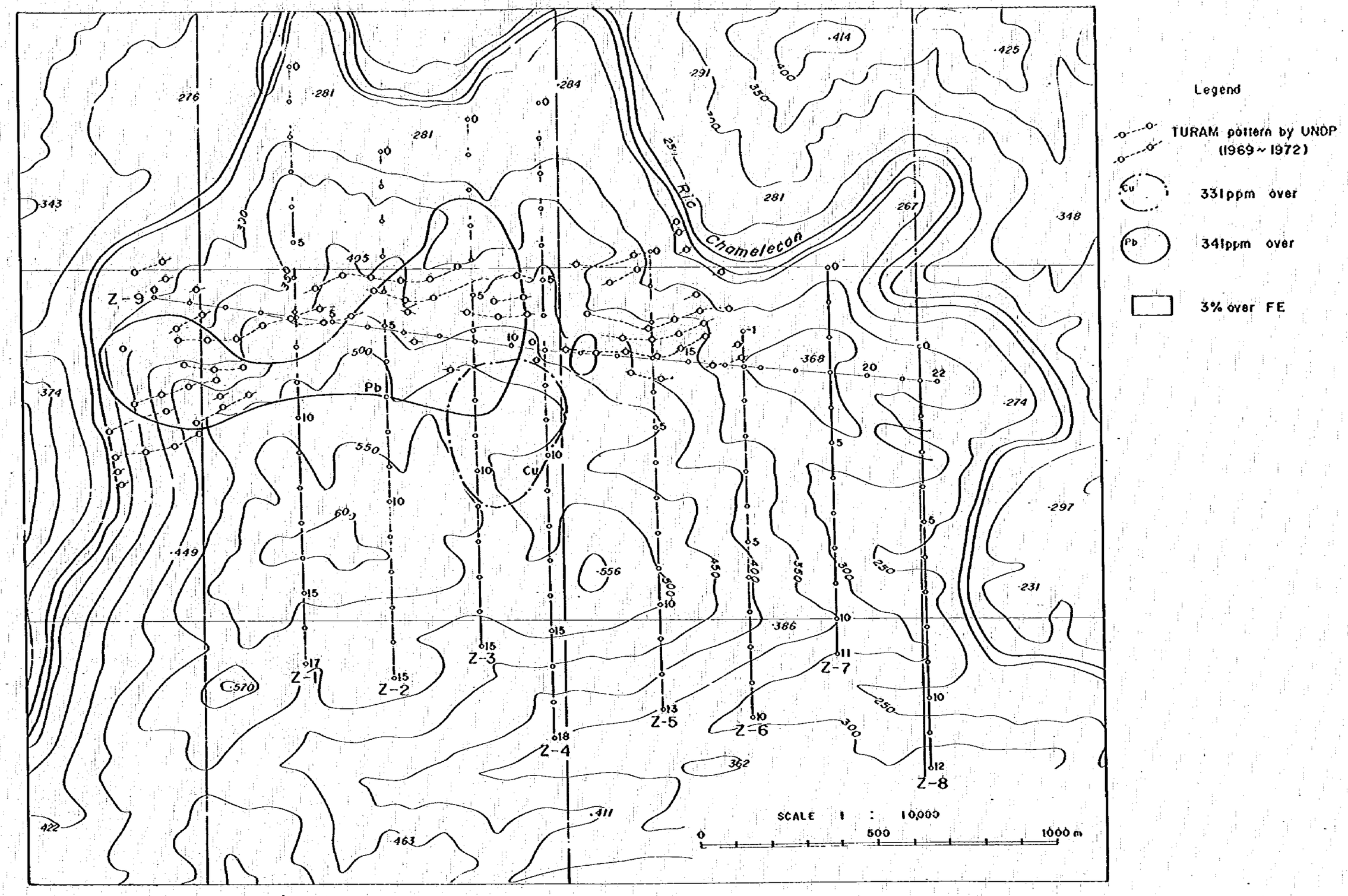
6-3 Summary of the Sector

In the survey area, metamorphosed pyroclastic rocks of the Vueltas del Rio Formation are distributed in the northern part but southward from there, while in the western part and in the southern part calcareous shale beds of Cantarranas Formation and massive limestones of Atima Formation are distributed. In the middle of them, intrusions of quartz dioritic porphyry and andesite are recognized. Indications of copper mineralization are found along the contact zone between limestone and the above igneous rocks, but they are small-scaled and alteration are weak there.

Local FE anomalies detected by the IP survey are roughly in correspondence with geochemical anomalies and with electro-magnetic anomalies detected by UNDP. However, scale and figures of the response bodies are not clearly drawn by these anomalies. Even if there would be some response bodies below

surface, it is thought that they might be very small. Therefore, the possibility of emplacement of considerable-scaled sulphide orebodies is thought to be small.

Fig. 12 Structural Pattern with Geochemical and I P Anomalies in The Zapotal III Sector



Chapter 7 Minitas Sector

7-1 Outline of the Area

This area was selected as a favorable area warranting further detailed investigation in the Petoa area, by the first year's surveys. The area is located about 1 km south of La Arada and occupies an area of 65 km^2, about 10 km in east and west and about 7 km in north and south. This area is accessible from La Arada to Pueblo Nuevo by vehicles in the distance of 6 km along the unpaved main national way running to Santa Barbara, the capital of the state. There is another access road from the national way directly to Minitas, through San Francisto del Valles. These roads are not completely maintenanced and the access is difficult in the rainy season.

The area is situated in a sheer mountainous land of the altitude of 130 m to over 900 m above sea level, with the relative height reaching 150 to 500 m. Water system of east-west or northeast-southwest is prevalent, and talus and terrace are developed in many places. The area is covered with forest of pine trees and other miscellaneous woods, utilized as pastures and coffee gardens. By the geochemical survey, geological survey, geophysical prospecting (Turam method) and diamond drilling carried out in the past by UNDP, copper and iron orebodies were found in skarnized portion in the Hacutalo area, while indications of skarn type mineralization in addition to many geochemical anomalies were discovered in the Minitas area.

In the first year, detailed geological survey, geochemical survey, geophysical survey (IP method) and diamond drilling of 2 holes of the total length of 623.3 m were carried out and the possibility was confirmed as to emplacement of contact replacement ore deposits and ore vein type mineralization. In the second year, detailed geological survey accompanying trenching and diamond drilling of 3 holes of total length of 901.8 m were

carried out in the extracted area of about 5 km^2, 3 km in east-west and 1 to 2 km in north-south.

7-2 Geology (Refer to PL. III-I-3, III-I-7)

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

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

(1) Minitas Formation

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

a) Metamorphosed andesite and andesitic pyroclastic rocks: Dark to greenish black, brownish black and greyish purple in color, the rocks are hard and with phenocrysts of feldspar and mafic minerals replaced by chlorite. The size of the phenocrysts varies from as coarse as several mm to fine grained, and the texture is porphyritic. The pyroclastic rocks have fragments or phenocrysts of feldspar, and irregular variation of the sizes of the constituent minerals is remarkable from fine grain to coarse grain. Sometimes the rocks contain essential breccias 1 to 5 cm in diameter. Generally, they are silicified and chloritized by regional

metamorphism and by mylonitization. Also, partly they are epidotized and calcitized and on the surface they are argillized by weathering. Due to these alterations, the determination of lithofacies of the rocks on the surface is extremely difficult.

b) Granodiorite: Distributed in the northern part of the survey area, the granodiorite is observed to have intruded the above-mentioned metamorphosed andesites, but is overlain unconformably by the Atima limestone beds. The granodiorite shows very complicated shape and form. The rock is grey to greenish grey, coarse grained and hollocrystalline. Reaction rim has not been found, but occurrence of some epidote has been recognized in places along the margin of the intrusive body. Along the marginal part, the rock constitutes abundant dykes. Partly schistosity develops. On the surface, it is recognized that the weathering decompose this rock to produce sands. Under microscope, granular texture is observed which is composed of quartz, potash-feldspar and plagioclase, though chloritized epidotized.

(2) Atima limestone beds

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

(3) Matagalpa Formation

Part of the volcanic rocks and pyroclastic rocks developed over the highland area in the southern part of this sector has been found to cover the Atima Formation etc. The period of their extrusion is thought to have been Tertiary Oligocene to Miocene Epoch. Upwards from the lower-

most, basalt, andesite and tuffs are developed. The basalt is dark grey to black hard cryptocrystalline rock showing porphyritic texture, bearing plagioclase, olivine, magnetite and pyroxene. The andesite is dark green, brown and reddish purple in color and has structure of autobrecciation. The tuffs are composed mainly of andesitic breccias, lappilli tuff and acidic tuff, but in places with welded tuff.

(4) Igneous Activity

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

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

b) Diorite porphyry: As a dyke, trending northwest-southeast, this diorite porphyry has been found to be distributed in the central part of this survey area. This rock is composed of phenocrysts of feldspar and microcrystalline groundmass. The intrusion of this rock into the Atima limestones has been observed. The rock is altered heavily by weathering.

c) Andesite: As dykes of the width of several ten meters, in the direction of northwest-southeast, the andesite is distributed in the eastern

part of this survey area. It is dark green to dark brown compact rock.

(5) Geological Structure

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

(6) Geological History

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

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

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

7-3 Comparison with UNDP Survey Results (Refer to Fig. 13)

(1) Petoa I

The block of Petoa I occupies an area of 0.38 km^2 located 2.5 km west of Petoa village. The block is along the contact zone of diorite and limestones. The contact zone extends ENE-WSW. The result of the geochemical exploration by the analysis of 99 soil samples is not encouraging. By the results of geophysical exploration by magnetic survey and by Turam method, E-W direction has been emphasized, along the contact zone and in the central part of the block. In the south of the block, there is an old exploration for iron, the extension of which is 10 m x 2 m in diorite. It is ore vein composed of hematite mass bearing gold. The ore vein contains chalcopyrite and malachite and, as mentioned above, ore grade is Fe 55.2%.

(2) Petoa II

This is a block of 0.16 km^2 about 1 km south of Petoa village. The block is underlain by diorite and limestone. The geochemical exploration was carried out by collecting 40 soil samples. The geophysical exploration was by magnetic survey and by Turam method, and magnetic high anomaly appeared around the old shaft. The iron ore vein in diorite is situated in the anomaly. This ore vein, containing malachite and azurite, is vertical and extends over 6 m to N 50°E, with the width of 2 m. Assay result is Cu 2.24%.

(3) Petoa III

Petoa III is a block of 1.15 km^2 adjoining to the northwest of Petoa village. The block is occupied by diorite, granodiorite, andesite and limestone, and includes a fault of NW-SE trend. Geochemically, 210 soil samples were analyzed. Geophysical exploration by magnetic survey and by Turam method was carried out. However, no noteworthy anomaly has been detected. No new indication has been found through the present survey.

(4) Petoa IV

This is a block of 0.93 km^2 adjoining to the northwest of Pueblo Nuevo village. The block is underlain by diorite which contains lenticular limestones. Assay result of 281 soil samples has shown a few weak anomalies, and the results of magnetic survey and Turam method survey has revealed an indication of an ENE-WSW fault. Pyrite-dissemination has been recorded in the northeastern part of the block.

(5) Minitas Norte

This is a block of 0.36 km^2 about 1 km northeast of Minitas village. The block is occupied by granodiorite, diorite and limestone, and a fault of NW-SE trend is included in this area. Geochemical copper-anomaly has been detected along the fault, by the assay of 179 soil samples. The results by magnetic survey and by Turam method are agreeable with the fault and the copper indications. But what was caught by a drill hole was pyrite dissemination only. Copper ore sample, collected as rollingstone in this survey, contains chalcopyrite, chalcocite, malachite and cuprite and the result of analysis shows the grade of Cu 10.11%.

(6) Mal Paso

Located at the southwest of Minitas village, this is a block of 0.48 km^2 where limestone and diorite are distributed. Yellowish brown silicified rock is observed, and rollingstones of basalt are found in this block.

Trend of limestone is E-W or NE-SW. By the result of geochemical exploration by 341 soil samples, copper anomalies are recognized trending east-west in the central part and in the eastern part of the area. They are thought to be extending to Minitas block. The geophysical exploration by Turam method was carried out by 259 survey points and caught a strong anomaly extending east-west to Minitas block.

(7) Minitas Block

UNDP carried out geochemical exploration by 1,660 soil samples in an area of 2.0 km^2. Cu-anomalies are distributed in east-west, in which eastern part is more anomalous. Zn-anomalies are accompanying to the Cu-anomalies, but more anomalous in the west. Pb is anomalous in the north-western part. The results of Turam survey of the 1,307 survey points show distinct trend of east-west with north-dip, indicating rock boundary. By the magnetic survey high anomalies are observed in volcanic rocks, partly in diorite. The results of EM or SP surveys are obscure. Pittings were employed in the geochemical anomalies, and the result shows that metal contents are higher at the depth. Drilling has revealed the following results; in DDH-13, ore of 2.84 m with the Cu grade of 0.99% in the skarnized zone of the width of 32.48 m; in DDH-14, ore of 1.80 m with Cu grade of 0.55% in the skarnized zone of the width of 2.30 m; and in DDH-15, Cu ore of 1.02% is found in the core of 0.80 m length. Conclusively, UNDP recommended the exploration by drilling in the anomalous zone along the boundary between limestone and diorite, as skarnized copper and iron minerals are seen extending east-west. Through the present survey, several copper and iron indications are confirmed around the top of the Minitas hill, extending east-west. Geologic-structurally and geochemically the results by UNDP surveys have been confirmed and it becomes distinct that the sector is quite favorable for the mineralization.

Therefore, it is desirable to keep carrying out further exploration works by drilling, trenching and geophysically by IP method, to investigate the potentiality of emplacement of sulphide ore deposits in the sector.

8) Macutalo Block

Drilling and trenching in addition to geochemical exploration and geophysical exploration by Turam method, by magnetic survey and by EM method, were carried out in an area of 0.32 km^2 by UNDP. Geochemically, by 512 soil samples, were detected two Cu-anomalies, where the causes of these anomalies were recognized to be mineralized area and iron-coverings on diorite, by way of trenching. Also, a zone extending NE-SW with the width of 120 m was caught by Turam method. By the drilling of 5 holes totalling 483.9 m, a skarnized zone 60 m wide was confirmed and the following assay results were obtained;

DDH-3: Cu-grade of 0.54 % along 22.1 m.

DDH-6: Cu-grade of 0.31 % along 13.4 m.

DDH-5: Cu-grade of 0.24 % along 13.1 m.

The skarnized zone is shallow in the east, plunging toward west. It contains abundant hematite and magnetite, and the assay result gives Fe 46.1 %. UNDP recommended the investigation for the extension of this skarnized zone. Considering that this is the outcrop of the mineralization which has been most distinctly outlined in the present survey, and that it contains parts of high grade Cu up to 2 %, it is expected that the confirmation of the existence of ore deposits in this zone would be possible, and consequently further works by means of geophysical exploration and drilling are recommended.