Nos.11 and 12 interpreted to have 5.0 to 6.0% in FE. In addition an east dipping body (Block No.13) was assumed to be 100m in thickness, 1,300 Ohm-m in resistivity and 7.0% in FE. Since this body, which corresponds to anomaly 2, gives a indication related to the lineament in NNE-SSW direction, it may be a alteration zone associated with mineralization along a fault.

A west dipping high FE body related to the IP anomaly I is assumed between Blocks Nos.1 and 4. This anomaly may be induced by two anomalous bodies (Block Nos.4 and 14), which suggest argillization and silicification associated with mineralization. Block No.3 with 800 Ohm-m in resistivity and 3.3% in FE, which corresponds to the low resistivity anomaly A, is located in the west of the Block Nos.4 and 14. West dipping bodies (Block Nos.15 and 16) with 3,500 Ohm-m in resistivity and 9.0 to 10.0% in FE, which corresponds to a middle deep anomaly between stations 8 and 12 may be a silicificated zone associated with mineralization concealed.

2) Line C2 (Fig.II-3-20)

Although a distinctive IP anomaly is not detected, several weak IP anomalies are recognized, which corresponds to the Central mineralized zone.

Relatively high FE anomalies ranging from 3.8 to 4.5% in FE, which are higher than the background of FE (2.5 to 2.7%), are distributed at surface near stations 16, 20, 24 and 31. They are also corresponded to the Central mineralized zone.

3-2-5 Discussion

The IP anomalies are delineated based upon the results of simulation on Line C2 and C4, and with the same procedure the the geophysical structure of the other lines was interpreted quantitatively. Results combined are shown in Fig.II-3-21.

Summary of the results are as follows:

1) Combining these results with photo interpretation, lineament is inferred between the Lines C2 and C3 in the same direction. As a result of the geophysical survey, an electrical contrast between these lines are obious: namely, the south side of Line C3 shows low resistivity and high FE; on the contrary, the north side of Line C2 high resistivity and low FE. This lineament suggests, therefore, a existence of fault.

2) The FE values in the survey area are, as a whole, low in the northwestern and southwestern part and high in a stretched zone from the northeast toward southwest. This belt indicates strong mineralization here, for the known mineralized zones are distributed

within this belt.

3) IP anomaly source 1 in the simulations correspond to the West mineralized zone. As a result of the simulation analysis on Line C4, a west dipping body of 2,000 Ohm-m and 7.0% FE is assumed at the depths of stations 3 to 4. This body, consistent silicification with N-S in strike and 40° W in dip, is distributed at the center of the IP anomaly I (n=1). As West mineralized zone is exposed in a creeks only and surroundings are covered by the weathered soil, the extension of the mineralized zone is not clear. West mineralized zone is assumed, Nevertheless, to continue to the north and south because the IP anomaly source 1 extends to Line C3 and to Line C5.

4) The anomaly IP source 2 continues from Line C3 to Line C6 along with a lineament in a NNE-SSW direction between the central and the southern mineralized zone. This source, which is assigred a 1,300 Ohm-m and 7.0% FE, is thought to be indicative of alteration associated with mineralization.

5) According to the high resistivity anomaly R of the resistivity plan map of Fig.II-3-11, a blind IP anomaly source 3 with about 200m thickness is assumed to continue from Line C3 to Line C6 and extend and between the IP anomaly source 1 and 2.

The IP anomaly source 3 corresponds to the IP anomaly III which is interpreted through simulation analysis as a west dipping body with 3,500 Ohm-m and 9.0 to 10.0% FE. Since a mineralization is confirmed at 100m south of Line C5, the mineralization is suggested to continue further to the south and.

6) IP amomaly sources corresponding to the Central mineralized zone are inferred at one location on Line C1 and at three locations on Line C2. According to the simulation, these sources are assumed to have a high resistivity and 4.0% FE and not to extend at deep underground, but near the surface only. Also they may not continue to the south beyond the lineament of NW-Se direction.

7) An IP anomalous small body with a middle resistivity and middle FE is assumed to extends in the vicinity of station 31 on Line C2 and to corresponds to the Central mineralized zone C5. In addition, several small mineralizated zone are expected in the vicinities of station 30 on Line C1 and station 27 on Line C3.

In this area, IP anomaly II was detected where no mineral showing is confirmed geologically. Followings are the reason considered:

1) Mineralization type differs location to location;

2) Fewer mineralized outcrops which is recognizable geologically, because weathered soil covers the area widely and limits outcrops to be exposed along the creeks only.

IP method geophysical exploration is thought to be a suitable means for delineating mineralized zone or for detecting concealed mineralized zone under such a natural and geological condition.

IP anomaly sources were assumed correctly through simulation analysis, the reasons of which are as follows:

1) Weathering and alteration are only the factors to be taken into account for apparent resistivity, because of monotonous distribution of granodiorite in the geophysical survey area;

2) FE value reflects mineralization and varies in proportion to intensity (amounts of sulfide);

3) No EM coupling (electro-magnetic coupling) is recognized because country rock (granodiorite as host rock) shows high apparent resistivity.

Necessary topographical correction was carried out first, to eliminate influence on apparent resistivity: to make the value lower at the bottom of valley; and to make it up at the top of the hill. Some of the data after topographical correction are shown in Fig.II-3-22.

As clarified on the cross section of line C2 before correction, topography inclines in one-sided direction macroscopically while surface fluctuated microscopically. Therefore, contour lines of apparent resistivity are disturbed, especially between stations 12 and 26. Contrary, after correction those contour lines flow smoothly and the change of apparent resistivity gets moderate. Data of the other 5 lines are also corrected topographically and listed on Table A-7.

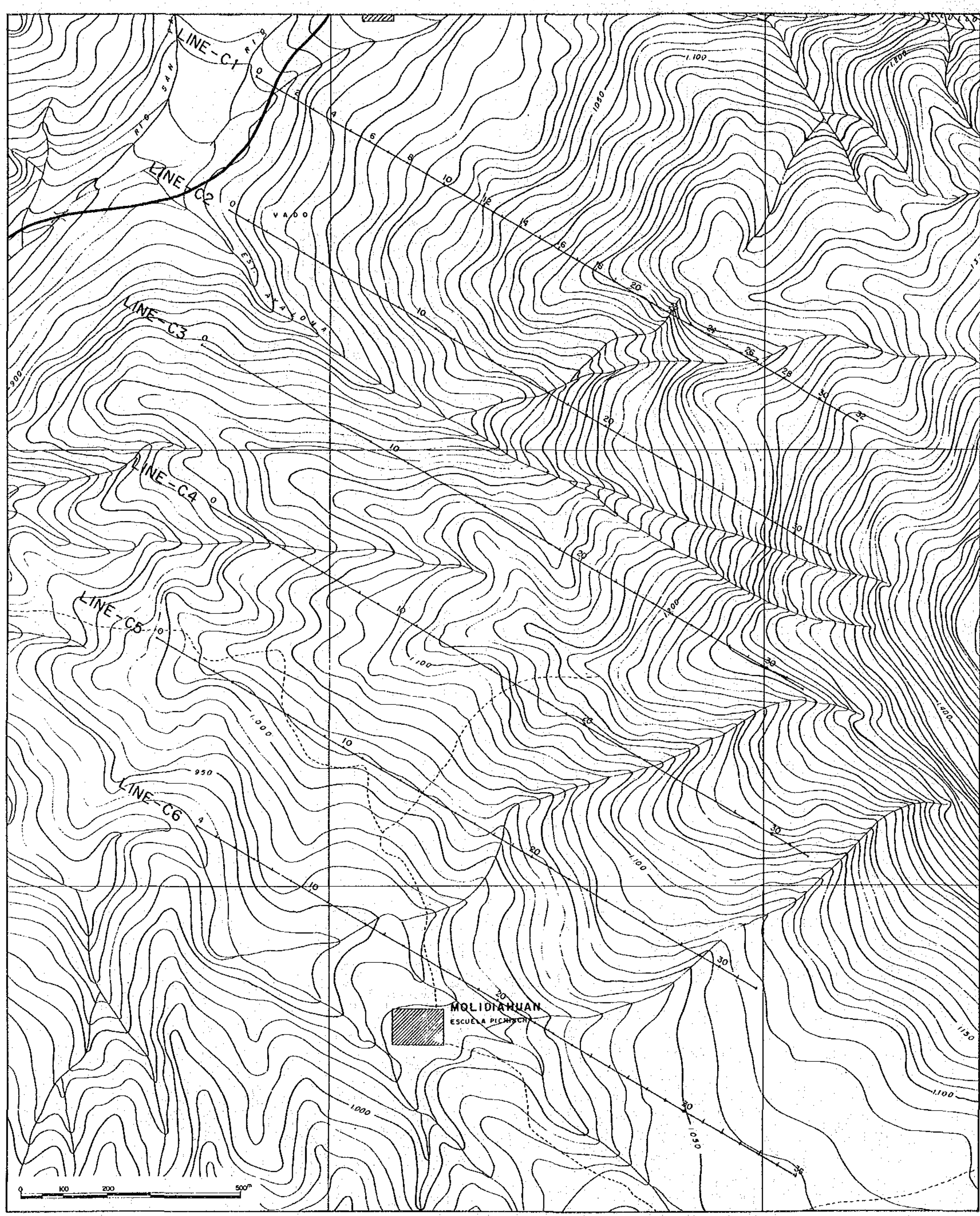


Fig. II–3–6 Location map of IP survey lines in the Chaso Juan area

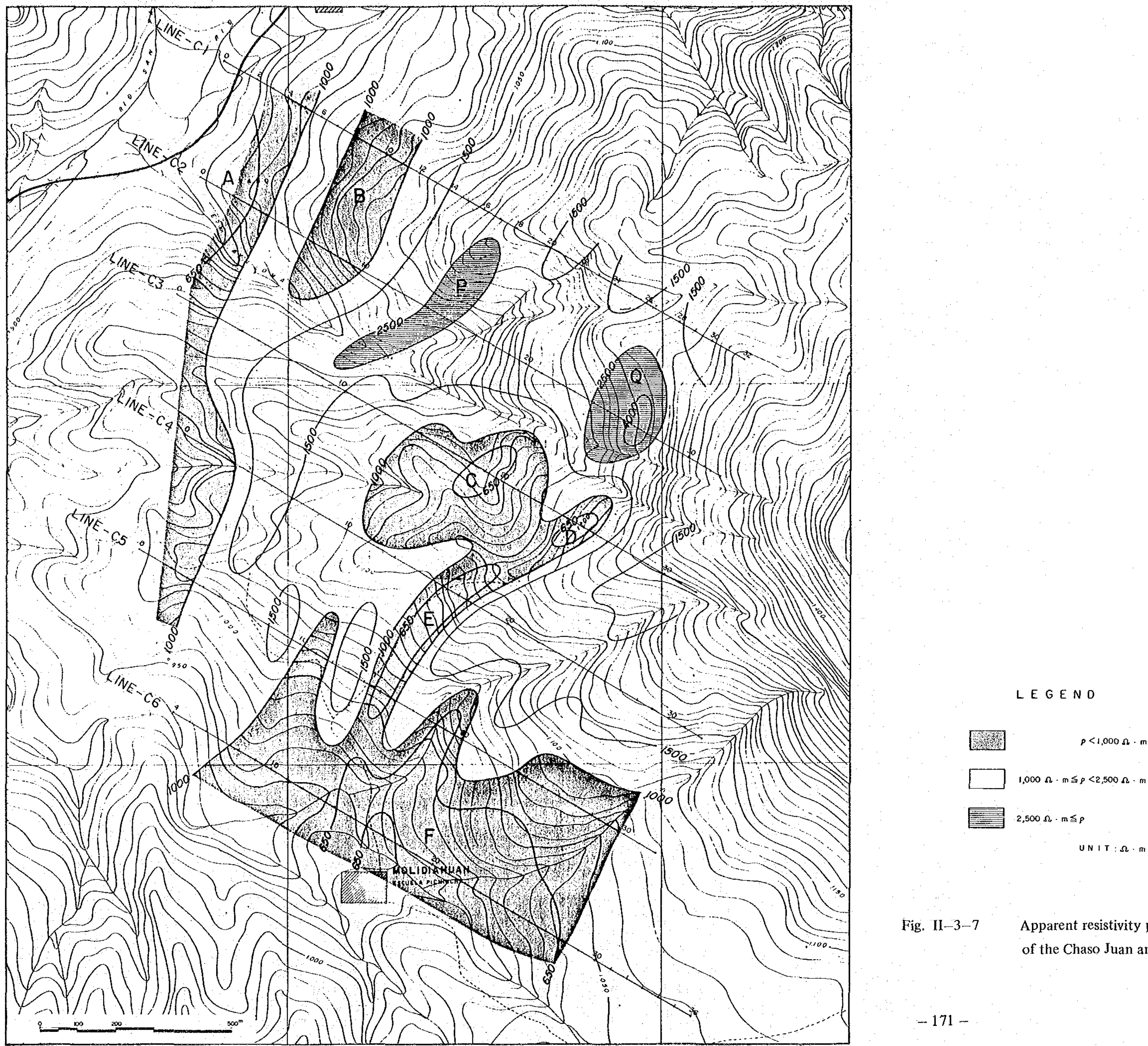
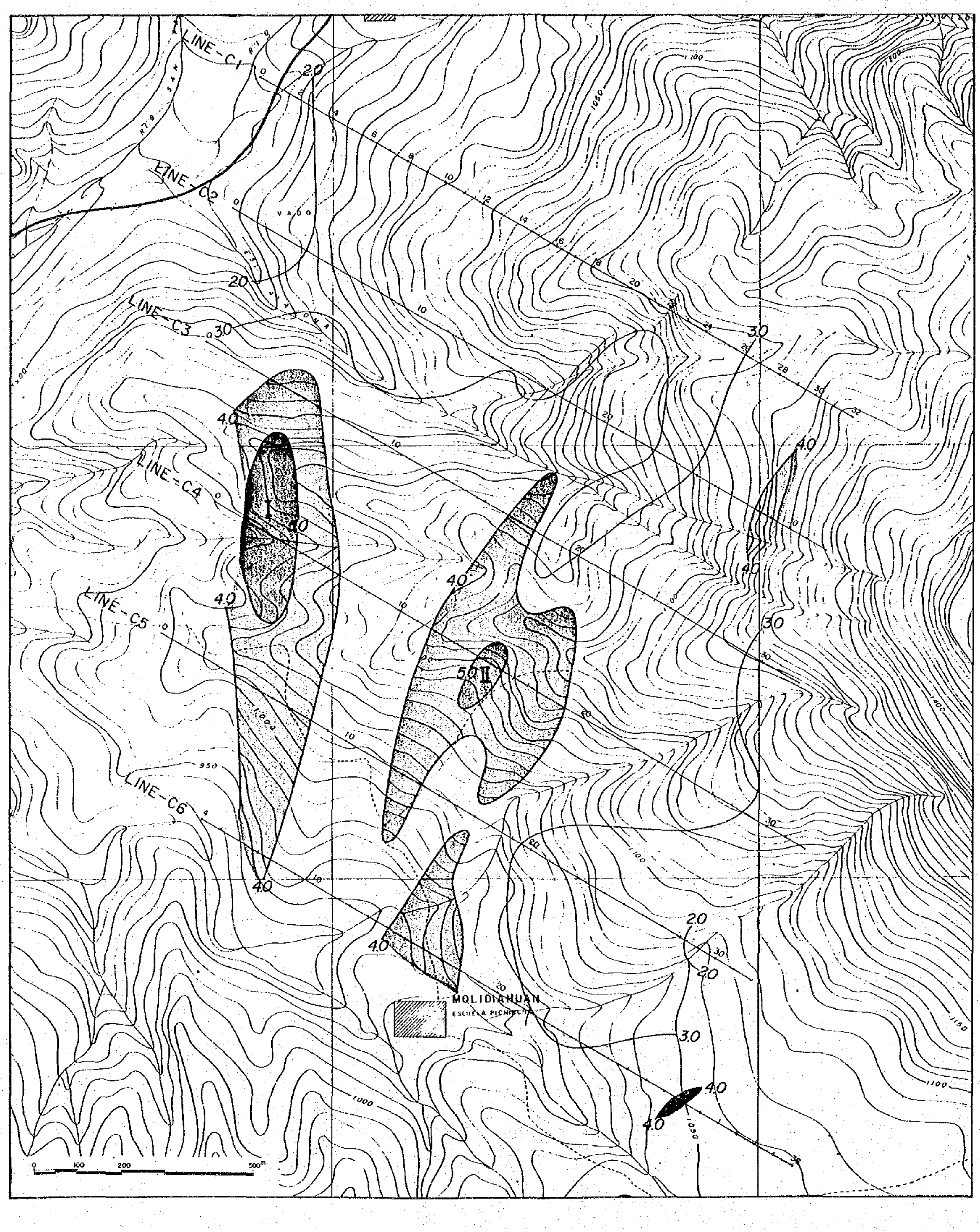


Fig. II–3–7 Apparent resistivity plan map (n=1) of the Chaso Juan area



LEGEND

5.0 %≦ ρ

4.0 %≦ ρ <5.0 %

ρ <4.0 %

UNIT : %

Fig. II–3–8 PFE plan map (n=1) of the Chaso Juan area

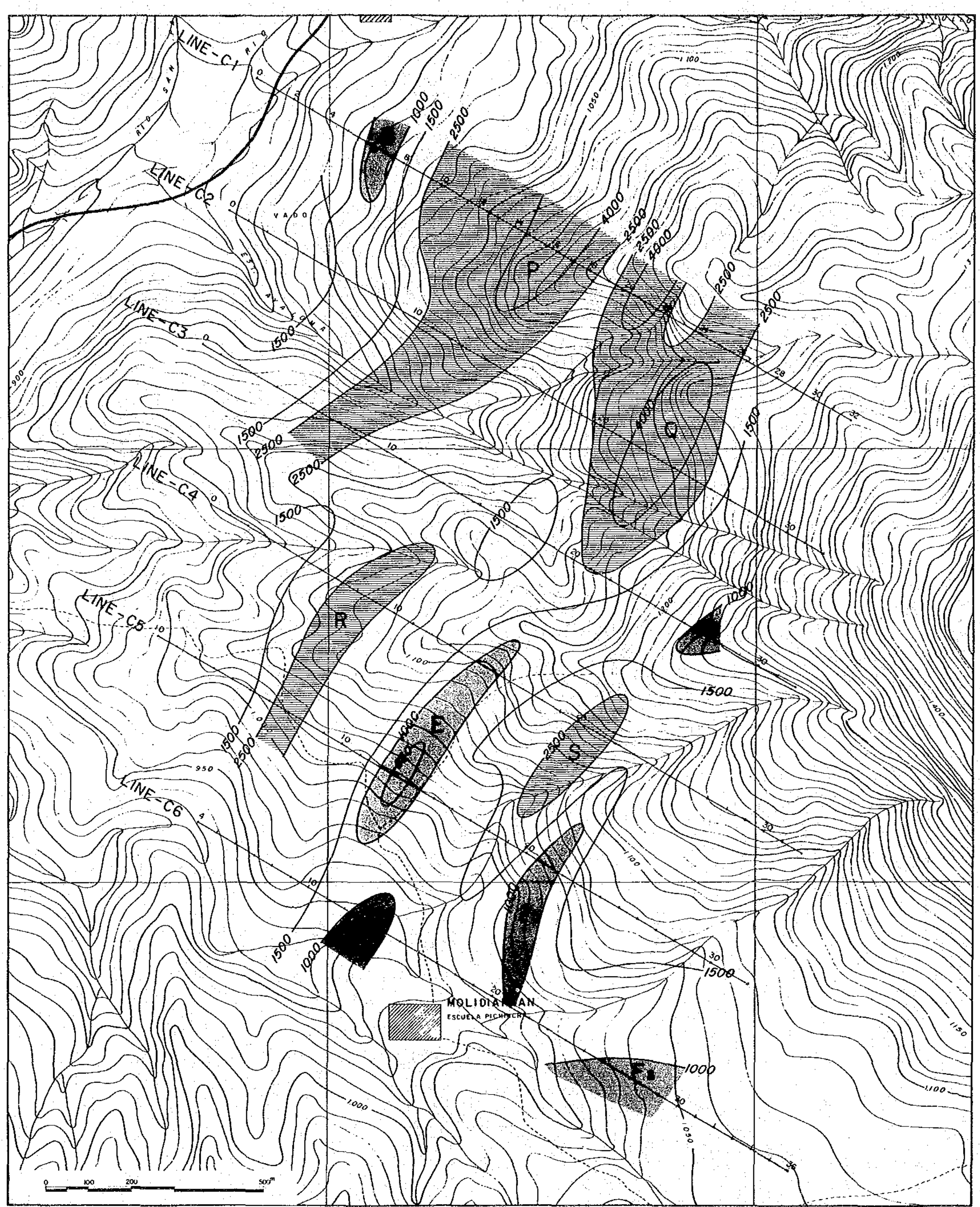
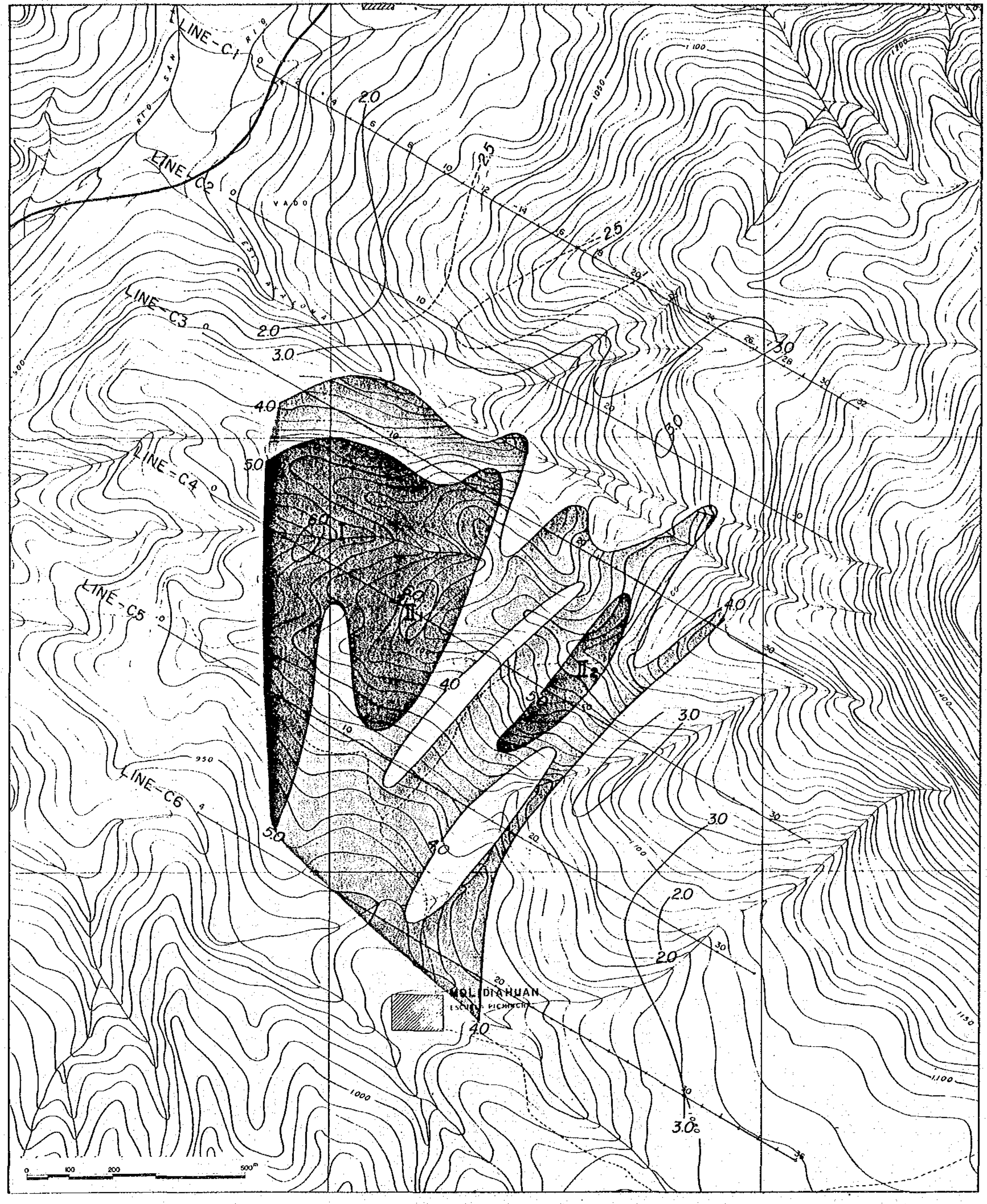


Fig. II–3–9 Apparent resistivity plan map (n=3) of the Chaso Juan area

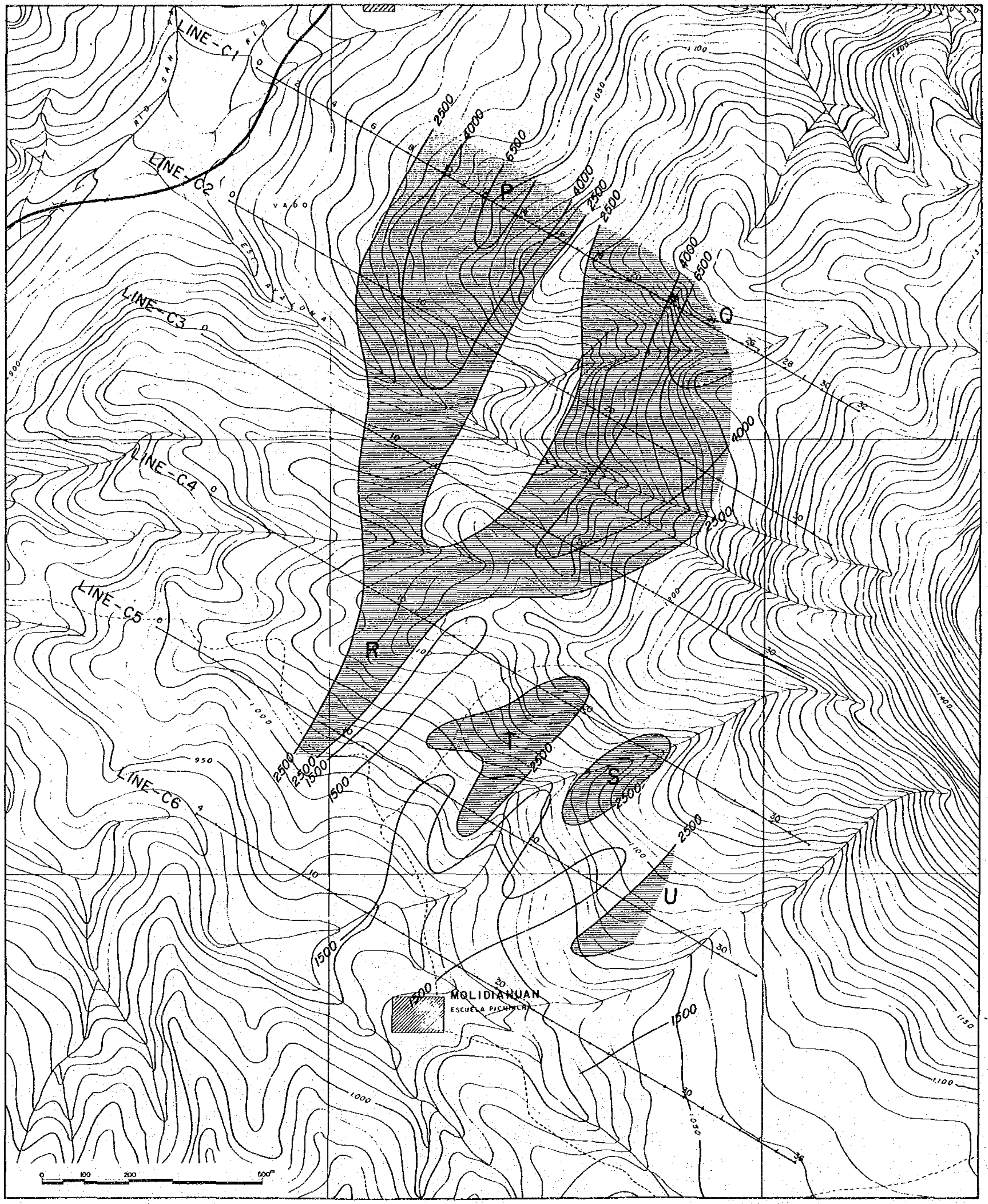


LEGEND

(dark)	5.0 %≦ ρ
(grey)	4.0 %≦ ρ<5.0 %
(white)	ρ<4.0 %

UNIT : %

Fig. II–3–10 PFE plan map (n=3) of the Chaso Juan area

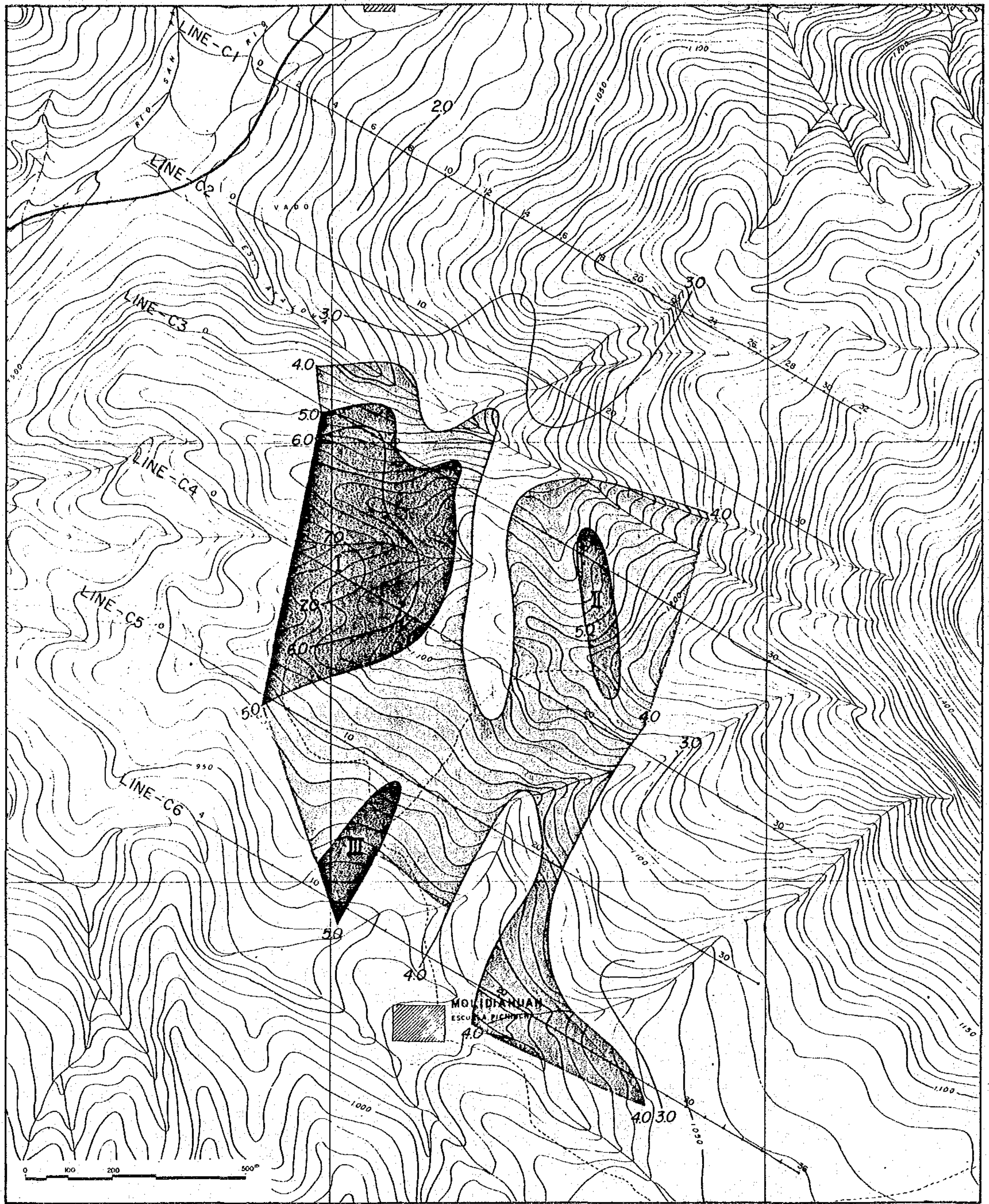


LEGEND

(dotted)	ρ < 1,000 Ω · m
(blank)	1,000 Ω · m ≦ ρ < 2,500 Ω · m
(hatched)	2,500 Ω · m ≦ ρ

UNIT : Ω · m

Fig. II–3–11 Apparent resistivity plan map (n=5) of the Chaso Juan area



LEGEND

5.0 % ≤ ρ

4.0 % ≤ ρ < 5.0 %

ρ < 4.0 %

UNIT : %

Fig. II–3–12 PFE plan map (n=5) of the Chaso Juan area

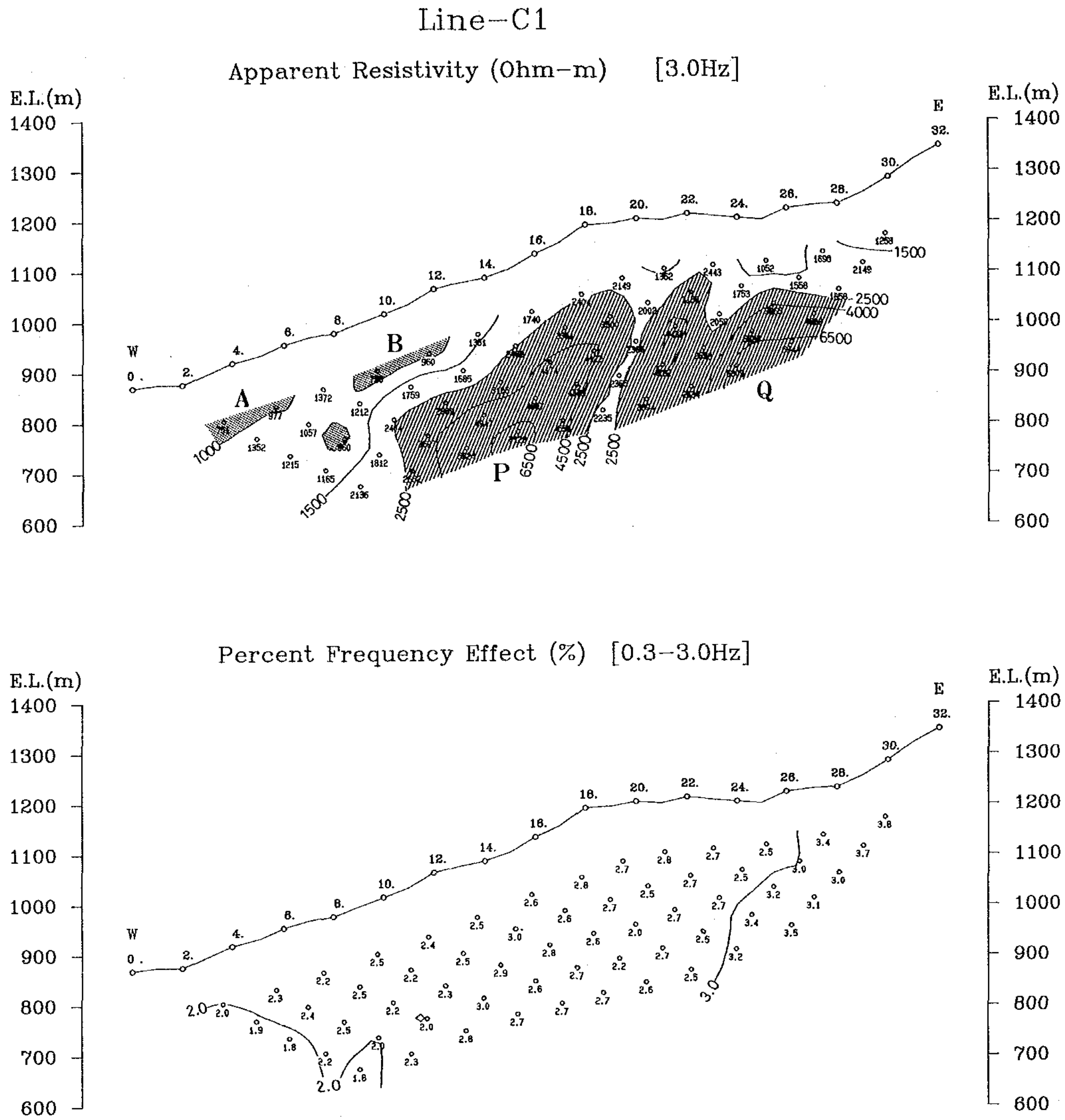


Fig. II-3-13 Pseudo-sections of apparent resistivity and PFE (line C1) of the Chaso Juan area

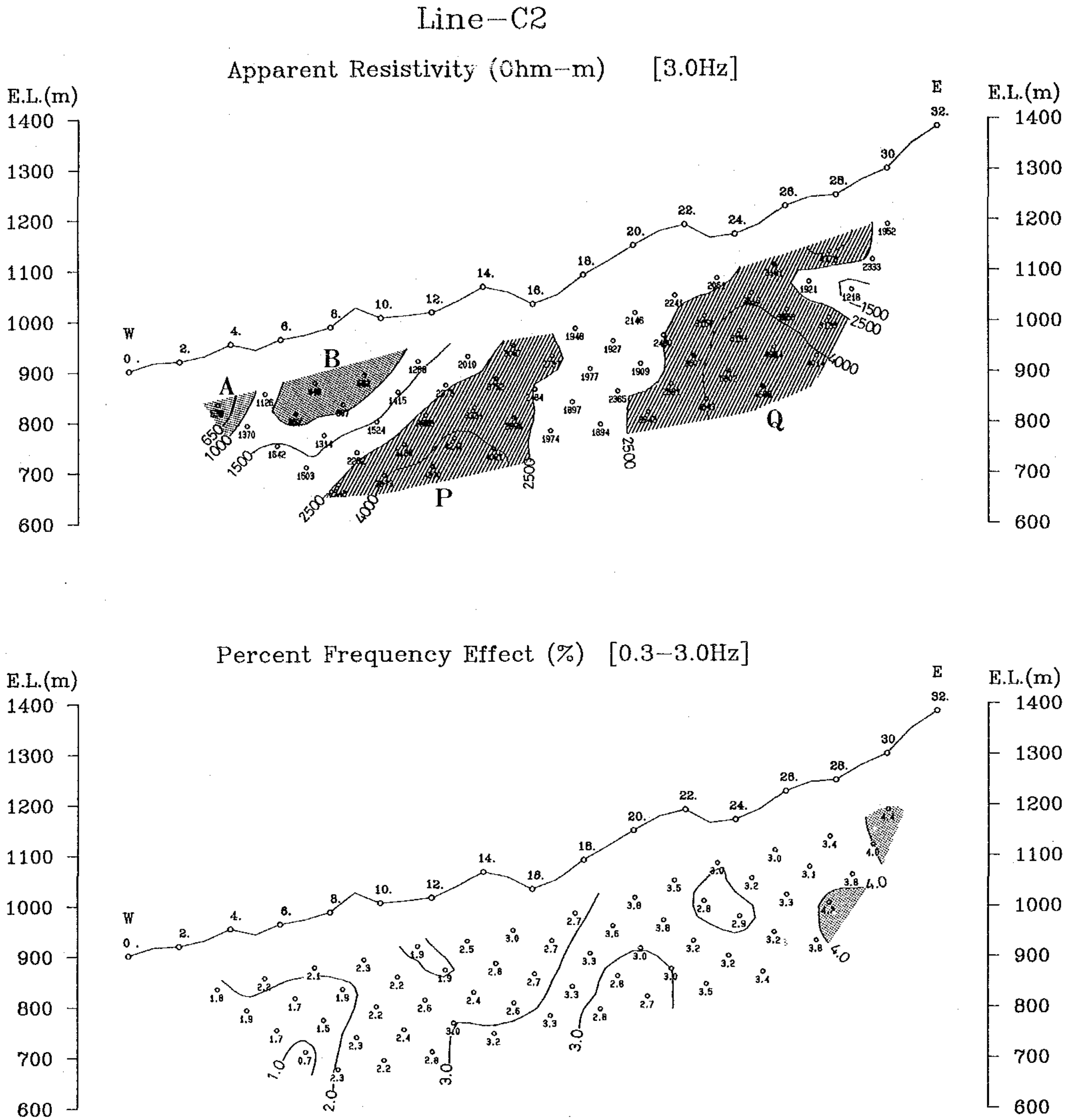


Fig. II-3-14 Pseudo-sections of apparent resistivity and PFE (line C2) of the Chaso Juan area

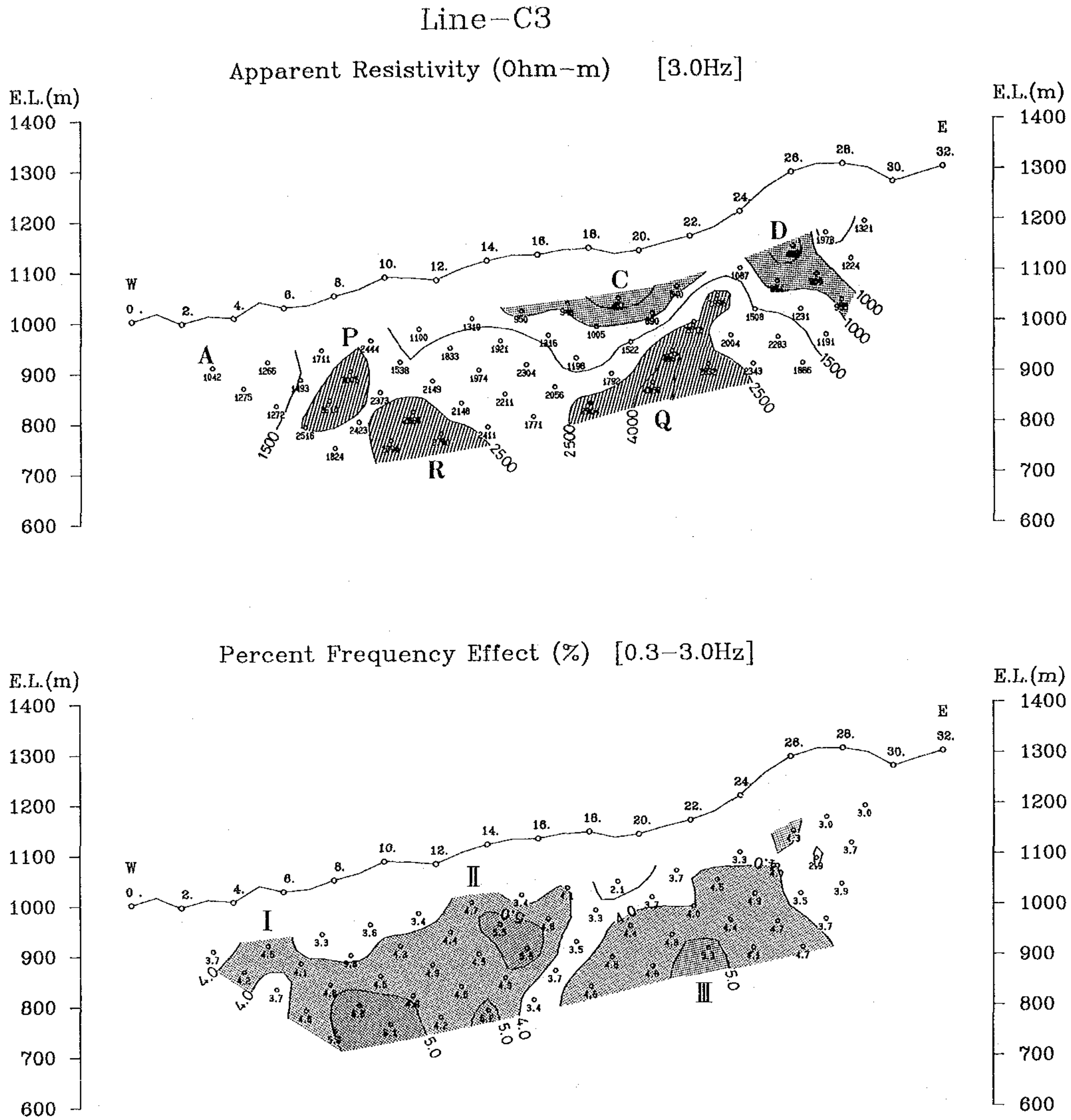
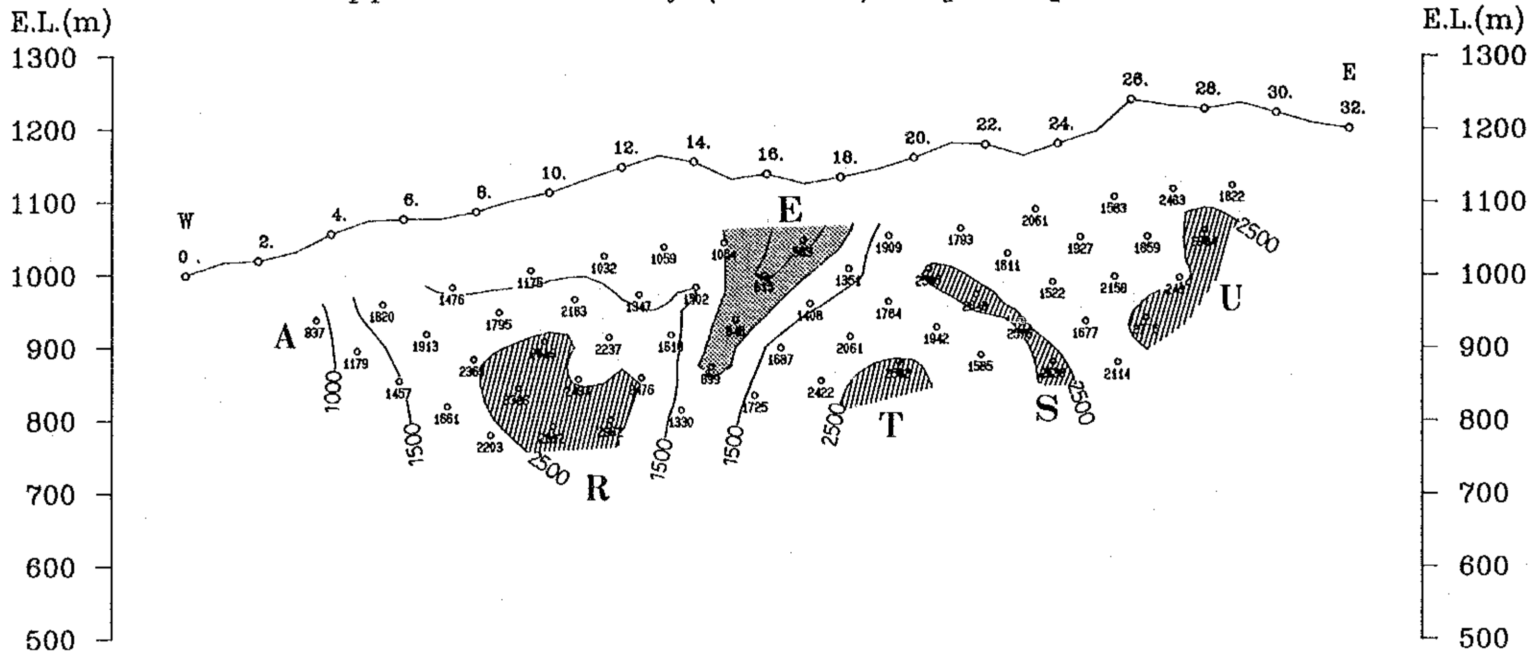


Fig. II–3–15 Pseudo-sections of apparent resistivity and PFE (line C3) of the Chaso Juan area

Line–C4

Apparent Resistivity (Ohm–m) [3.0Hz]



Percent Frequency Effect (%) [0.3–3.0Hz]

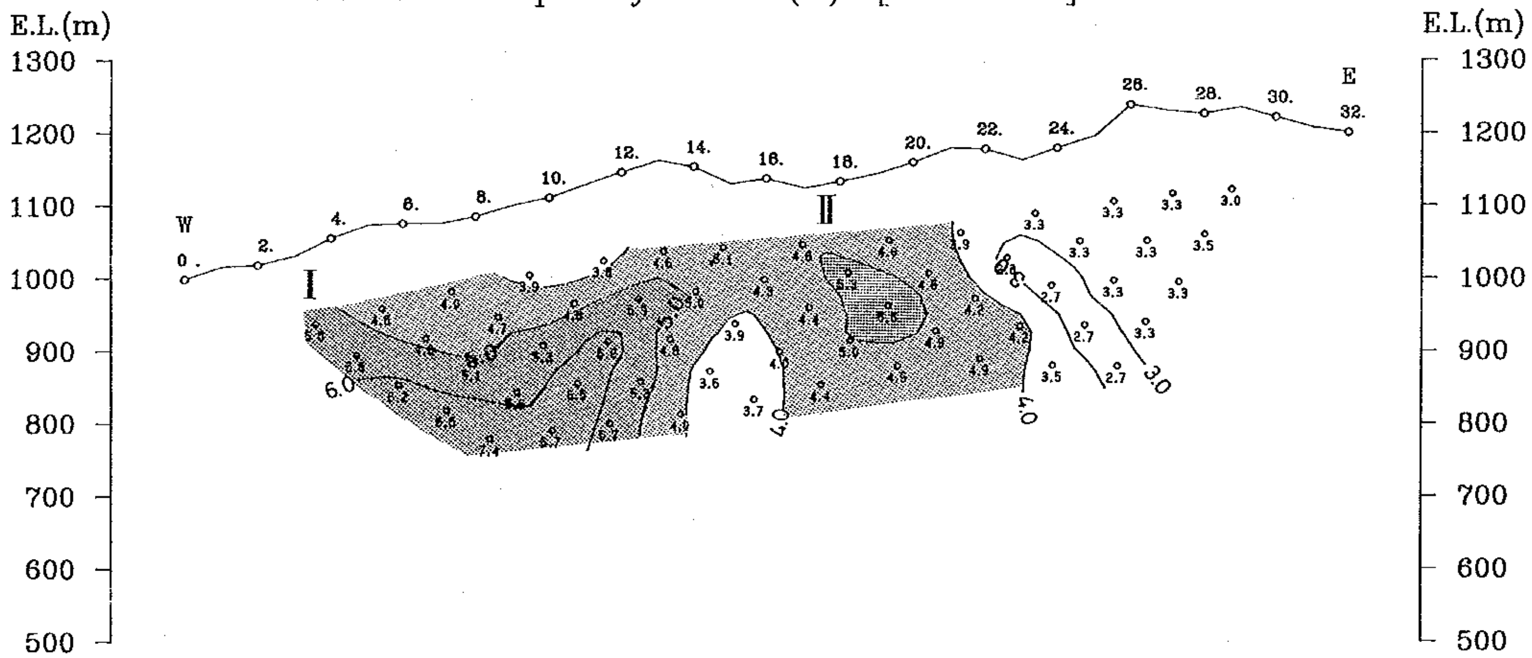
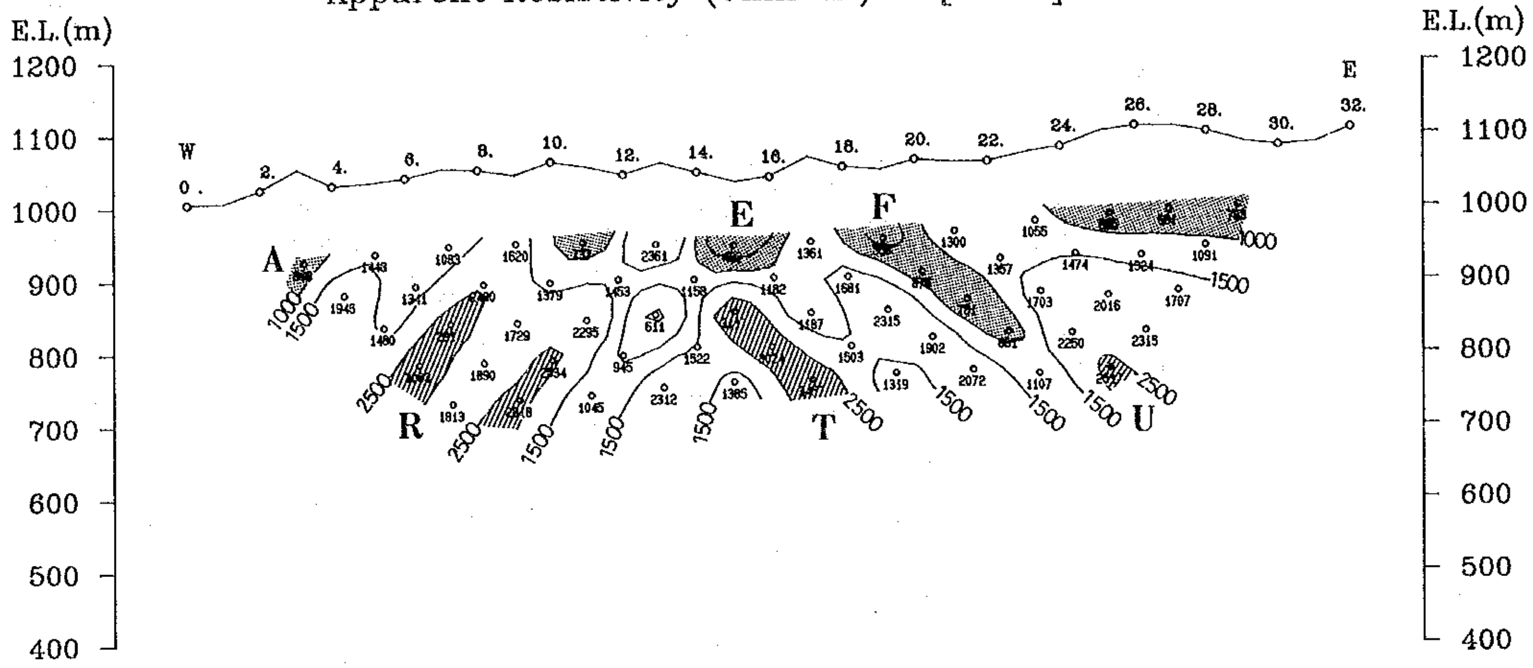


Fig. II–3–16 Pseudo-sections of apparent resistivity and PFE (line C4) of the Chaso Juan area

Line−C5

Apparent Resistivity (Ohm−m) [3.0Hz]



Percent Frequency Effect (%) [0.3−3.0Hz]

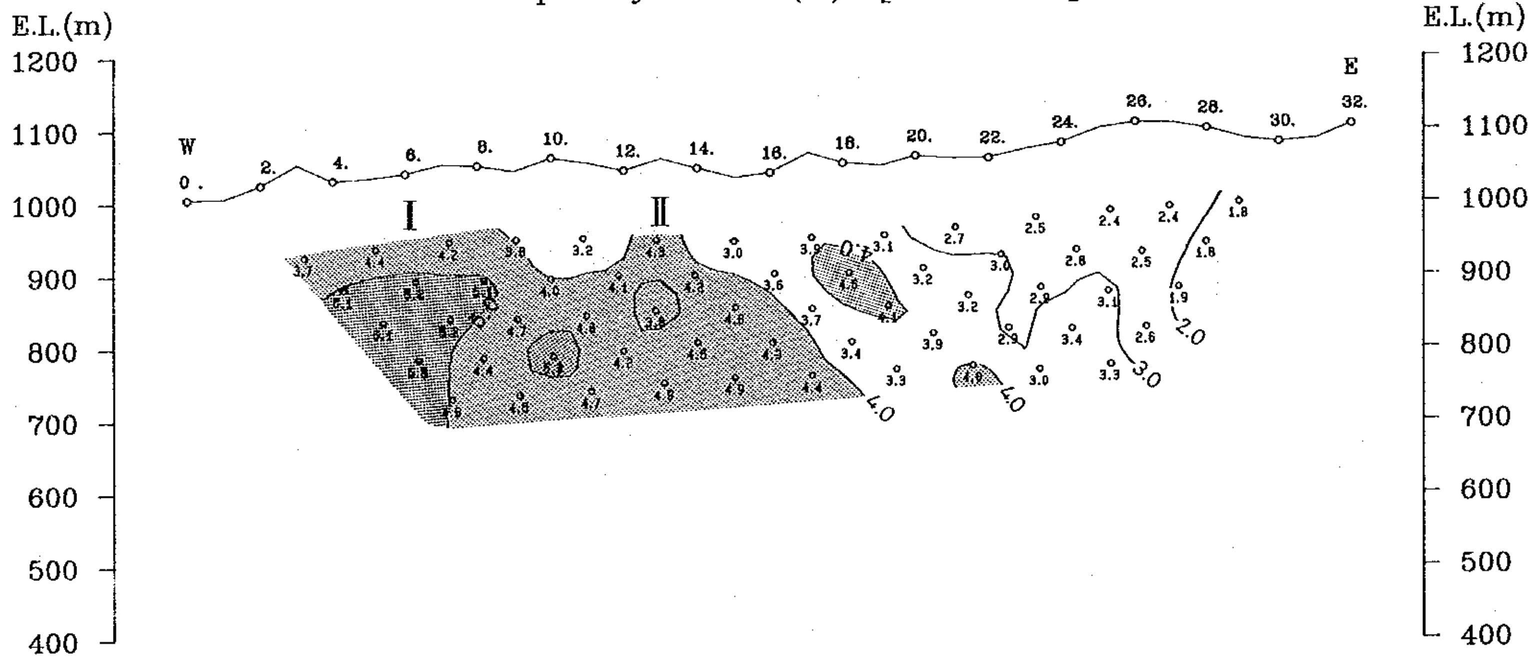
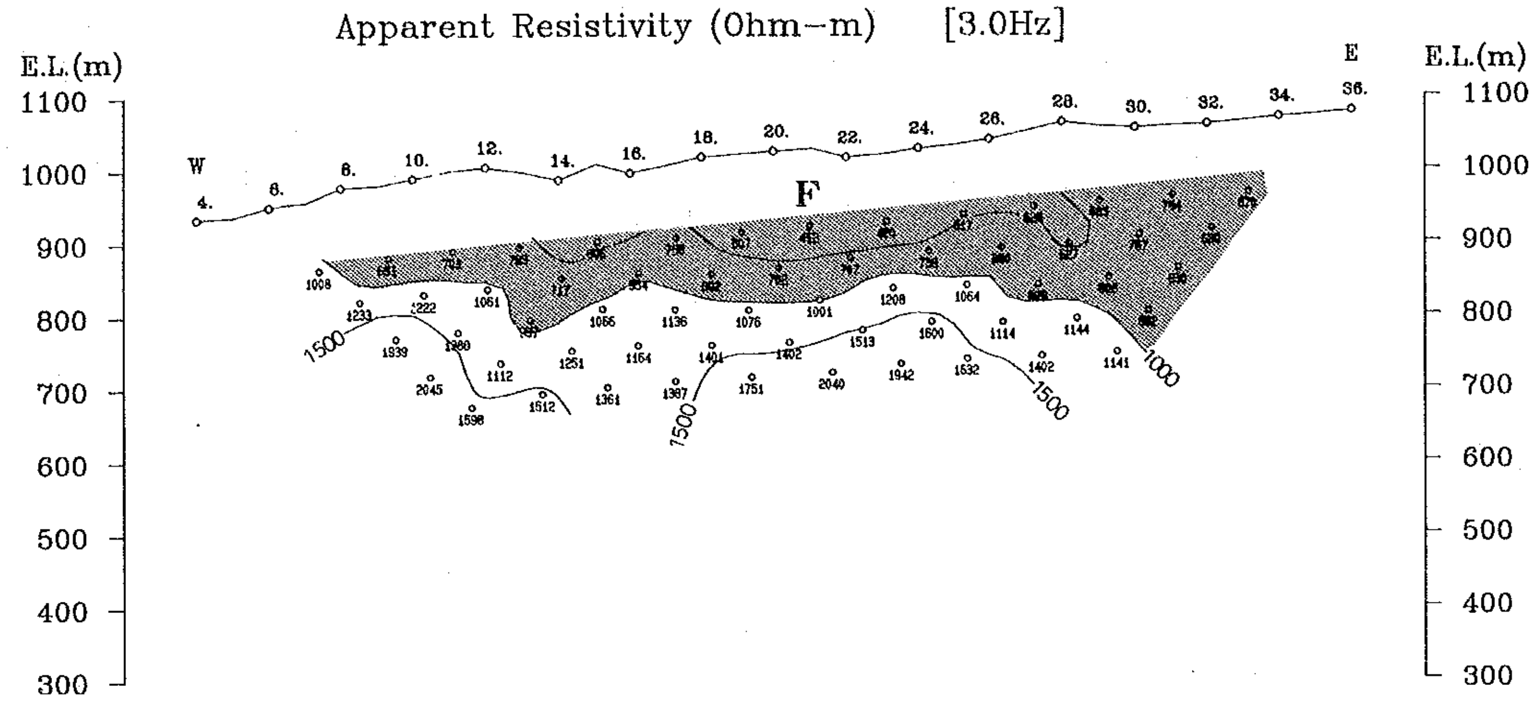


Fig. II−3−17 Pseudo-sections of apparent resistivity and PFE (line C5) of the Chaso Juan area

Line–C6



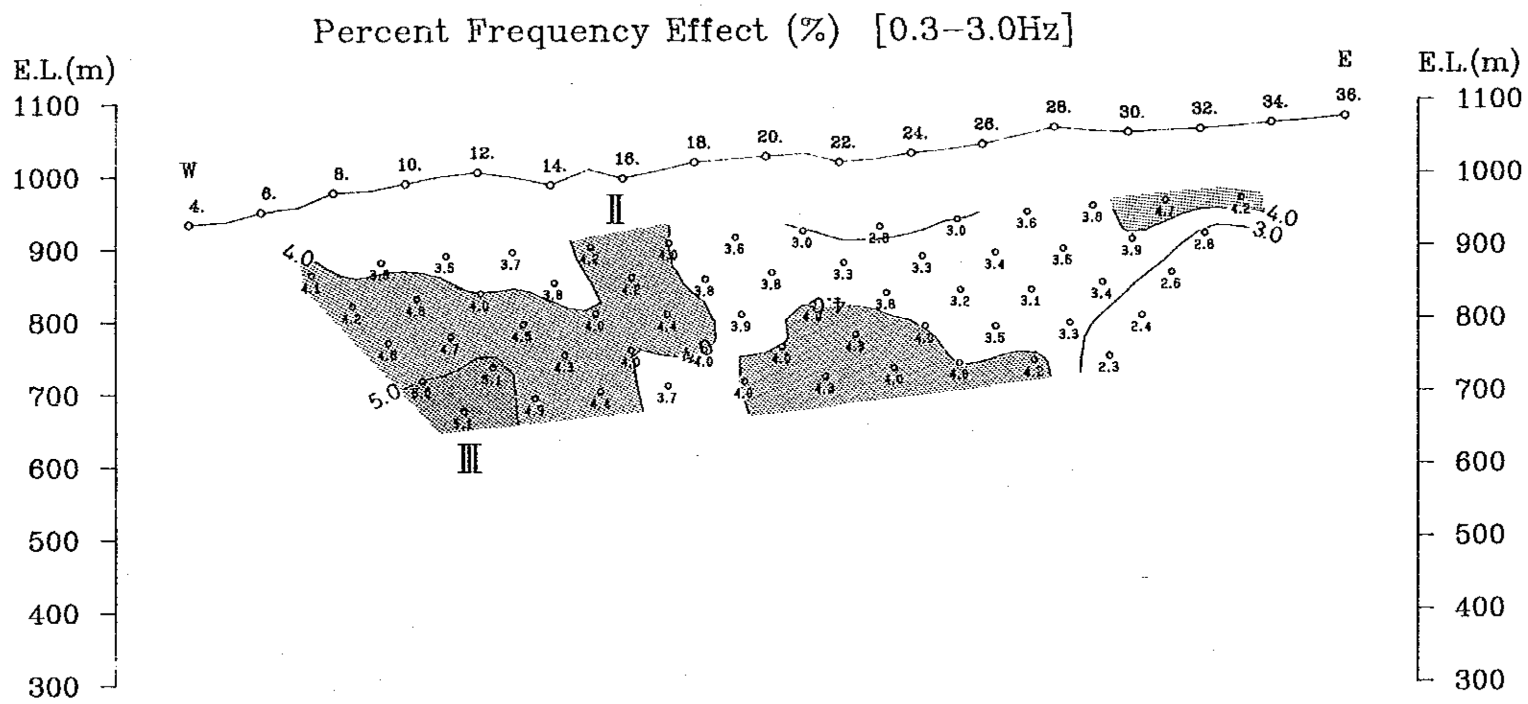
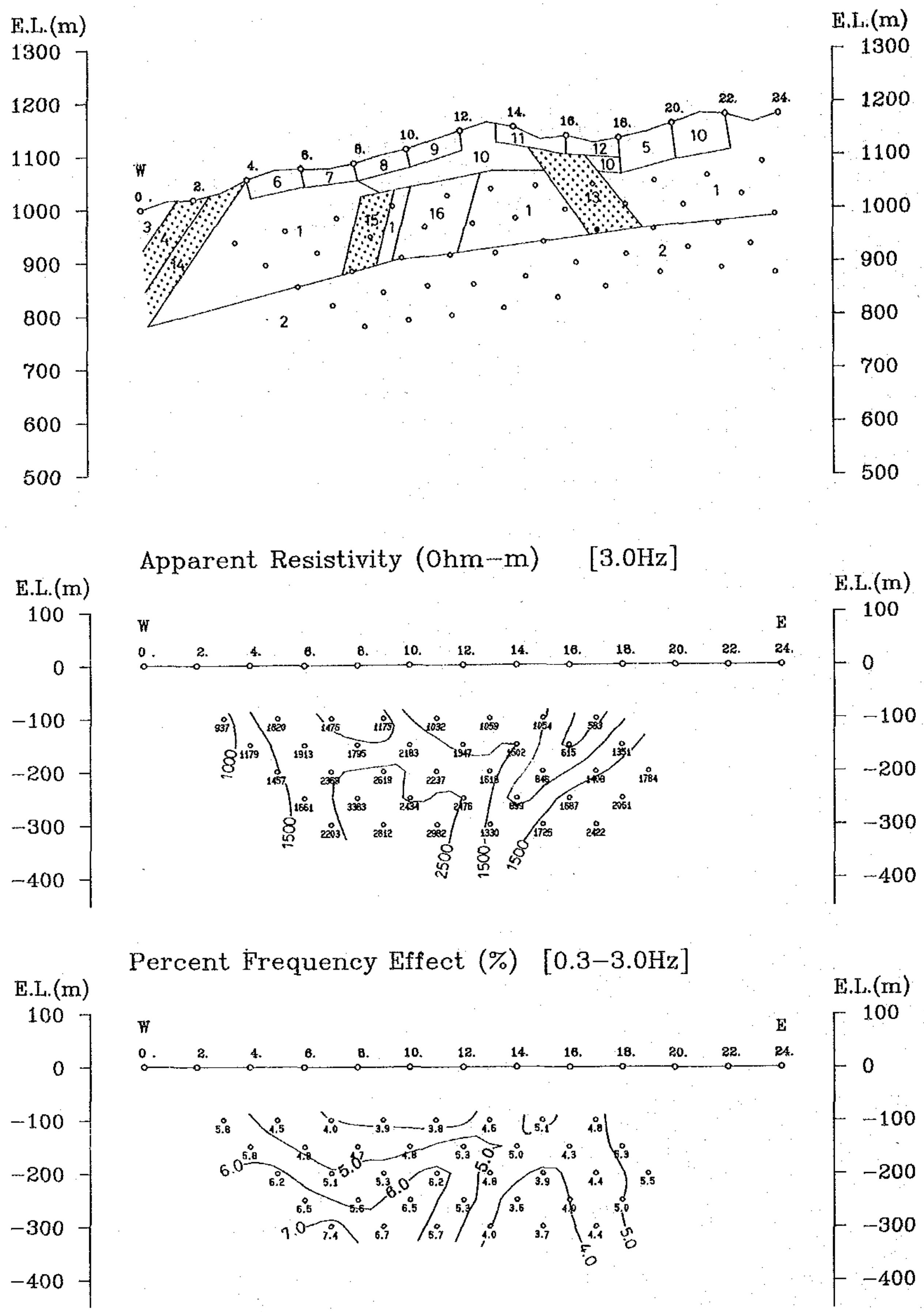


Fig. II–3–18 Pseudo-sections of apparent resistivity and PFE (line C6) of the Chaso Juan area



BLOCK NUMBER :	1	2	3	4	5	6	7	8	9	10
RESISTIVITY (ohm-m):	2000.	4500.	800.0	800.0	450.0	1400.	1000.	800.0	800.0	1000.
P.F.E. (%) :	4.50	4.50	3.30	8.00	3.50	4.50	3.50	2.80	3.00	3.80

BLOCK NUMBER :	11	12	13	14	15	16
RESISTIVITY (ohm-m):	1000.	1000.	1300.	2000.	3500.	3500.
P.F.E. (%) :	6.00	5.00	7.00	7.00	10.0	9.00

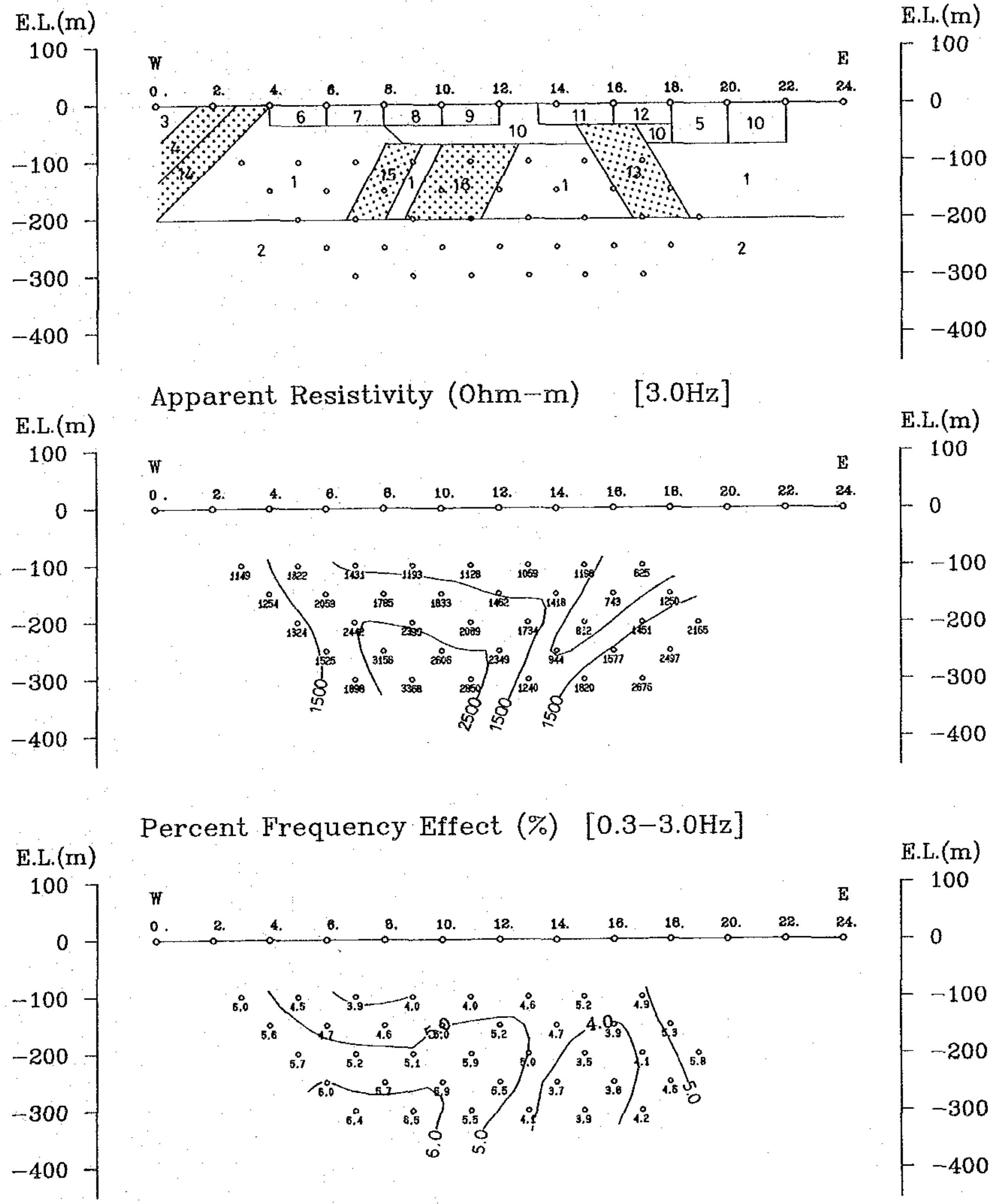
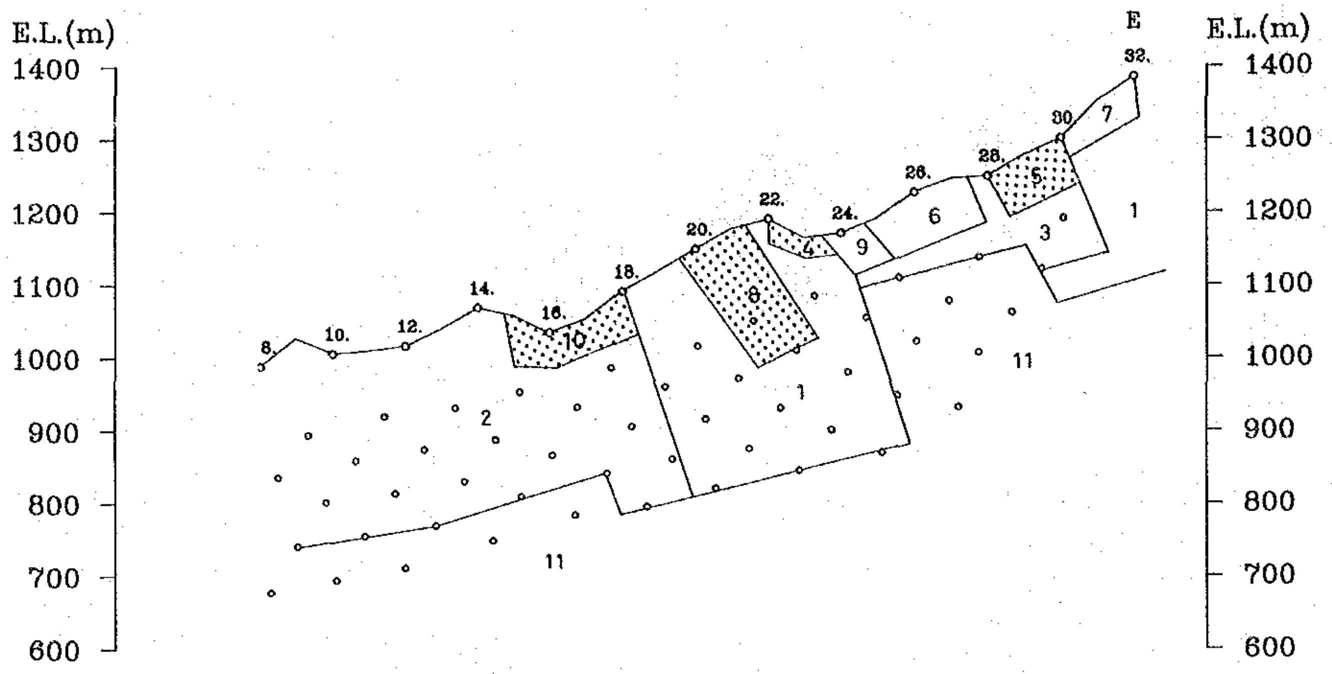
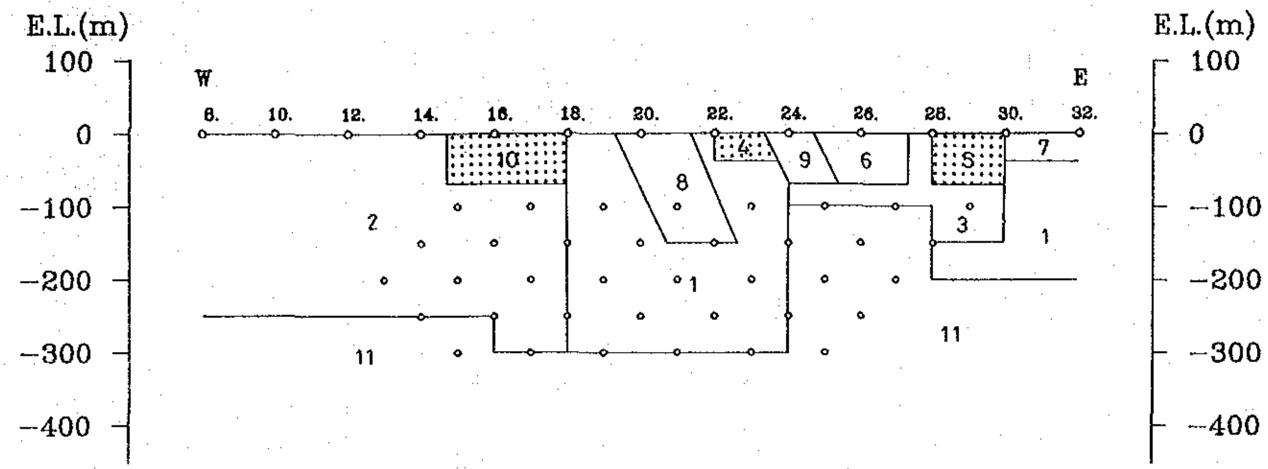


Fig. II-3-19 Analyzed section (line C4) of the Chaso Juan area

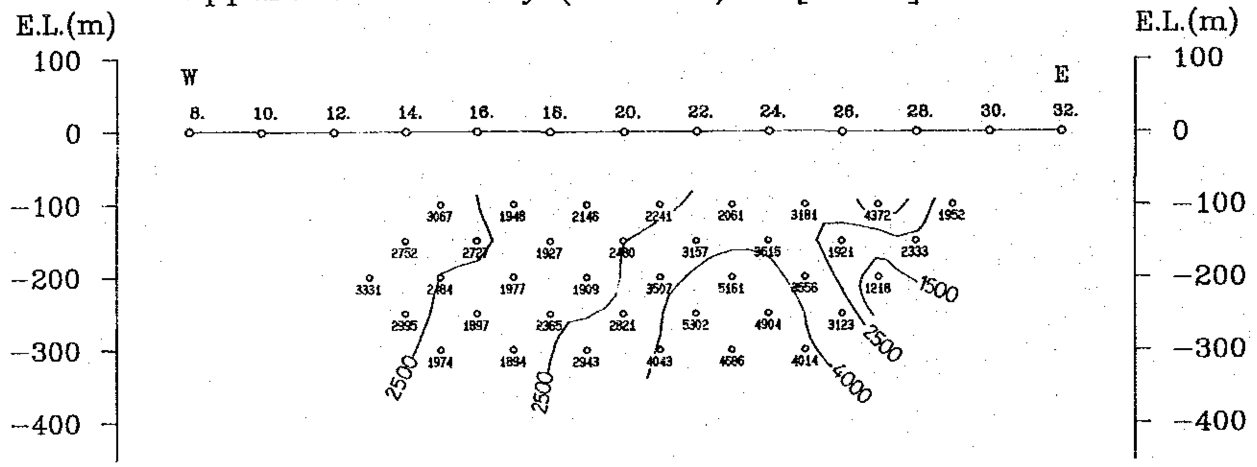


BLOCK NUMBER :	1	2	3	4	5	6	7	8	9	10
RESISTIVITY (ohm-m):	1800.	2500.	4000.	1500.	1500.	5000.	2500.	2500.	2000.	2800.
P.F.E. (%) :	2.70	2.50	2.70	3.50	4.50	2.70	3.00	4.30	3.80	3.80

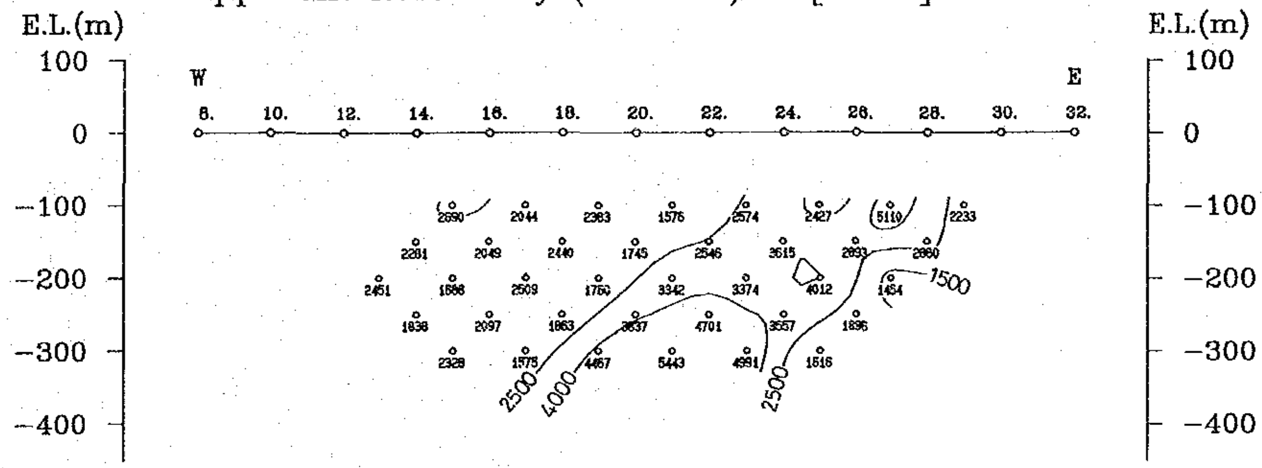
BLOCK NUMBER :	11
RESISTIVITY (ohm-m):	1000E+05
P.F.E. (%) :	3.00



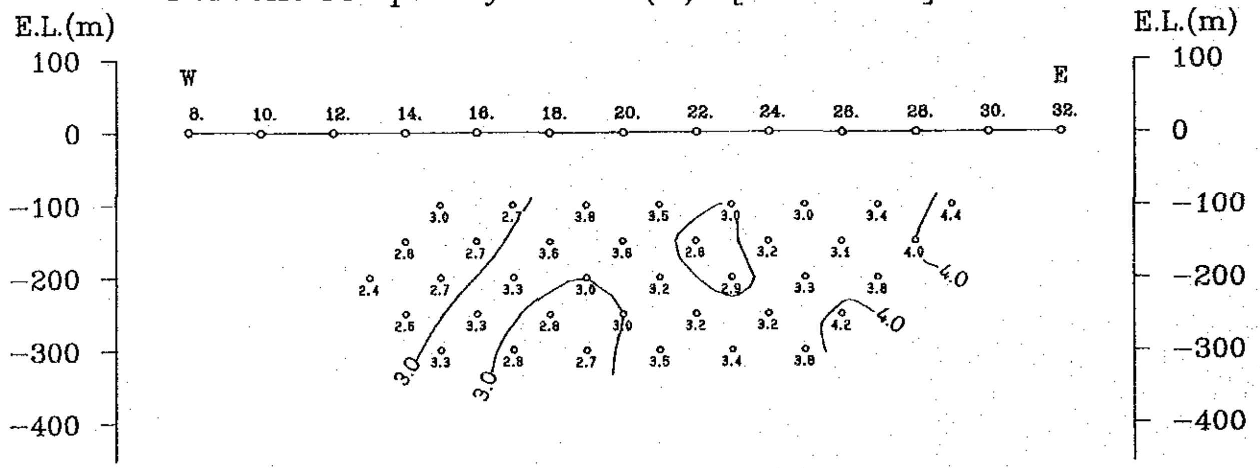
Apparent Resistivity (Ohm−m) [3.0Hz]



Apparent Resistivity (Ohm−m) [3.0Hz]



Percent Frequency Effect (%) [0.3−3.0Hz]



Percent Frequency Effect (%) [0.3−3.0Hz]

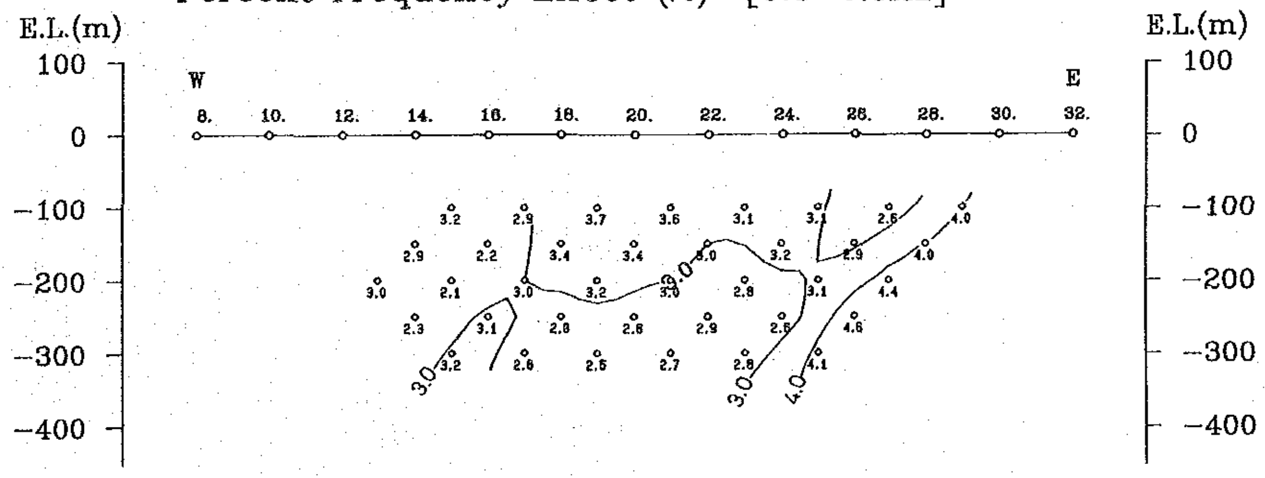
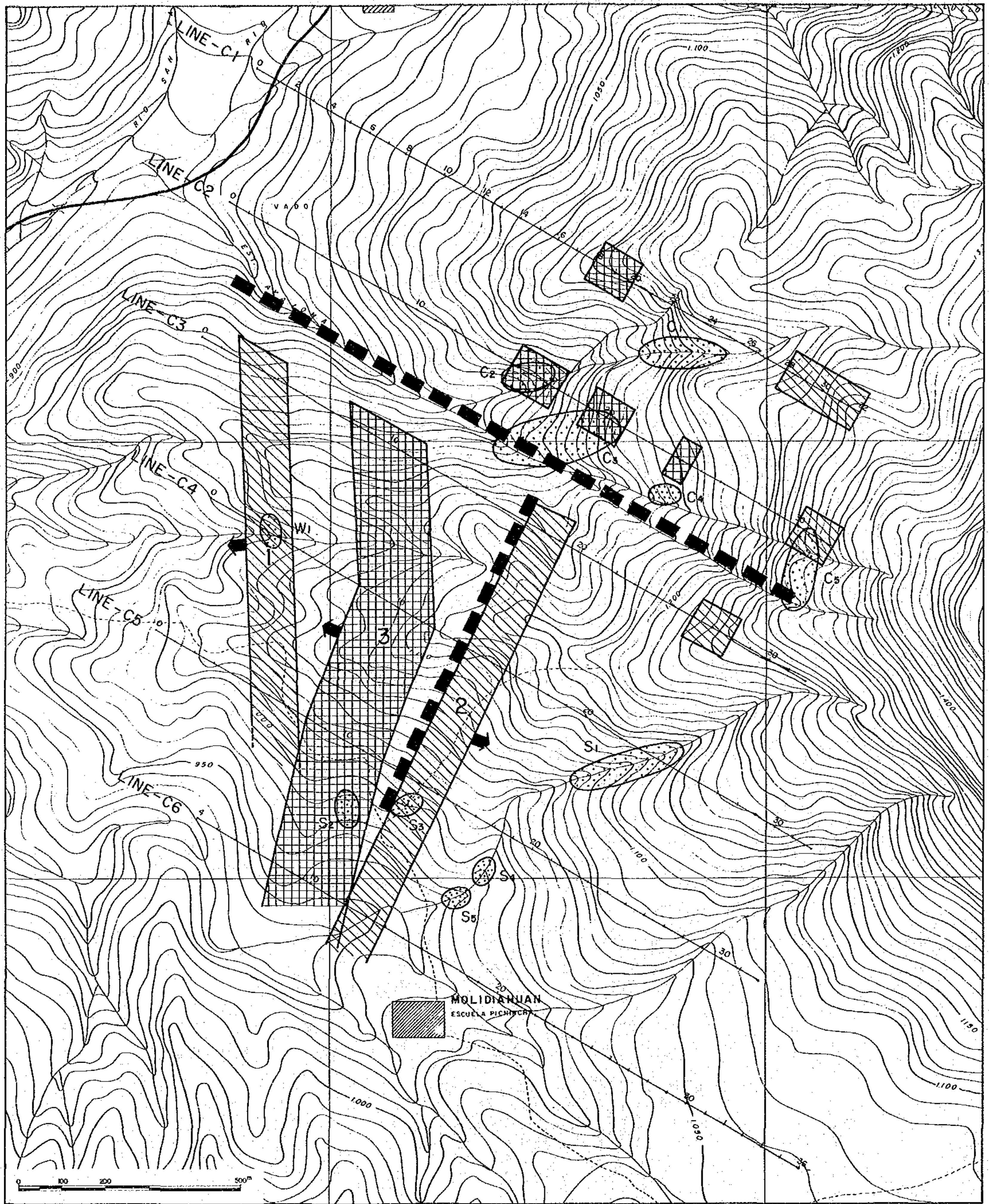


Fig. II−3−20 Analyzed section (line C2) of the Chaso Juan area



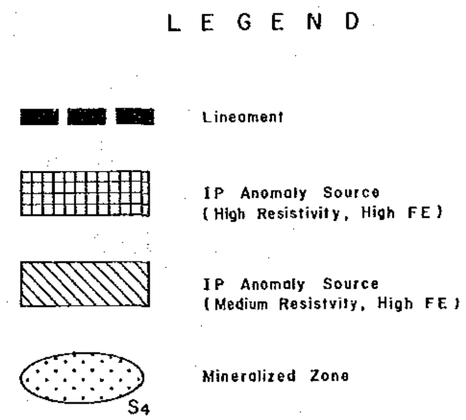


Fig. II–3–21 Interpretation map of the Chaso Juan area

Line–C2

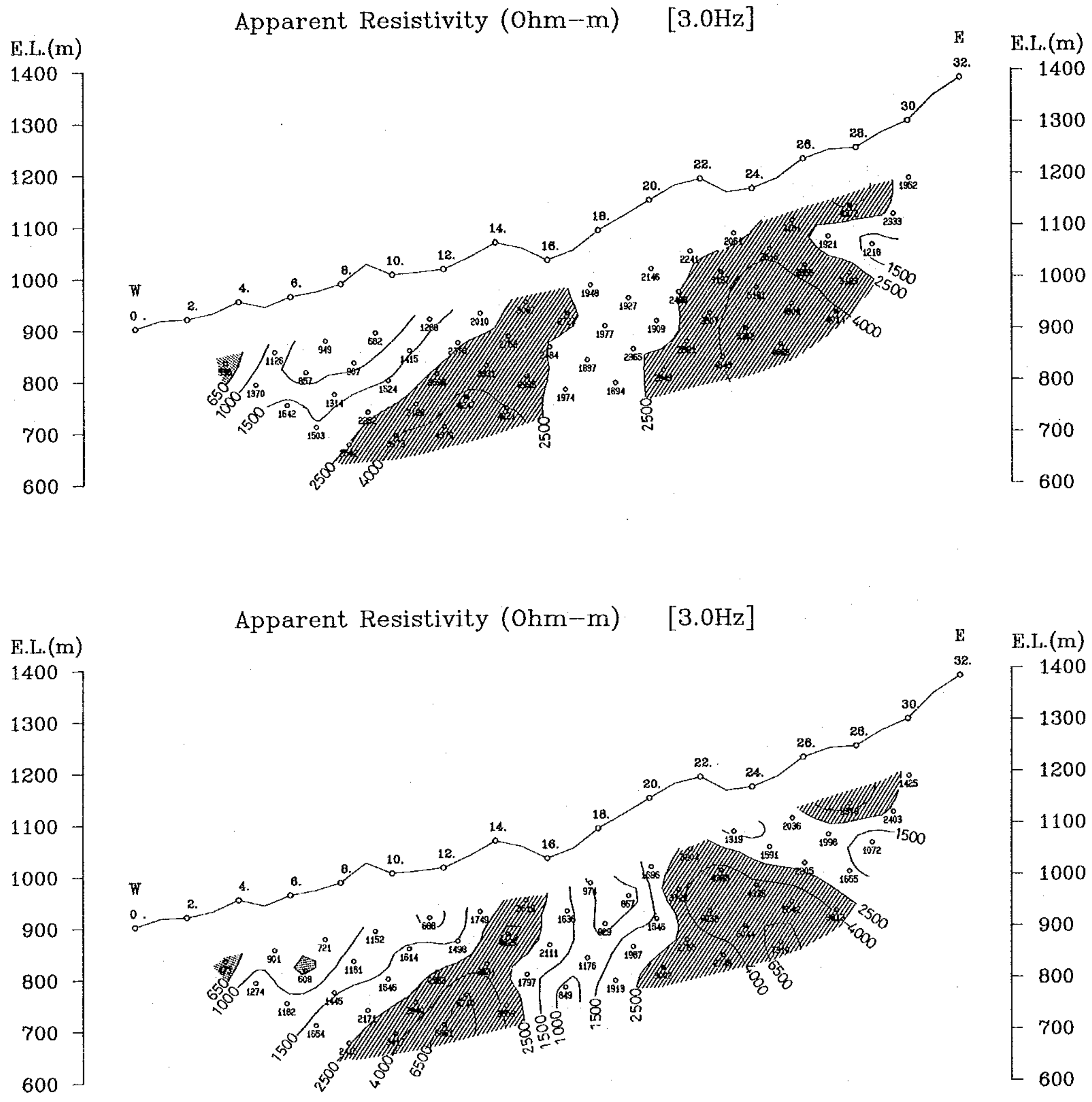


Fig. II–3–22 Example of topographical correction of the Chaso Juan area

3-3 Consideration of survey results in Chaso Juan area

The characteristics of mineralization in this area obtained as a result of geological, geophysical surveys (IP method electric exploration), and magnetic susceptibility measurement, etc. for two years are as follows:

Porphyry-copper type mineralized zone in this area is smaller in scale and more sporadic than any other areas in the Bolivar area. From the minerallogical point of view, pyrite generally spreads in a wide range with copper, but pyrite in this area is present in a small range and limitted in a portion where chalcopyrite is observed, moreover its extension outward is very narrow. On the outside, magnetite remains as an auxiliary component mineral of rock. Further more, chalcopyrite/pyrite ratio is high in this area, and there chalcopyrite mineralized zones is Characteristically wider than pyrite mineralized zone.

Alteration of host rock is different in each mineralized zone. The south side of the Central mineralized zone is affected by chloritization and weak silicification, the West mineralized zone by strong silicification and biotitization, and the South mineralized zone by silicification and weak chloritization. These facts are considered to indicate that the west in this area has been exceedingly eroded, followed by the south and the central portion in dicending order. This agrees with the current topography that the central portion is high, and the west and south mineralized zones are situated middle of the hill.

As regards hydrothermal activities in this area, mineralized zones are scattered in a small scale, and this indicates that, hydrothermal fluids have risen up through plural pores as passages, and that sulfur partial pressure may have been low in the hydrothermal fluids because magnetite still remains as auxiliary component mineral, and because the chalcopyrite/pyrite ratio is high.

Viewing the mineralized zone in this area from the exploration standpoint, the area, which is ranked top, is the south side of the Central mineralized zone where the IP anomalous zone (II) is recognized as a result of geophysical survey. Ore shoots may remain possiblly because the South mineralized zone is expected to continue up to the Central mineralized zone and because erosion has not advanced yet here, compared with other areas. On the other hand, the northern side of the central mineralized zone has high resistivity and low FE as the result of the geophysical survey, and silicification seems to extend there. Extension of sulfide minerals, however, cannot be expected.

The West mineralized zone is proved to have only a small potential for economical mineral deposits because lower part or limit of mineralized zone is exposed at the current ground surface by weathering.

Chapter 4 Telimbela area

The Telimbela area is situated 10 km north of the Balzapamba area. The access by road can be done from Balzapamba via Babahoyo (135 km), and takes about 3 hours by car. In this area, detailed geological survey was conducted.

4-1 Geological survey

4-1-1 Purpose of survey and survey method

The purposes of the Phase II survey are to clarify the relationship between mineralization, and geological structure and igneous activity, and to detect prosperous mineral showings by comprehensively studying the data of this survey and existing geochemical survey and to disclose the distribution and features of mineralized zone. Especially in the northeastern, eastern and southwestern parts of the area, extension of mineralized zones were expected according to the results of the Phase I survey.

Before the field survey and compiling, similar works in Chaso Juan area were performed.

4-1-2 Geology

The area is underlain by the Macuchi Formation and granitic rocks which were emplaced in the Macuchi Formation (Plate II-4-1, Fig.II-4-1 and Fig.II-3-2).

(1) Macuchi Formation Ban

Macuchi Formation Ban is mainly distributed in a northwestern half of this survey area. This Formation consists of dark green basaltic andesite and hornfels originating from andesite. The hornfels is dark green or black, massive and tight, and the cracks are filled with quartz and chlorite, and with pyrite and chalcopyrite locally.

(2) Granitic rocks

Granitic rocks are distributed in a southeastern half and consist of leucocratic hornblende-biotite quartz diorite (Qd), hornblende quartz diorite (HQd), quartz porphyry (Qp), melanocratic diorite dike (DI) and porphyritic quartz diorite dike (PQd).

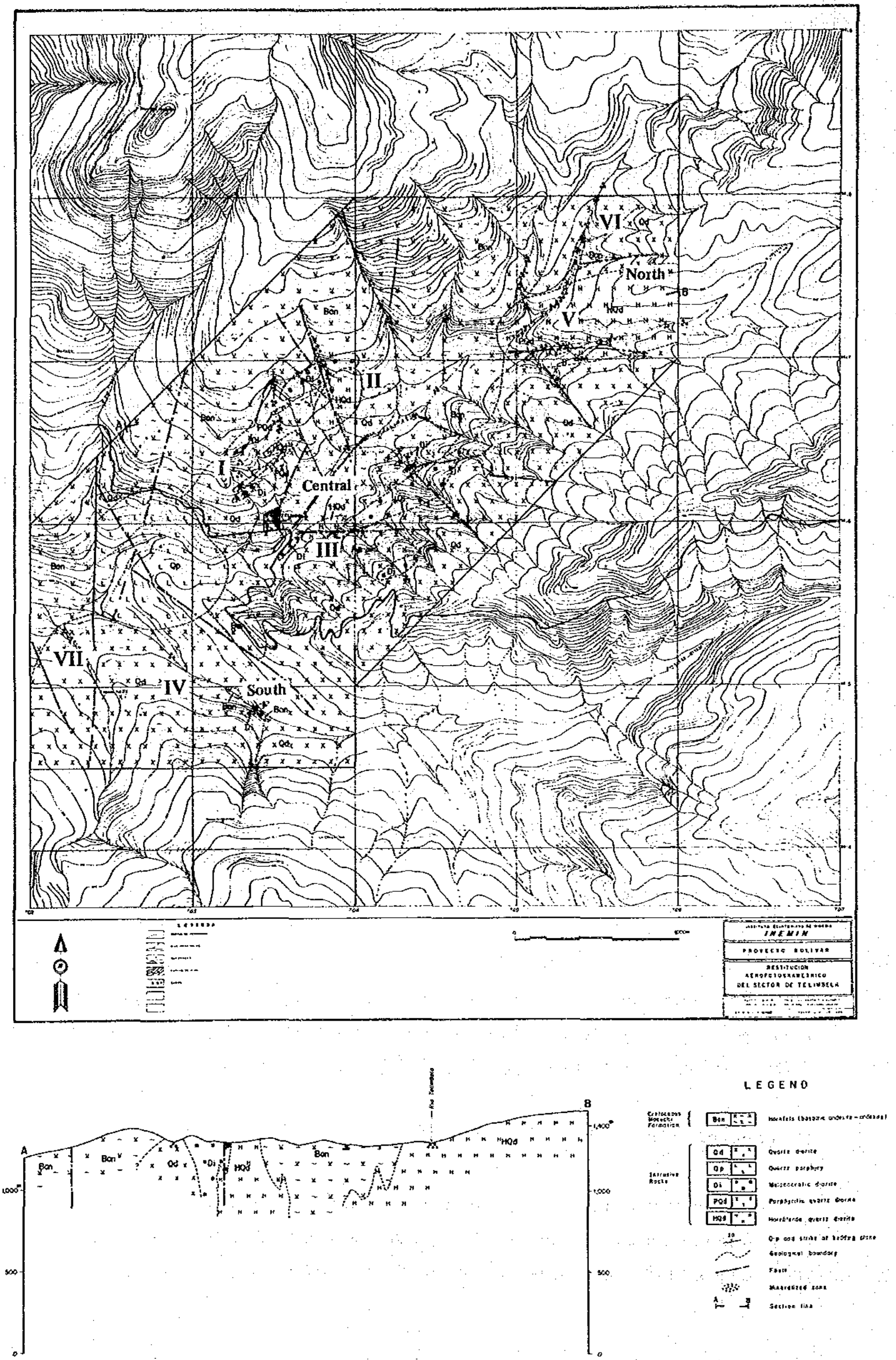


Fig. II–4–1 Geological map and distribution of mineral showings of the Telimbela area

1) Leucocratic hornblende-biotite quartz diorite (Qd)

Hornblende-biotite quartz diorite (Qd) is distributed over almost entire granitic rock distribution area. The texture is holocrystalline and equi-granular. The grain size is medium-grain or locally coarse-grain (south) or fine-grained (north and east).

2) Melanocratic diorite dike (Di)

Melanocratic diorite dike (Di) (10 rock bodies) intrude into the central part to the southern part, trending toward the NE-SW. These rock bodies are various in scale, ranging from 1 km long and 200 m wide to 100 m long and 30 m wide.

3) Porphyritic quartz diorite dike (PQd)

In the porphyritic quartz diorite dyke (PQd), two rock bodies intrude into the central part, and one rock body into the northeastern part, trending toward the NE-SW. The scale of these rock bodies is presumed to range from 450 m long and 30 m wide to 100 m long and 20m wide.

The microscopic characteristics of the rock body (PQd) in the northeast are as follows:

Porphyritic quartz diorite dike (B2019)

Location: 1.9 km northeast of Telimbela, along the river Rio Telimbela

Texture: Porphyritic

Constituent minerals: Plagioclase > biotite > quartz, hornblende > apatite, opaque minerals

Alteration minerals: Chlorite > albite, sericite, epidote

Biotite is affected locally by sericitization.

4) Hornblende quartz diorite (HQd)

Three rock bodies of the hornblende quartz diorite (HQd) intrude into the central part, and one rock body into the eastern part, presumably trending toward the NE-SW or ENE-WSW. The scale of these rock bodies is more than 1,200 m long and 500 m wide in the northeastern part, while 200 to 400 m long and 80 to 200 m wide in the central part.

For the hornblende quartz diorite intruding into the northeastern part, microscopic observation, isotopic age determination and entire rock analysis were made.

The characteristics under the microscope are as follows:

Hornblende quartz diorite (C2062)

Location: 1.8 km northeast of Telimbela, along the river Rio Telimbela

Texture: Holocrystalline, equigranular

Constituent minerals: Plagioclase > hornblende > quartz > apatite, opaque minerals

Alteration minerals: Chlorite > albite > epidote, leucoxene

Biotite is locally affected by chloritization and epidotization, and plagioclase is metamorphosed to albite.

5) Quartz porphyry (Qp)

Quartz porphyry (Qp) intrudes into the southwestern part in a stock form. The scale of the stock-shaped rock body is presumed to be about 800 m in diameter. This stock-shaped rock is situated at the lineament intersection of the NNE-SSW and NW-SE trends.

For this rock body, microscopic observation, age determination and entire rock analysis were made.

The characteristics under the microscope are as follows:

Quartz porphyry (C2016)

Location: 1.0 km southwest of Telimbela, along the river Rio Telimbela

Texture: Porphyritic

Constituent minerals: Quartz, plagioclase > K-feldspar, opaque minerals

Alteration minerals: Quartz, sericite, chlorite>albite, epidote>calcite, leucoxene

Plagioclase is affected locally by sericitization, and biotite by chloritization and epidotization.

6) Aplite dike (Ap)

One rock body of the aplite dike (Ap) intrudes into the southern part, trending toward the NE-SW. The scale of the rock body is 100 m long and 20 m wide.

The characteristics of this rock body (Ap) under the microscope are as follows:

Aplite dyke (B2012)

Location: 0.6 km east of Telimbela, along the southern branch of the river Rio Telimbela

Texture: Porphyritic to micrographic

Constituent minerals: Plagioclase > biotite > K-feldspar, opaque minerals

Alteration minerals: Sericite > chlorite > albite, biotite

Biotite is locally affected by chloritization.

The hornlende quartz diorite (HQd) and quartz porphyry (Qp) are dated as 15.7±1.0 Ma and 14.5±3.0 Ma by the K-Ar method respectively (Table II-3-1).

The hornblende-biotite quartz diorite conducted in the Phase I survey was dated as 19.4±0.6 Ma by the K-Ar method.

The results of chemical analyses of these rock bodies (Qp and HQd) are shown on Table II-3-2, and SiO_2-FeO*/MgO chart and normative quartz-orthoclase-plagioclase triangular chart in Fig.II-3-3 and Fig.II-3-4 respectively.

(3) Geological structure

Structurally emphasized is the NNE-SSW trend fault and NE-SW trend dikes and mineralized zones in the western part of the area.

Lineaments develop in NNW-SSE to NW-SE trend and in E-W trend. Lineaments in the Telimbela area are much more distinctive than those in the Chaso Juan area.

4-1-3 Mineralization and alteration

The survey in this year confirmed seven copper mineralized zones including zones confirmed in the Phase I survey. Particularly the mineralized zones in the northeastern part are most promising. These mineralized zones are of porphyry-copper type, and observed in granitic rocks mainly and also in the Macuchi Formation.

In this area, copper mineralized zones extend generally in the NE-SW direction. Ininner part of each mineralized zones, chalcopyrite and pyrite dominates in forms of dissemination and film-like, and in veinlets locally. Only veinlets along cracks are observed instead of dissemination in the outer part. The veinlets are comprised of sulfide minerals only.

Macroscopically, chalcopyrite exists in the center part of the mineralized zone, and pyrite extends widely through the entire area. For relationship with alteration, chalcopyrite is associated with chloritization and silicification. Properties of each mineralized zone are as follows:

(1) Central mineralized zone

The Central mineralized zone is divided into Zone I and Zone II, and is distributed in the NE-SW direction.

Zone I occurs in granitic rocks, and consists of chalcopyrite-pyrite-(molybdenite) dissemination and veinlet zones extending over an are of 500 m x 350 m. Analytical results of ore samples obtained from this area show 1.60 % in Cu at maximum (Fig.II-4-2). As the results of the microscopic observation of sample No. C2024, disseminated chalcopyrite, pyrite and magnetite were observed. The assemblage of alteration minerals identified by X-ray diffractive analysis is quartz-sericite-chlorite. Furthermore, K-feldspar (in one sample) and secondary biotite (in two samples) were also identified in the Phase I survey.

Zone II occurs in granitic rocks as well as the Macuchi Formation, and consists of

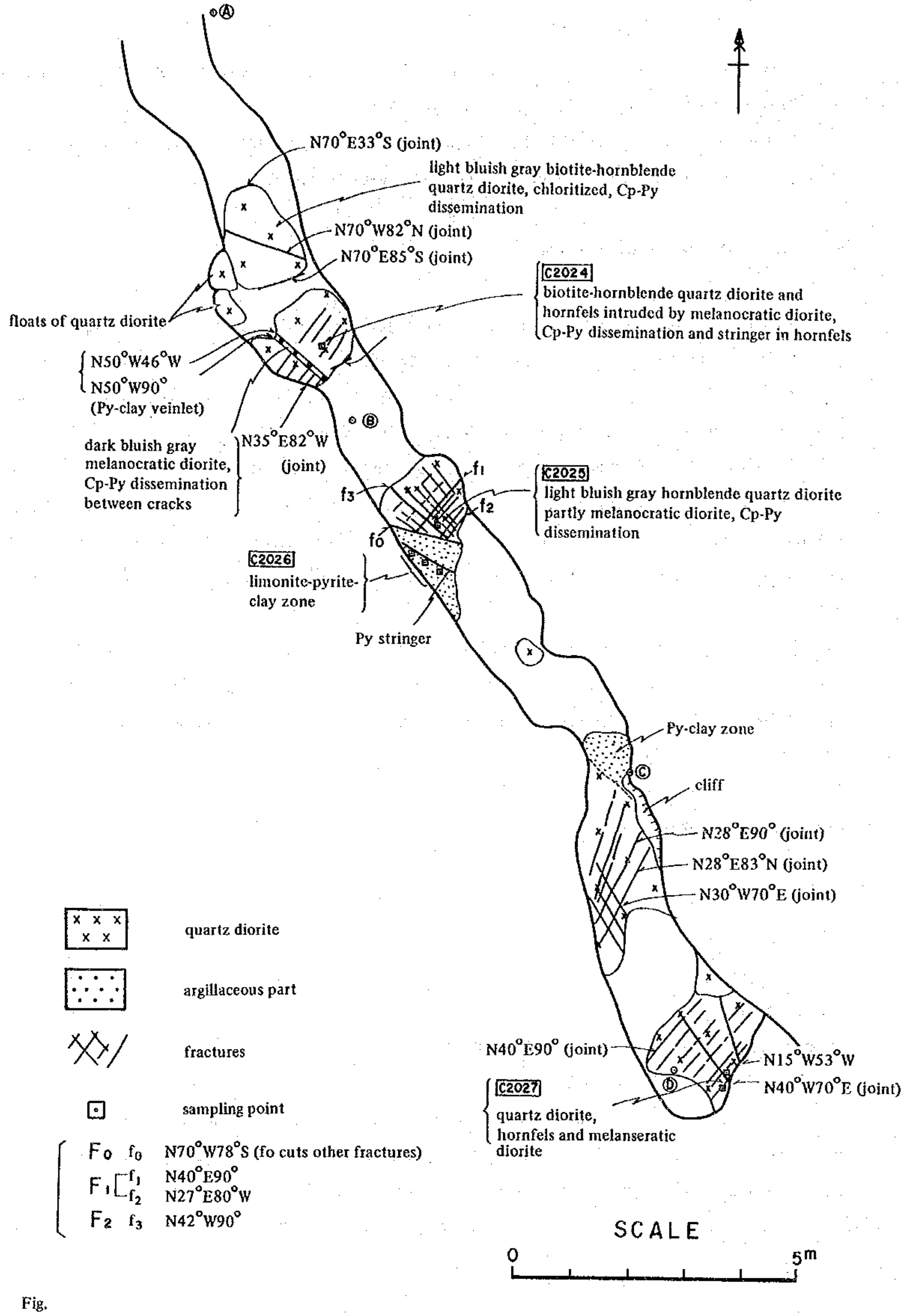


Fig. II–4–2 Geological sketch of mineralization of zone I in the Telimbela area chalcopyrite-pyrite-(molybdenite) dissemination and veinlet zones, which are distributed over an area of 200 m x 400 m. The assay of ore samples is 0.2 g/t in Au at maximum, 1.6 g/t in Ag, and 0.16 % in Cu. The sketch of the mineralized Zone I is shown in Fig.II-4-2.

(2) South mineralized zone

The South mineralized zone occurs in granitic rocks, and is divided into Zone III, Zone IV and Zone VI.

Zone III is pyrite disseminated and veinlet zones, and distributed over an area of 400 m x 900 m.

Zone IV is the southeastern extension of the Zone III, and is chalcopyrite-pyrite-(molybdenite) dissemination and veinlet zones, and observed for about 150 m along the valley.

The assay of ore samples collected from these mineralized zones show 0.05 % in Cu at maximum. As the results of the microscopic observation of sample No. C2019, chalcopyrite-pyrite-magnetite-chalcocite-covelline were observed in veinlets. Assemblage of alteration minerals is quartz-chlorite-(sericite).

(3) North mineralized zone

The North mineralized zone is a new zone, confirmed by the Phase II survey, divided into Zone V and Zone VI.

Zone V is chalcopyrite-pyrite dissemination and veinlet zones mainly in hornblende quartz diorite (HQd), which extends in an area of 400 m x 1,200 m. The assay of ore samples collected from these mineralized zones show 0.2 g/t in Au, 9.5 g/t in Ag, and 0.80 % in Cu at maximum.

As the results of the microscopic observation of sample No.A2035, observed were chalcopyrite in a anhedral form, and a small quantity of magnetite and hematite in a dissemination form.

Zone VI is chalcopyrite-pyrite dissemination and veinlet zones which continues for about 400 m along the river, and occurs not only in granitic rocks but also in the Macuchi Formation. The assay of ore samples collected from these mineralized zones show 0.4 g/t in Au, 5.8 g/t in Ag and 1.65 % in Cu. As the results of the microscopic observation of sample No.A2041, paragenesis of chalcopyrite-pyrite-magnetite was observed in quartz veinlets (3 mm wide).

Assemblage of alteration minerals was quartz-sericite-chlorite.

4-1-4 Results of magnetic susceptibility measurement

The data of the magnetic susceptibility measurement were analyzed in the same manner as in the Chaso Juan area. The obtained map is shown together with the locations of the mineral showings in Fig.II-4-3.

For anomalous zones of the magnetic susceptibility, the following three places were detected: one in NE-SW direction including the Central and South mineralized zones; next in the east side of Zone III; and the other in the North mineralized zone. Among them, the scale of the foremost former anomalous zone is more than twice that of the anomalous zone detected in the El Torneado mineralized zone in the Balzapamba area. In Zone II, the magnetic susceptibility of the volcanic rocks of the Macuchi Formation decreases from 83 x 10^{-3} to 36 x 10^{-3} SI units toward the main mineralized zone. The demagnetization caused by mineralization is observed.

In the northern mineralized zone, the anomalous zone does not cover the entire mineralized zone, but is locally detected. This is possibly because the actual background value of the said mineralized zone is somewhat higher than that of other mineralized zones.

Accordingly, the anomalous and background values are set as follows: less than 10.0 x 10^{-3} SI units for extremely low; 10.1 to 20.0 x 10^{-3} SI units for considerably low; 20.1 to 40.0 x 10^{-3} SI units for low; and more than 40.1 x 10^{-3} SI units for background.

The anomalous zone delineated based on this anomalous values is wider than the anomalous zone shown in Fig.II-4-3, and almost harmonizes with the area of the North mineralized zone. The absolute value of the magnetic susceptibility in the North mineralized zone is two times higher than that of other mineralized zones, the ratio of the anomalous values to the background, however, is quite the same.

4-1-5 Consideration

As the result of the geological survey and magnetic susceptibility measurement for two years and rock geochemical survey of the previous year, the properties of porphyry copper type mineralized zone in the area are as follows.

Taking a broad view, the mineralized zone in the Telimbela area is distributed over the peripheral part of granitic batholith, trending toward the NE-SW. A number of dikes intrude into mineralized zones, which are hornblende quartz diorite (HQd), quartzporphyry (Qp), melanocratic granodiorite (Di) and porphyritic quartz diorite (PQd) dikes, etc. The dikes are also extending in the NE-SW direction. In the north of this area, a major tectonic line which continues from Guayaquil to the east of Quito in the NE-SW direction. The

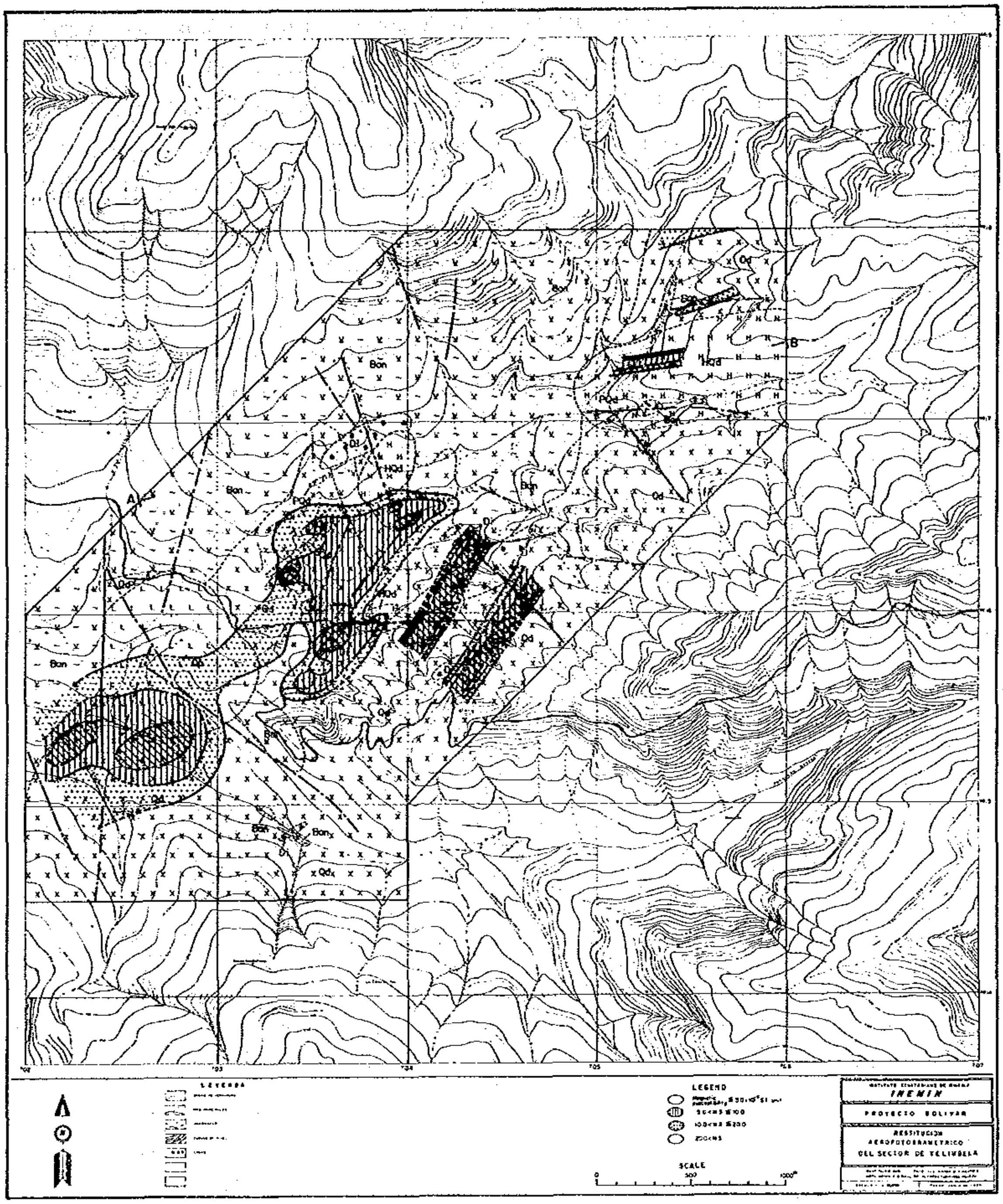


Fig. II–4–3 Interpretation map of magnetic susceptibility of the Telimbela area alignment direction of the intrusive rocks and mineralized zones in this area coincides with the major tectonic line. This implies that the igneous activity and its subsequent hydrothermal activities are associated with the major tectonic line. Quartz porphyry (Qp) is dated as 15.8±1.0 Ma, consequently hornblende quartz diorite(HQd) as 14.5±3.0 Ma, and the isotopic values of the intrusive rocks show the youngest age in the Bolivar area.

This fact means that the igneous activity of granitic rocks in this area has continued to the last in the Bolivar area. The scale of mineralized zone in this area is larger than any other areas surveyed in the Bolivar area, and the Macuchi Formation is affected by strong mineralization. Also pyrite dissemination and veinlets are widely observed in granitic rocks. Mineralized zones exist in a wide range, therefore, the area is very promissive in exploration, especially at the North mineralized zone where the scale and intensity has been confirmed through the survey of this year.

Chapter 5 La Industria-Yatubi area

The La Industria-Yatubi area is situated 25 km northwest of the Balzapamba area. The access by road can be done from Balzapamba via Babahoyo (125 km), and takes 2.5 hours by car. In this area, geological and geochemical surveys were made.

5-1 Geological survey

5-1-1 Purpose of survey and survey method

The purposes of these surveys are to clarify the relationship between mineralization, geological structure and igneous activity, and to select further prosperous mineral showings by studying data comprehensively of these surveys and existing geochemical survey and to disclose the distribution and features of mineralized zone. These surveys were especially made with a view to confirming the outcrops of boulders of hematite-quartz network veins (gossan).

Before the field survey and compiling, similar works in Chaso Juan and Telimbela areas were performed.

5-1-2 Geology

The area is underlain by granitic rocks (Plate II-5-1, Fig.II-5-1 and Fig.II-3-2). Almost all granitic rocks are quartz diorite (Qd) which is considered to be batholith. Also five melanocratic diorite dykes (Di) are observed 10 to 120 m wide trending toward the NNW-SSE. The quartz diorite was dated as 25.5 ± 0.9 Ma by the K-Ar method in the Phase I survey.

For geological structure, WNW-ESE and ENE-WSW lineaments and NNW-SSE trend melanocratic diorite dykes (Di) are dominated in this survey area. The ENE-WSW trend is apparently cut by WNW-ESE trend lineament. In addition, N-S tand E-W trend lineaments are interpreted to be short and few, however, the relationship with other geological structures is obscure. Only evidence cleared is that they are well reflected in the topography (ridge, and valley).

5-1-3 Mineralization and alteration

Through the surveys of this fiscal year detected are a couple of outcrops at the following two places, which are considered to to be a part of hot spring type gold ore deposit and a source of boulders (Fig.II-5-1):

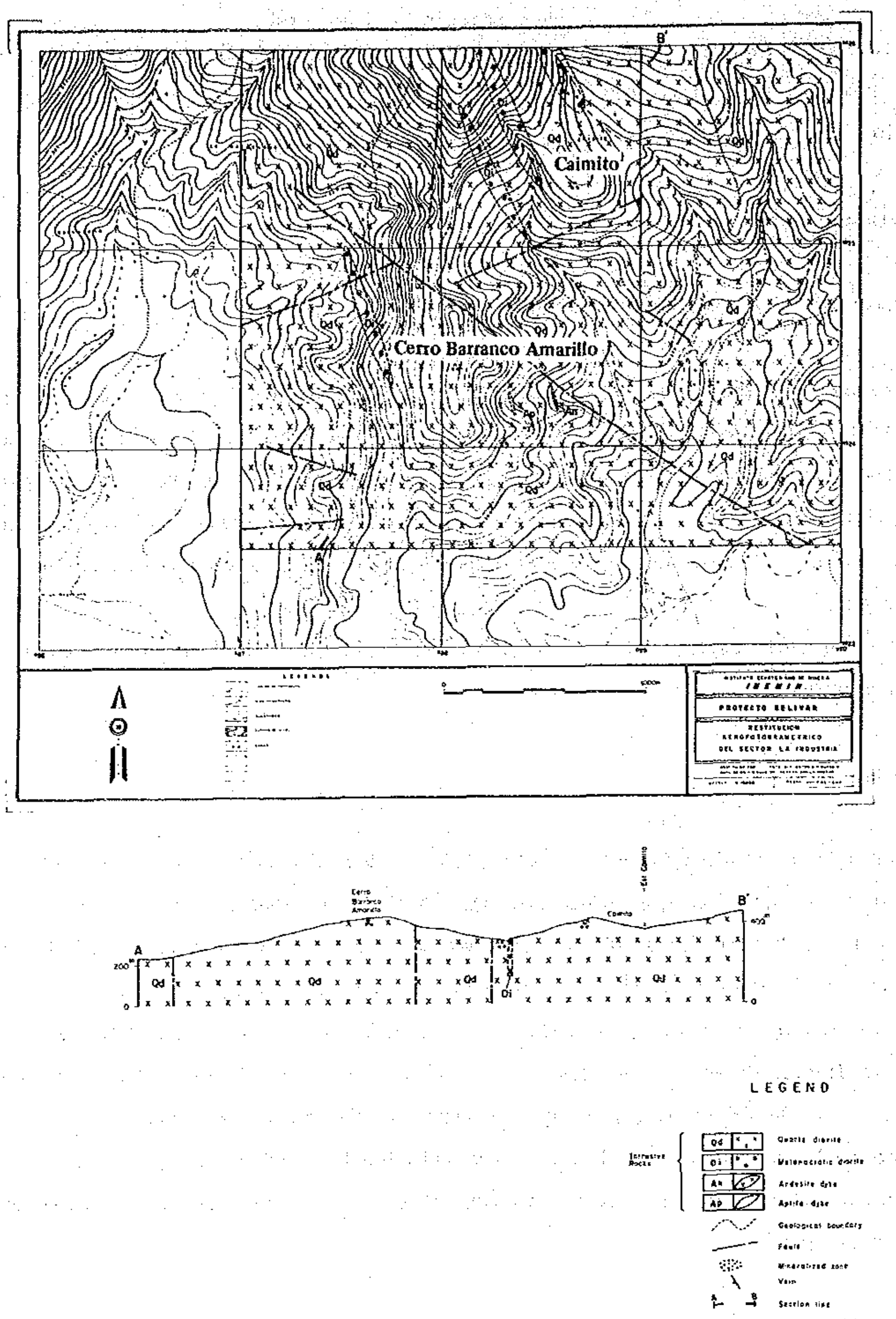


Fig. II–5–1 Geological map and distribution of mineral showings of the La Industria-Yatubi area

(1) At the mountaintop of Cerro Barranco Amarillo (hereinafter CBA mineralized zone)
(2) At the mountaintop of Southern part of Caimito (hereinafter Caimito South mineralized zone)

Since the survey area is covered with surface soil by weathering, the entire extension of this mineralized zones is not disclosed yet. However, the scale of each outcrop is estimated as follows:

(1) CBA mineralized zone: Two outcrop: 100 m + α and 50 m + α are distributed for about 1 km along the ridge trending toward the N-S.
(2) Caimito South mineralized zone: Outcrops and boulders are scattered for about 100 m in the southern slope near the summit.

In these mineralized zones, metallic sinter-needle-like mineral-(hematite)-(white clay)-quartz vein occur in irregular network pattern in silicificated rock. The host rocks quartz diorite, which is affected intensely by silicification and white alteration.

The mineralized zones are divided into the following two kinds of veins based on the mineral composition of the vein:

(a) Metallic sinter-(needle-like mineral)-hematite-quartz vein: Large quantities of metallic sinter and small quantities of needle-like mineral occur. The metallic sinter has black metallic luster, and coexists with quartz in the veins or exists in skelton form.
(b) Needle-like mineral-(metallic sinter)-(hematite)-quartz vein: Large quantities of needle-like minerals and small quantities of metallic sinter occur. The needle-like mineral shows black, dark green, white or transparent in color and radial in crystal form, and coexists with quartz in druses. Generally, on the surface of this mineral and in voids or opennings among needle-like minerals are adhered with black metallic sinter.

For these distributions, vein (a) is mainly observed in the outcrops of the mountaintop and vein (b) is mostly abundant in boulders along valley though it occurs also in the outcrops at the mountaintop. The assay of vein (a) was 0.3 g/t in Au, 16.3 g/t in Ag and 0.03 % in Cu at maximum.

Taking a broad view of the mineralized zone, white argillized zone, below the silicificated rocks where the above mentioned network veins occur, is distributed in the eastern slope of the CBA mineralized zone. Similarly in the Caimito South mineralized zone, white argillized zone below the quartzite is distributed along the western valley of and in the western slope of Caimito South. In these white argillized zones, the texture of the host rocks has completely disappeared, and the above mentioned networks vein (a) and (b) locally exist. Around the veins, hematite irregularly spread soutward from the vein as if it permeated the thin cracks. Results of X-ray diffractive analysis show that the white clay comprises assemblage of quartz-sericite and kaoline. Also the needle-like mineral is identified to be DORABAITO. As mentioned in the Phose I report, porphyry copper type mineralized zone is distributed in the north of this area, with which the assemblage of quartz-sericite may be associated.

In addition to the mineralized zones, a white alteration is overlapped with alteration zones mentioned above and other is observed away from those alteration zones. This alteration is accompanied by silicification weakly and locally. Pyrite is generally automorphic in crystal form and is disseminated uniformly in the entire alteration zone. At the outcrops, most of pyrite are altered to limonite. And marakaito is observed locally.

5-1-4 Results of magnetic susceptibility measurement

Data of the magnetic susceptibility measurement were analyzed in the same manner as in the Chaso Juan area. The obtained map is shown together with the locations of the mineral showings in Fig.II-5-2.

Anomalous zones of the magnetic susceptibility were detected in the CBA mineralized zone and along the valley in the central part.

The former corresponds with the area of the CBA mineralized zone. The latter coincides with white alteration zone in the western part of the Caimito South mineralized zone and a part of the porphyry copper type mineralized zone. However, at the outcrops, where weathering has not advanced, in hot spring type gold ore deposit and porphyry copper type mineralized zones, a result indication excessive demagnetization phenomenon was obtained as compared with outcrops of unaltered part, and this measurement was meaningful.

For areas abounding in weathered parts like this area, it is necessary to detect anomalous zone of relative magnetic susceptibility including the weathered parts in future.

5-1-5 Consideration

Summarizing the mineralized zone mentioned in item 5-1-3, such a model is considered that white argillized alteration zones are distributed below and silicificated zones above and that metallic sinter-needle-like mineral-hematite-quartz-white clay network veins extend through both. This model closely resembles so called hot spring type Au deposit model. The results of the assay confirmed concentration of gold to a certain degree. The above network veins exist more in the silicificated zone. The intensity of silicification increases toward the center part of hydrothermal activities, where the silicificated zone

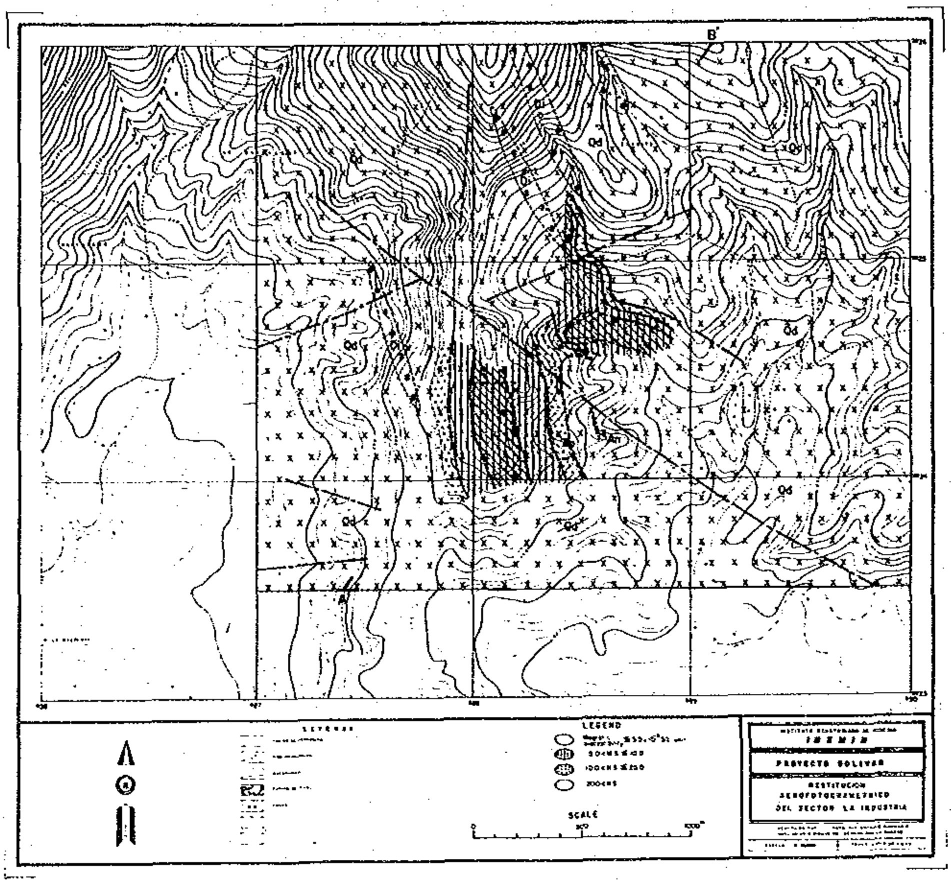


Fig. II–5–2 Interpretation map of magnetic susceptibility of the La Industria-Yatubi area is likely to extend downward. Outcrops of silicificated rocks are distributed only at the mountaintop and white argillized alteration zone appears near the mountaintop and dominates downward. Network quartz veins in the silicificated rocks show crystalline structure, and the host rock is subjected to addition type and strong silicification. "Leached silicification", due to leaching of other components, is only observed in a part of boulders in the valley. From these facts, it is considered that the greater part of this silicificated rock have been eroded, and the silicificated rocks at the mountaintop is the lower part of the silicificated zone.

The fact is not known generally that dorabaito is present in druses of network veins in hot spring type gold ore deposit. Since this mineral is crystallized in druses, this mineral should be studied further whether it is associated with hot spring type gold ore deposit or whether it is associated with another type of hydrothermal activities overlapped.

In this area, alteration zone (white argillized zone and weak silicificated zone) is distributed in quartz diorite, and partly overlaps with hot spring type gold ore deposit. This alteration zone is accompanied by sulfide minerals instead of oxides. Marakaito is also observed locally, which originates from chalcopyrite. On the other hand, porphyry copper type mineralized zone is distributed in the north of this area. Therefore, this alteration zone considered to be associated with porphyry copper type mineralization.

As regards the relationship between the porphyry copper type mineralization and the the mineralization which closely resembles hot spring type gold ore deposit, it is considered that the former had been produced by earlier hydrothermal activities than the latter because the white argillized alteration zone accompanied with pyrite was cut by network veins accompanied with silicification in the summit of the Cerro Barranco Amarillo. Comparing this with three stages of thermal activities in the Bolivar area classified last year, followings are considered: the porphyry copper type mineralization corresponds to thermal activities of the 1st stage (the Miocene to the Pliocene), and the mineralization which closely resembles hot spring type gold ore deposit corresponds to thermal activities of the 2nd stage (the Pliocene to the Pleistocene) in view of the assemblage of ore mineral and alteration mineral in this area.

5-2 Geochemical survey

5-2-1 Purpose of survey and survey method

Since hot spring type Au mineralization can be expected in this area, soil geochemical survey was carried out together with geological survey to detect the center part of mineralization and to disclose its extension. Soil layer B was sampled using a hand auger or scoop at places along the survey route which was selected away from the valley or on the ridge. The sampling interval was 100 to 200 m, and closer intervals in vicinities of the mineralized outcrops (Figure A-1). At each sampling points, recorded were the test sample No., color, component material of soil, depth of sampling, and geological condition, etc. 205 test pieces were sampled.

5-2-2 Analysis component, analysis method and data processing

205 test pieces of soil samples were processed by the method shownin Figure A-4. In accordance with methods shown in Figure A-5, Au and Ag were analyzed by the atomic absorption method, five components, Cu, Pb, Zn, Mo and As were analyzed by the Plasma emission spectrochemical analysis (ICP), and Hg by the reduction evaporation atomic absorption method. Detectable limit of these elements in analysis is 0.01 ppm for Au, 0.1 ppm for Ag, 1 ppb for Hg, and 1 ppm for other elements.

The analyses results of 205 samples for 8 elements were input to computer and processed statistically (Table A-6).

(1) Univariate analysis

To determine the anomalous value for each element, a histogram, boxplot and density traces (Kurzl,H. 1988) were prepared (Figure A-6).

To determine the threshold value, "Exploratory Data Analysis (EDA)" of Kurzl, H. (1988) is excellent. Unlike conventional Lepelttier (1964) and Sinclair (1974), this method is always capable of processing statistical numerical values objectively without being affected by type of distribution of data, and detecting appropriate anomalous value group. This can be highly evaluated (Table II-5-1).

(2) Multivariate analysis

Multivariate analysis comes in various methods, Among them, factor analysis is effective as an analysis method which is designed to explain variations represented by multiple variables using a much fewer representative, hypothetical variations (factors), thereby scientifically attaining simplicity. To explain relationships of each sample with mineralization or characteristics of host rock, this method indicates certain factor to each sample by assignig factor score in proportion of participation.

For computation concerning five elements Cu, Pb, Zn, As and Hg (except Au, Ag and Mo, which samples exceeded 95 % below the detectable limit in analysis), data were processed by varimax rotation, one of factor analysis method. As a result, two factors were identified, namely ① Hg-Pb and ② Zn-Cu. A correlation matrix between elements is shown on Table II-5-2, and factor loading, communality and factor contribution as identified by factor analysis, on Table II-5-3, and the factor score of each factor for individual sample, on Table A-6.

5-2-3 Results of analyses

(1) Univariate analysis

Concentration distribution for each element obtained during data processing is shown in Fig.II-5-3. The concentration was classified into five grades respectively, and numerical values of EDA were used for the boundary value.

For Au, Ag and Mo, the concentration distribution charts are not given because over 95 % of the samples were below the detectable limit in analysis.

1) Gold: 0.06 ppm is observed for 1 sample in white argillized alteration zone (hot spring type gold ore deposit zone) in eastern slope of Cerro Barranco Amarillo (hereinafter called CBA), 0.08 ppm for 1 sample in right below the said alteration zone, and 0.38 ppm for 1 sample in the northeastern part.

2) Silver: 0.4 ppm is observed for 1 sample in white argillized alteration zone in eastern slope of CBA.

3) Copper: Anomalous zones, more than 72.5 ppm threshold value, were widely detected in a slope along small valley including white argillized alteration zone in eastern slope of CBA (Fig.II-5-3(1)), in white clay alteration zone in the west of the Caimito South mine-

Table II–5–1 Geochemical statistic data

	L. Fence	L. Wisker	L. Hinge	Median	U. Hinge	U. Wisker	U. Fence	Min.	Max.
Au	–	–	–	–	–	–	–	0.00	0.38
Ag	–	–	–	–	–	–	–	0.0	0.4
Cu	12.50	24.00	35.00	42.00	50.00	72.00	72.50	15	185
Pb	5.50	9.00	16.00	20.00	23.00	26.00	33.50	1	125
Zn	-5.00	20.00	28.00	39.00	50.00	64.00	83.00	7	121
Mo	–	–	–	–	–	–	–	0	2
As	-1.00	0.00	2.00	3.00	4.00	5.00	7.00	0	10
Hg	-48	47	78	121	162	225	288	18	783

Table II–5–2 Correlation matrix of minor elements of geochemical data

	Cu	Pb	Zn	As	Hg
Cu	1.000				
Pb	.113	1.000			
Zn	.412	.241	1.000		
As	.164	.076	.213	1.000	
Hg	-.207	.555	-.069	-.017	1.000

Table II–5–3 Results of factor analysis of geochemical data

	Factor Loadings		Communality
	Factor 1	Factor 2	
Hg	-0.625 -0.755	-0.458 -0.178	0.602 0.601
Pb	-0.772 -0.734	-0.058 -0.248	0.599 0.601
Zn	-0.330 -0.083	0.567 0.651	0.430 0.430
Cu	0.161 0.094	0.622 0.636	0.413 0.413
As	-0.154 -0.032	0.283 0.321	0.104 0.104
Factor Contributions	22.9 22.5	20.0 20.5	42.9 43.0

upper: before varimax rotation
lower: after varimax rotation

ralized zone and in the silicificated alteration zone (porphyry copper type mineralized zone) on its southern side where limonite veinlets are locally observed. In addition, small scale anomalous zones were detected at three places in the western slope of CBA.

4) Lead: Anomalous zones, more than 33.5 ppm threshold value, were widely detected in a slope with a gradual descent in the west of CBA, middle scale anomalous zones in eastern and southeastern slopes of CBA, and small scale anomalous zones in the north of Caimito South mineralized zone (Fig.II-5-3(2)).

5) Zinc: Anomalous zones, more than 83.0 ppm threshold value, were detected below a steep slope in the west of CBA, middle scale anomalous zones in a part of eastern slope of CBA and about 1 km southeast of the Caimito South mineralized zone (Fig.II-5-3(3)).

6) Molybdenum: Eight samples showed 1 ppm and one sample 2 ppm scatteringly in areas other than the CBA mineralized zone.

7) Arsenic: Anomalous zones, more than 5.0 ppm auxiliary threshold value, were detected at two places in the southeastern slope of CBA, and at one place each below the steep in the west, and north of CBA. also small to middle scale anomalous zone was detected at one place in white alteration zone in the west of the Caimito South mineralized zone, and at four places in valley in the south of the said mineralized zone (Fig.II-5-3(4)).

8) Mercury: High anomalous zones, more than 288.0 ppb threshold value, were observed on the ridges right above the Caimito South mineralized zone and southeast of the said mineralized zone (Fig.II-5-3(5)). Low anomalous zones more than 225.0 ppb in auxiliary threshold value are distributed in middle scale around the high anomalous zones, and also are scattered at two places in the southwestern to western slopes of the CBA, and in small scale along the ridges in the northeast and north of the CBA.

(2) Multivariate analysis

More than 1.5 points earned in absolute value for each factor was rated as a high factor score, more than 0.5 and less than 1.5 as a medium factor score, and more than 0.0 and less than 0.5 as a low factor score. Fig.II-5-4 shows a factor score distribution chart.

Negative high to medium score zone of the first factor, which corresponds to Hg-Pb elements and includes a mercury anomalous zone. These zones are distributed in southeastern and western slopes of the CBA, northeastern and northern ridge lines of the CBA, right above the Caimito South mineralized zone and ridge in the southeast of the said mineralized zone. On the other hand, positive high to medium score zones are distributed in the same areas as the copper anomalous zones, which occur at the white argillized alteration zone in the eastern slope of the CBA, and at the west of the Caimito South mineralized zone.

Zones which earned positive high to medium factor scores in the second factor (Zn-Cu) are scattered, and overlaps with a part of the copper or zinc anomalous zone, and also with a part or almost all of the copper or zinc anomalous zone especially in white argillized alteration zone in the eastern and western slopes of the CBA and in the west of the Caimito South mineralized zone. On the other hand, zones which earned negative high to medium factor scores were widely detected in the southwestern slope of the CBA and in the northwest of the area, in addition, in the silicificated zone at the mountaintop of CBA and Caimito South mineralized zone.

5-2-4 Consideration

A comprehensive geochemical anomalies (Fig.II-5-5) were detected through determining process of the threshold value for each element by univariate analysis and anomalous factor score zones (positive and negative) for both factors by multivariate analysis (factor analysis). Comprehensive geochemical anomalous zones were selected and delineated at four places, where anomalies are overlapped, by means of superimposing geochemical anomalous zones for each element, and high and medium score zones for each factor. Constituents for each comprehensive geochemical anomalies are shown in Fig.II-5-6, which consist of geochemical anomalous zones of each element, and high or medium factor scores (called "*anomalous*" in *Fig.II-5-6*).

The comprehensive geochemical anomalous Zone I is an anomalous zone corresponded to the Caimito South mineralized zone, and consists of two parts: one is the silicificated zone of said "anomalous" at the mountaintop in the east; the other is white argillized alteration zone in the west.

The comprehensive geochemical anomalous Zone II is an anomalous zone indirectly corresponded to the CBA mineralized zone. This anomalous zone is considered to be a pseudoanomalous zone resulted from synergy of halo ① and halo ②. The western slope of the CBA is steeper than the eastern, therefore the elements moved from the mineralized zone to halo ① on the gradual descent slop. Halo ② occurred by releaching of the elements from ore boulders.

The comprehensive geochemical anomalous zone III corresponds with the CBA mineralized zone. This anomalous zone is considered to be a white argillized alteration parts of the silicificated zone, at and below the mountaintop, and in the area of ore boulders.

The comprehensive geochemical anomalous zone IV is an anomalous zone corresponds to a part of boulders in the southeastern part of the Caimito South mineralized zone.

In this area, hot spring type Au mineralization and porphyry copper type mineralization are overlapped as mentioned above. Yet, large number of samples are left unused because their minor element contents in soil are below the detectable limit in analysis. Therefore, it is difficult to detect the indication elements for each mineralization. Since, the comprehensive geochemical anomalous zone is distributed around the outcrops of the hot spring type Au mineralization and around their boulders, the objectives of the survey have been fully accomplished.

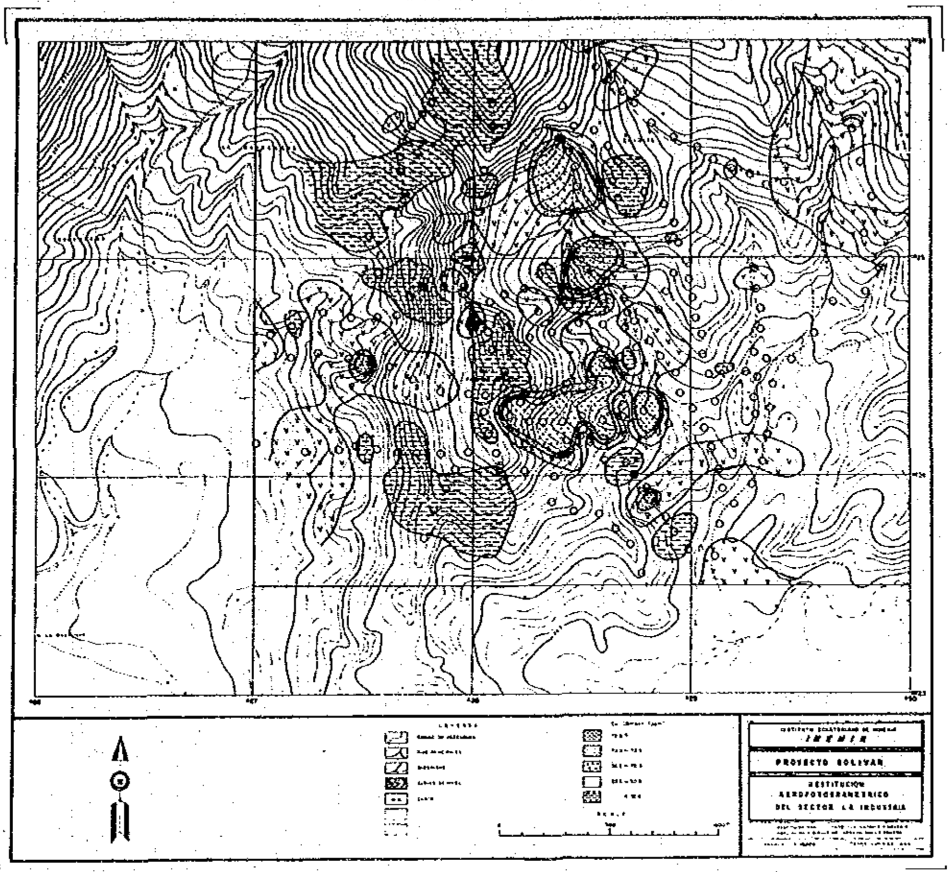


Fig. II–5–3(1) Distribution map of minor element in soil of the La Industria-Yatsubi area (Cu)

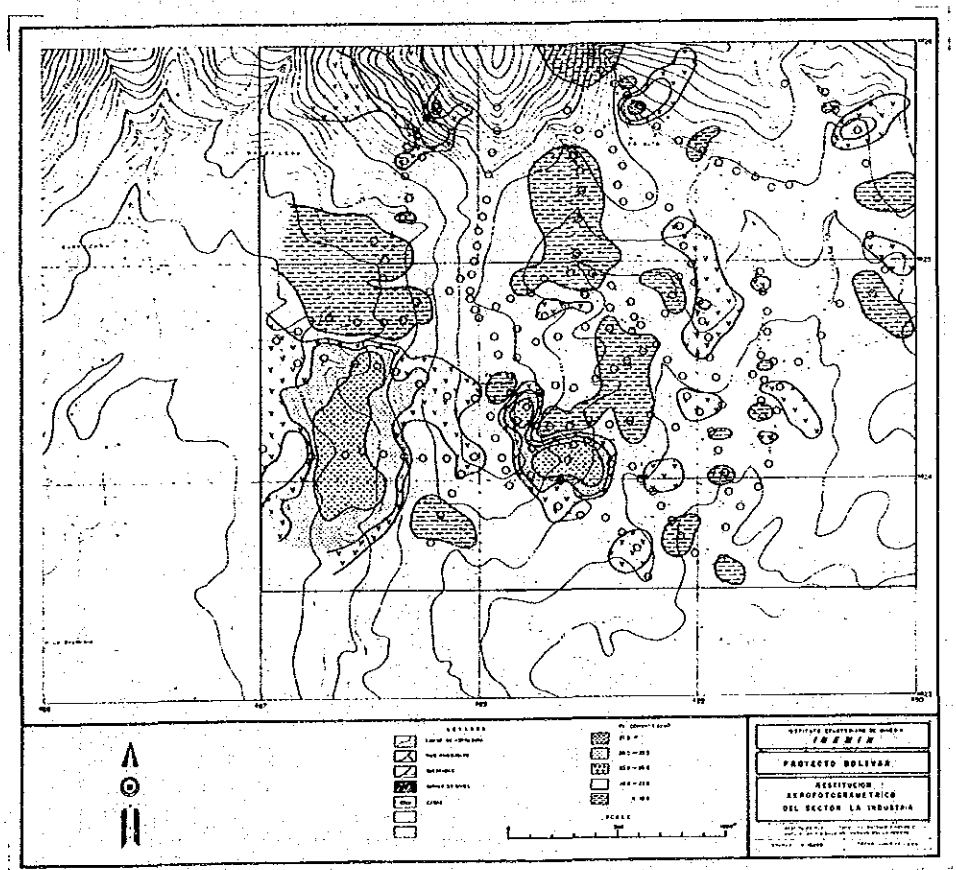


Fig. II–5–3(2) Distribution map of minor element in soil of the La Industria-Yatubi area (Pb)

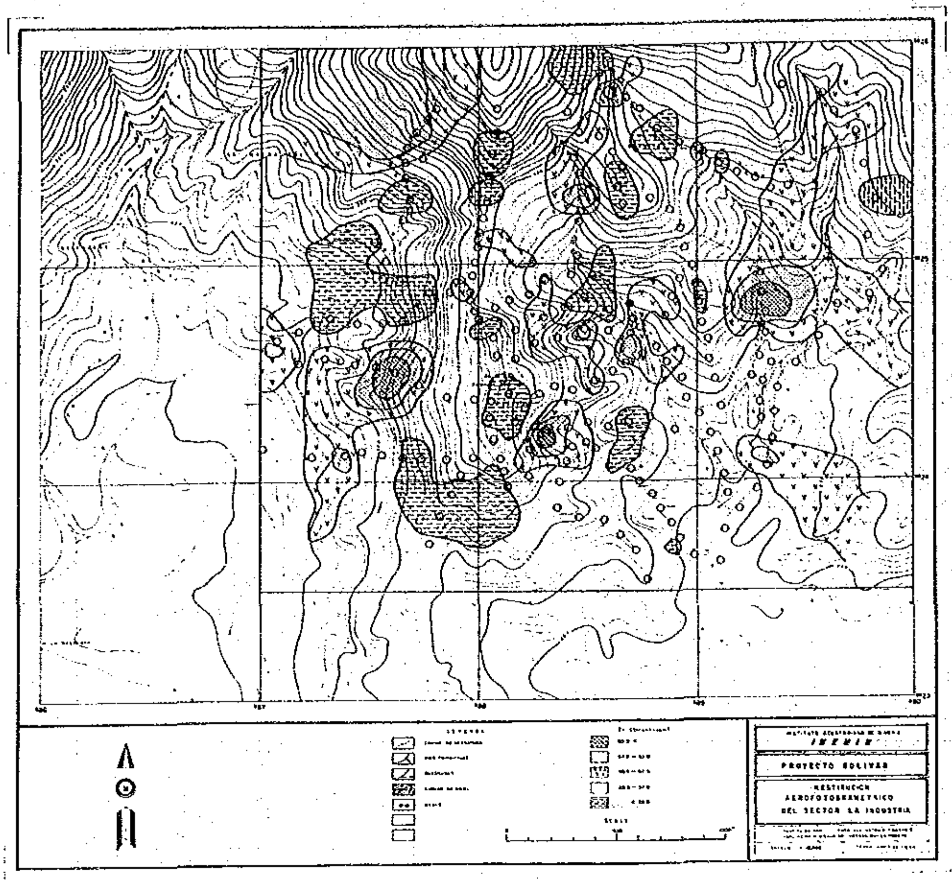


Fig. II–5–3(3) Distribution map of minor element in soil of the La Industria-Yatubi area (Zn)

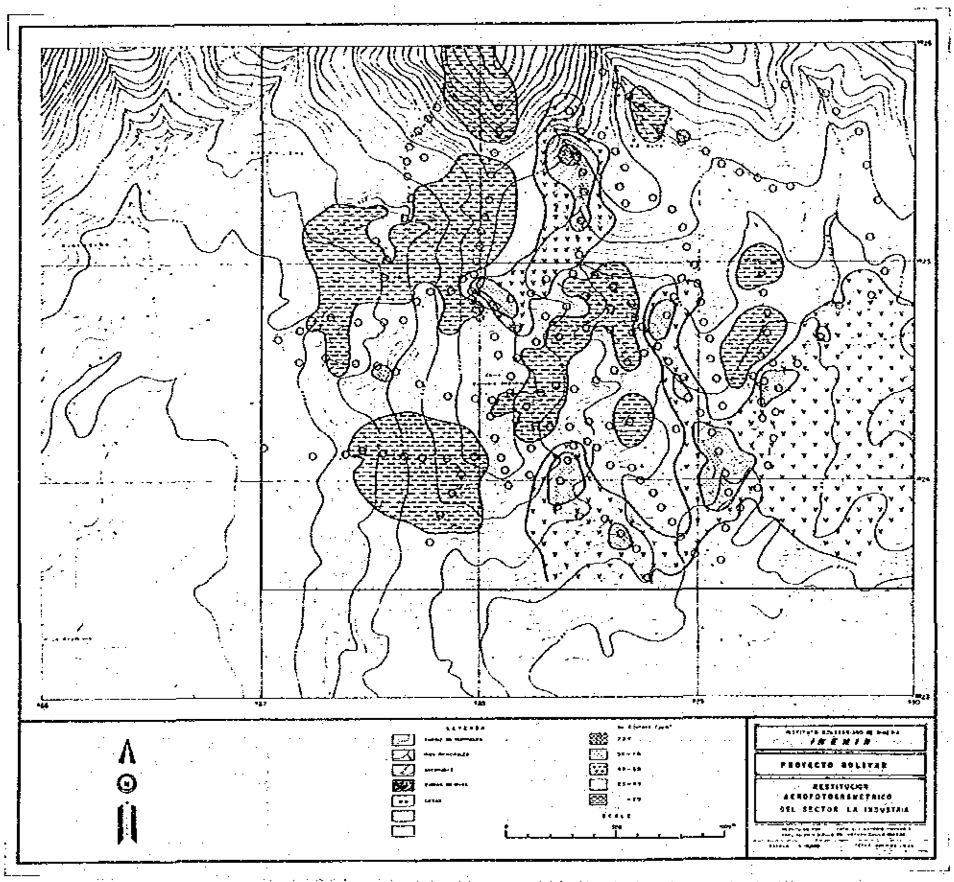


Fig. II–5–3(4) Distribution map of minor element in soil of the La Industria-Yatubi area (As)

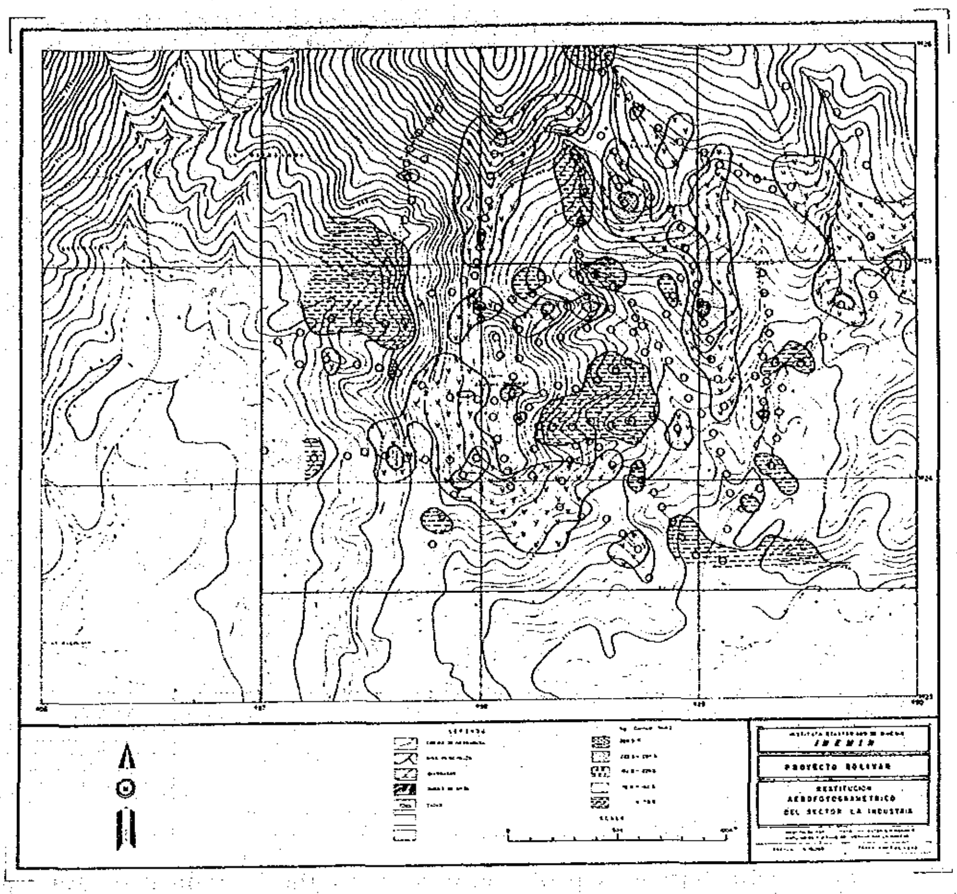


Fig. II–5–3(5) Distribution map of minor element in soil of the La Industria-Yatubi area (Hg)

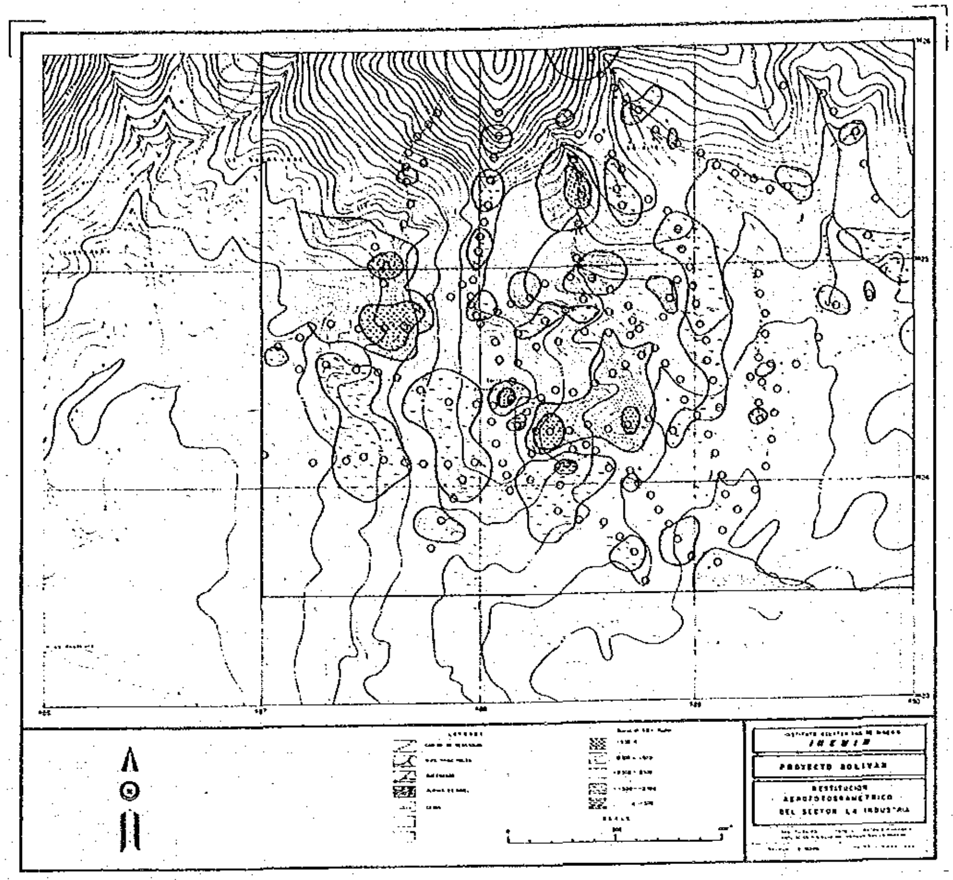


Fig. II–5–4(1) Distribution map of factor score of the La Industria-Yatubi area (Hg-Pb)

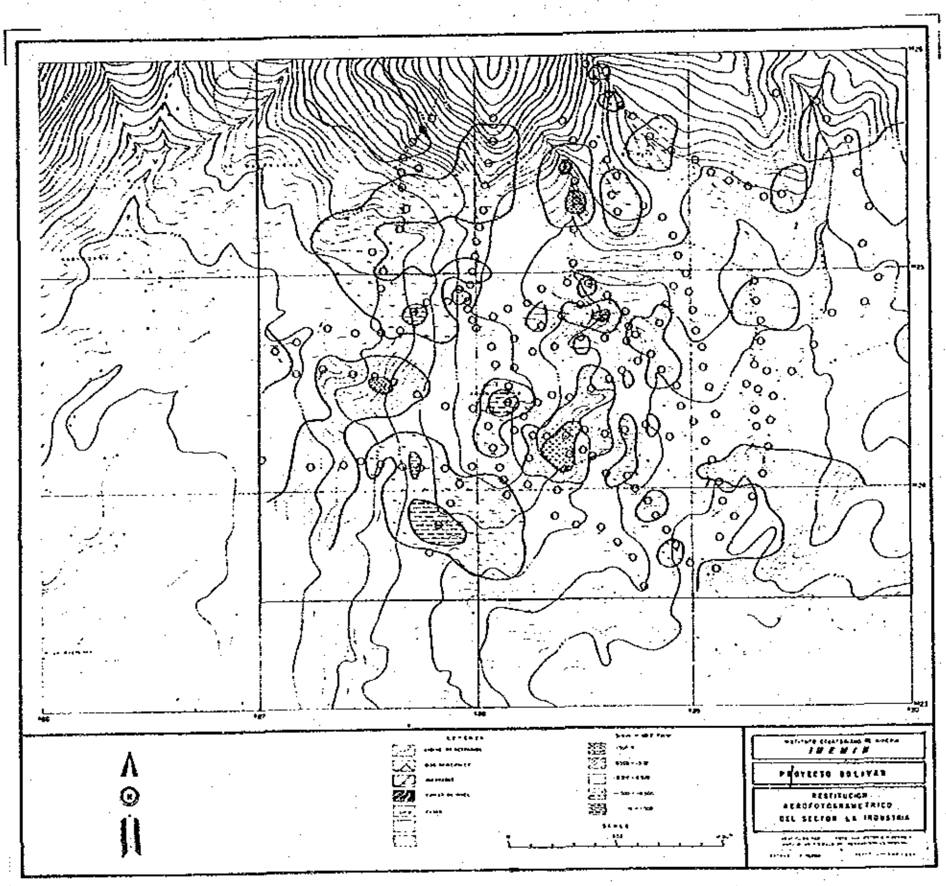


Fig. II–5–4(2) Distribution map of factor score of the La Industria-Yatubi area (Zn-Cu)

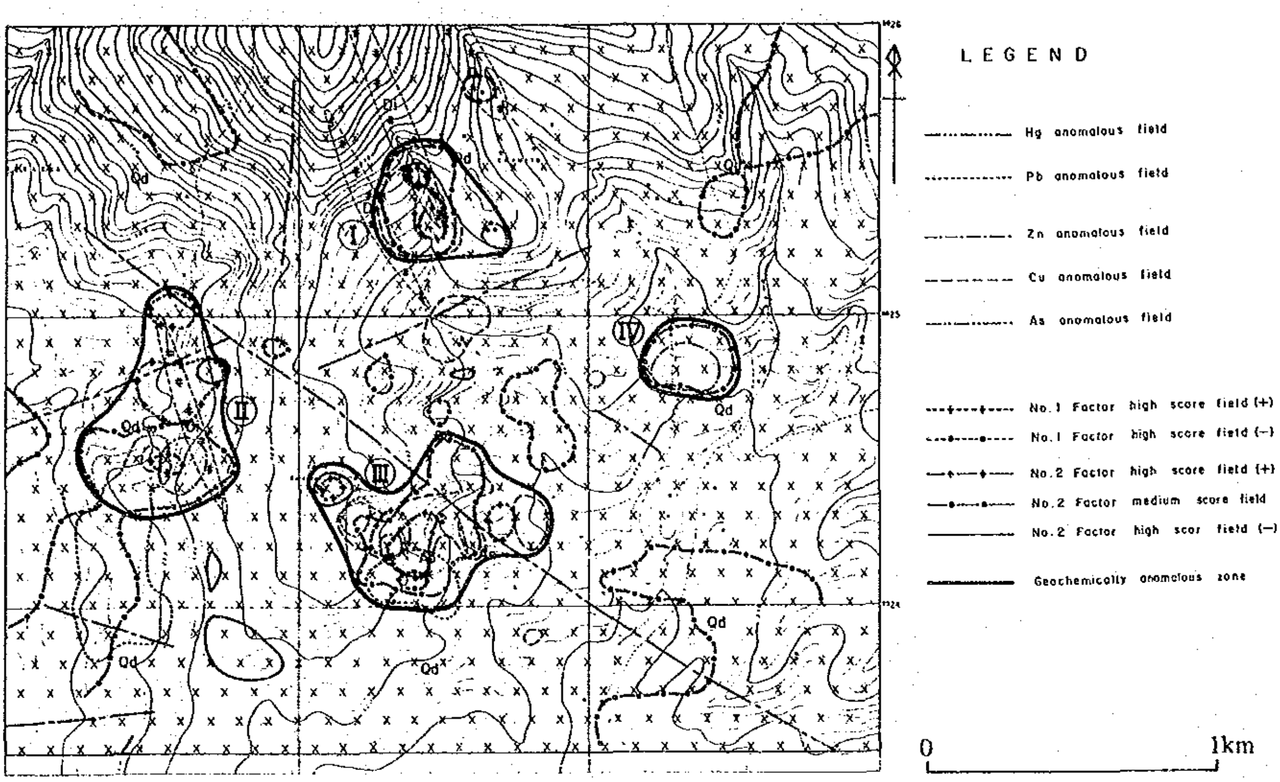


Fig. II–5–5 Synthetic geochemical anomaly map of the La Industria-Yatsubi area

Anomaly	Element	Synthetic geochemical anomalous zone			
		I	II	III	IV
No.1 Factor high score (+)	Hg, Pb	////	////	////	
No.1 Factor high score (–)	–Hg, –Pb			////	
No.2 Factor high score (+)	Cu, Zn	////	////	////	
No.2 Factor high score (–)	–Cu, –Zn		////	////	
No.2 Factor medium score	Cu, Zn	////	////	////	////
Hg anomaly	Hg	////			
Pb anomaly	Pb		////	////	
Zn anomaly	Zn		////	////	////
Cu anomaly	Cu	////	////	////	
As anomaly	As	////			

Fig. II–5–6 Constituents of synthetic geochemical anomalous zones

Chapter 6 Las Guardias area

The Las Guardias area is situated 5 km southeast of the Balzapamba area. It takes half an hour by car. In this area, detailed geological survey was made.

6-1 Geological survey

6-1-1 Purpose of survey and survey method

The purposes of this survey is to clarify the relationship between mineralization, and geological structure and igneous activity, and to detect prosperous mineral showings based on the results.

Before starting the survey, a base map was prepared by using the topographic map at a scale of 1:5,000 which was enlarged from the 1:10,000 map prepared in the Phase I survey. The routes were selected by studying existing geological data. In compiling the data and route map, aerial photographs were used to summarize onto a topographic map at a scale of 1:10,000. The magnetic susceptibility measurement was taken place for each outcrop along the main routes using a portable magnetometer, contemporaneously with geological survey, in order to investigate the relationship between mineralization and magnetic susceptibility.

6-1-2 Geology

The area is underlain by the Macuchi Formation and granitic rocks which were emplaced in the Macuchi Formation (Plate II-6-1, Fig.II-6-1 and Fig.II-6-2).

(1) Macuchi Formation

The Macuchi Formation consists of member An-1 and member Qan-1. Member An-1 corresponds to the member A of the Balzapamba area, and member Qan-1 to the member B respectively.

1) Member An-1

Member An-1 of the Macuchi Formation is distributed in the southwestern part (southern bank of river Rio Jorge) and the northern part. Lithology mainly comprises coessential tuff (Tf).

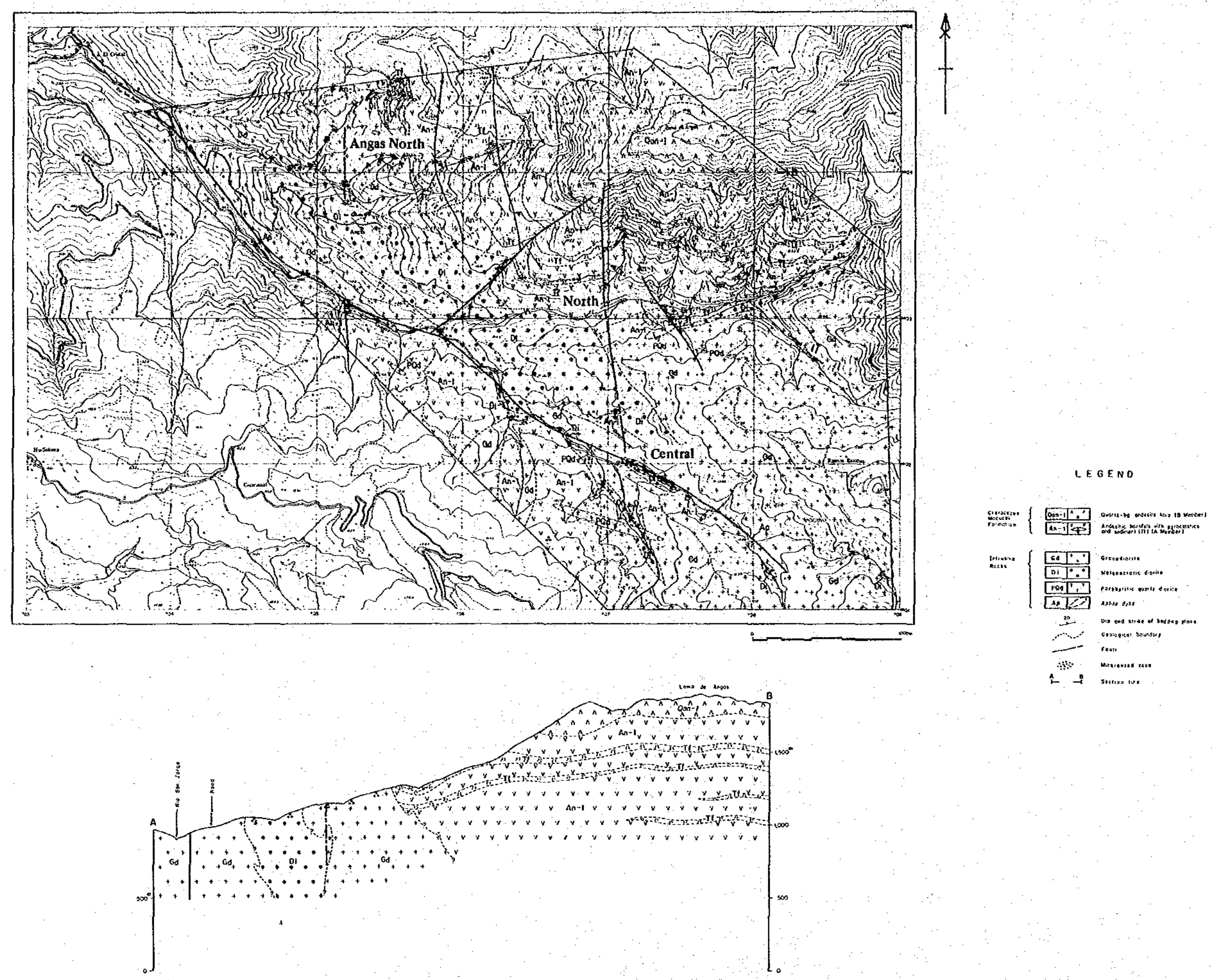
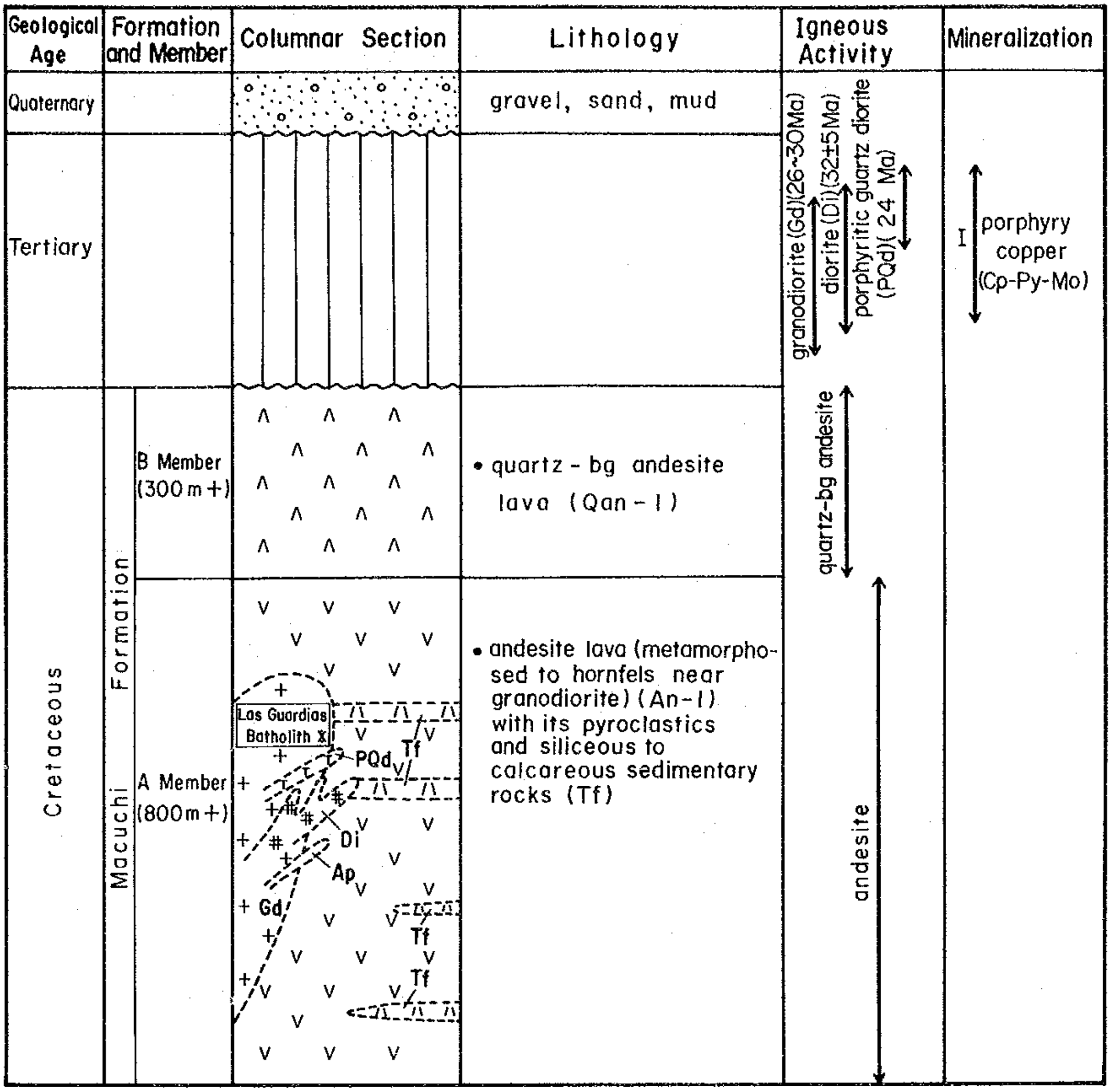


Fig. II–6–1 Geological map and mineral showings of the Las Guardias area



※ Las Guardias Batholith does not show the geological time of its intrusion but its occurrence.

Fig. II–6–2 Generalized stratigraphy in the Las Guardias area

2) **Member Qan-1**

Member Qan-1 of the Macuchi Formation is distributed only in vicinities of the summit of Mount Loma de Angas (altitude: 2,057 m) in the north. Lithology is andesite lava in dark gray with quartz phenocryst.

(2) Granitic rocks

Granitic rocks are distributed in the northwestern part to central part and in the southern part, and consist of melanocratic biotite-hornblende granodiorite to quartz diorite batholith (Gd), melanocratic diorite dike (Di) and porphyritic quartz diorite dike (PQd) and aplite dike (Ap).

1) **Leucocratic biotite-hornblende granodiorite to quartz diorite batholith (Gd)**

Leucocratic biotite-hornblende granodiorite to quartz diorite batholith (Gd) are widely distributed in the northwestern to southern parts. Lithology is holocrystalline and equi-granular (medium-grain through coarse-grain). Hornblende is observed here more than in the Balzapamba area. Coarse grain tends to dominate in the northeast and south, and both coarse and medium grains in the central part.

2) **Melanocratic diorite dike (Di)**

Melanocratic diorite dike (Di) are intruded into the northern, central, and southern parts of Angas. The scale of each intrusive rocks are as follows:

① In the northern part of Angas, four rock bodies (NE-SW trend for 3 bodies, sheet-like for 1 body) are observed. The scale of the rock bodies is presumed to range from 150 m long and 30 m wide to 100 m long and 20 m wide.

② In the central part, 1 rock body (NE-SW trend for 1 body) is observed. The scale of the rock body is presumed to be about 3 km long and 0.7 km wide.

③ In the southern part, four rock bodies (NW-SE trend for 3 bodies, sheet-like for 1 body) are observed. The scale of the rock bodies is presumed to range from 900 m long and 80 m wide to 100 m long and 20 m wide.

④ In the eastern part, seven rock bodies (NE-SW trend for 3 bodies, NW-SE trend 1 body and sheet-like for 3 bodies) are observed. The scale of these rock bodies is presumed to range from more than 1.5 km long and 200 m wide to 100 m long and 20 m wide.

For the rock body which is intruded into the central part mentioned in ②, conducted were microscopic observation, isotopic age determination and chemical analysis of whole rock.

The microscopic characteristics are as follows:

Melanocratic diorite (A2092)

Location: 1.5 km southeast of Angas, along the river Rio San Jorge

Texture: Holocrystalline, equi-granular

Constituent minerals: Plagioclase > hornblende > quartz, biotite > apatite, opaque minerals

Alteration minerals: Chlorite > sericite, epidote, leucoxenebiotite is locally affected by chloritization and epidotization.

3) Porphyritic quartz diorite dike (PQd)

The porphyritic quartz diorite dike (PQd) is observed in the central, southern and eastern parts. The direction and scale of intrusion are presumed as follows:

① In the central part, 1 rock body, the intrusion is in NW-SE direction. The scale of the rock body is 150 m long and 40 m wide.

② In the southern part, 2 rock bodies, in WNW-ESE, 800 m long and 60 m wide, and in N-S, 150 m long and 30 m wide.

③ In the eastern part, 2 rock bodies, in NE-SW, 200 m long and 80 m wide, and in NE-SW, 100 m long and 30 m wide.

For the rock body which is intruded in N-S direction into the southern part mentioned in ②, conducted were microscopic observation, isotopic age determination and chemical analysis of whole rock.

The microscopic characteristics are as follows:

Porphyritic quartz diorite (A2076)

Location: 2.3 km southeast of Angas, along the river Rio San Jorge

Texture: Porphyritic

constituent minerals: Plagioclase > quartz, hornblende > biotite > apatite, opaque minerals

Alteration minerals: Albite, chlorite > biotite, sericite, epidote, leucoxene

Biotite is locally affected by chloritization and epidotization, and plagioclase is also locally metamorphosed to albite.

4) Aplite dike (Ap)

Aplite dikes (Ap) are observed in the northern part of Angas (1 rock body, sheet-like), in the northwestern part (1 rock body, NW-SE trend), and in the southern part (2 rock bodies, NE-SW trend). The scale of the rock bodies is all small and presumed to be less than 100 m long and less than 10 m wide.

Porphyritic quartz diorite dike (PQd) and Melanocratic diorite dike (di) are dated as 23.9±4.8 Ma and 31.6±4.7 Ma respectively as shown on Table II-3-1. The biotite-hornblende-quartz diorite conducted in the Phase I survey were dated as 30.1±1.1 Ma by K-Ar method.

Chemical analyses of these rocks (PQd and Di) are shown on Table II-3-2, and SiO2-FeO*/MgO chart and normative quartz-orthoclase-plagioclase triangular chart in Fig.II-3-3 and Fig.II-3-4 respectively.

(3) Geological structure

For the geological structure in this area, NW-SE trend develops characteristically while NE-SW trend dominates in other areas. This is indicative for mineral exploration. For instance, faults which continues from the northwest to the southeast along the river San Jorge, melanocratic diorite dikes, and the mineralized zones extend in the NW-SE direction. In addition, NE-SW trend and N-S trend faults and N-S trend fold axis in the Macuchi Formation can be cited. This area is situated on the extension of the NE-SW trend structure, which develops in the Balzapamba area, and situated also in and around the intersection of NE-SW and NW-SE trends.

6-1-3 Mineralization and alteration

Trough the Phase II survey confirmed are twelve copper mineralized zones including zones confirmed last year. In these mineralized zones, porphyry-copper type mineralization is observed in granodiorite and the Macuchi Formation (Fig.II-6-1).

In the mineralized zones in this area, chalcopyrite and pyrite are present as scattered dissemination and film-like veinlets. In granitic rocks, both dissemination and veinlets are observed, while veinlets tend to abound in the Macuchi Formation. Molybdenite is locally observed in quartz veins.

For alteration, the chalcopyrite-pyrite mineralized zone is affected by silicification and chloritization, and the former is noticeably observed. Secondary biotite and epidote are locally observed. White alteration zone is also locally observed. Pyrite is only the ore minerals that exist in this alteration zone.

The principal mineralized zones in this area are scattered on the peripheral part of the melanocratic diorite intrusive rocks and along the faults in NW-SE trend. Individual mineralized zones trend mostly toward the NW-SE. These mineralized zones can be divided into three zones: Angas North; North; and Central.

The properties of these mineralized zones are as follows:

(1) Angas North mineralized zone

Angas North mineralized zone is situated around northwest of Angas. The mineralized zone comprises chalcopyrite-pyrite-(molybdenite) dissemination and veinlets which occur in melanocratic diorite and granodiorite. The individual mineralized zones are scattered in an area of 250 m x 500 m. The assay of ore samples was 0.2 g/t in Au, 8.3 g/t in Ag, 0.35 % in Cu and 0.79 % in Mo at maximum. Microscopic observation of sample No. C2043 showed that chalcopyrite, pyrite in broken form, molybdenite in dendritic form, sphalerite, and covelline occur in chalcopyrite-pyrite-molybdenite ore. Alteration of the host rock is characterized by silicification and chloritization. In addition X-ray diffractive analysis identified sericite.

(2) North mineralized zone

North mineralized zone is distributed along the river San Jorge in south of Angas. The mineralized zone occurs as chalcopyrite-pyrite dissemination and veinlets along NW-SE trend faults, in melanocratic diorite, granodiorite, and the Macuchi Formation. Dissemination zones with 50 m wide were detected at two places, which were thought to be as a principal mineralized zones in the Phase I survey and the other zone detected in the Phase II survey, are scattered further in an area of 100 m x 400 m in NW-SE direction. Individual dissemination and veinlet zones trend also toward the NW-SE. The host rock is subjected to strong silicification and biotization. Assay results of ores show 0.6 g/t in Ag and 0.04 % in Cu at maximum.

(3) Central mineralized zone

The mineralized zone in the central part is situated in Motilones valley. The mineralized zone comprises chalcopyrite-pyrite dissemination and veinlets in melanocratic diorite, granodiorite and the Macuchi Formation. The individual mineralized zone is scattered in an area of 50 m x 350 m. Assay results of ores show 0.2 g/t in Au, 2.1 g/t in Ag and 0.47 % in Cu at maximum. The host rock is affected by strong silicification and weak chloritization. In addition X-ray diffractive analysis identified sericite.

6-1-4 Results of magnetic susceptibility measurement

The data of the magnetic susceptibility measurement were analyzed in the same manner as in the Chaso Juan area. The result is shown together with geology in Fig.II-6-3.

For high and medium magnetic susceptibility anomalous zones, detected are small and intermittent zones at 20 places. Among them, 16 places are distributed in the northeastern to southern parts. These demagnetization are considered to be caused by mineralization. Four anomalous places in the north and northeast coincide with the tuff area in the Macuchi Formation.

6-1-5 Consideration

As the result of the geological survey, magnetic susceptibility measurement and rock geochemical survey for two years, the properties of the mineralized zone in this area are as follows.

The principal mineralized zones are distributed along the faults in NW-SE trend and on peripheral part of melanocratic diorite intrusive rocks trending toward the NW-SE. The direction of mineralized zones and intrusive rocks in the Balzapamba area and Telimbela area harmonize with those of the major tectonic lines, which extend from the central part of Ecuador to the north. Mineralization in this area, in contrast to NE-SW trend, is associated with the faults or intrusive rocks trending toward the NW-SE which may be a conjugate set of major tectonic lines.

The Angas North mineralized zone is situated at the intersection of two directions: NW-SE direction and NE-SW direction. In the former direction line up three mineralized zones, Angas North, North, and Central zones, while in the latter direction line up other mineralized zones such as El Torneado, Osohuayco, and Angas North. A intersection is preferable as structural trap or ore shoots for mineral deposits. This is the point why these mineralized zones have been taken up for the Phase II survey. Though mineralized outcrops are proved to contain high metal contents in gold, silver and copper, each mineralized zone in this area is small in scale and discontinuous.

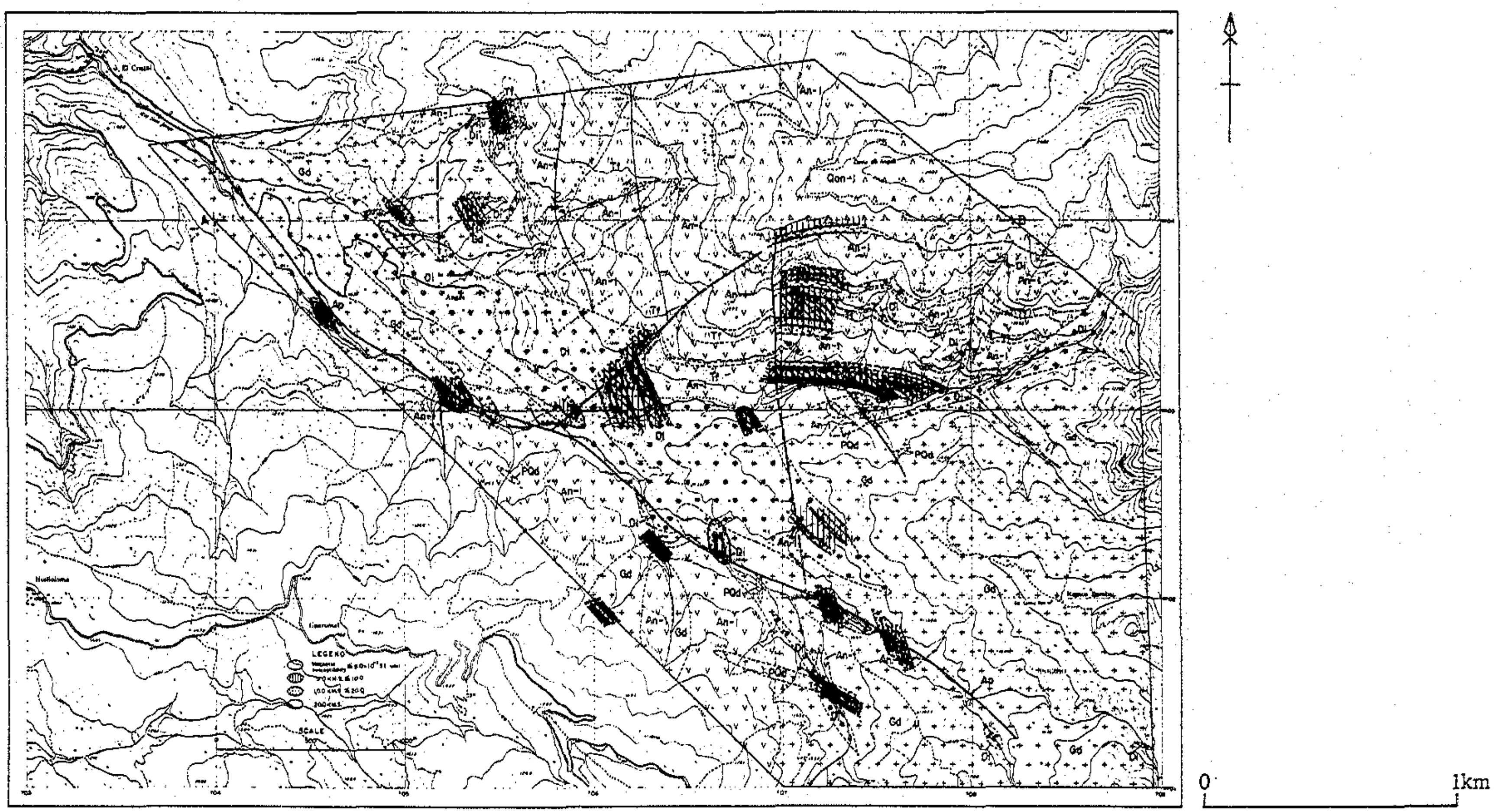


Fig. II–6–3 Interpretation map of magnetic susceptibility of the Las Guardias area

PART Ⅲ CONCLUSIONS AND RECOMMENDATIONS

Chapter 1 Conclusions

1-1 El Torneado zone, Balzapamba area

Mineralization observed in the El Torneado zone is of the porphyry copper type, and is divided into two sub-zones on the basis of their modes of occurrence: namely, a "dissemination" zone and a "network" vein zone. The former extends over an area of about 400 m x 400 m. The latter is distributed within the former zone in the direction of NNE-SSW, at a scale of 40 to 70 meters in width and 70 to 350 meters in length. The two zones are distributed in the manner where the former zone is cut by the latter. The geologic age of mineralization is earlier in the former.

The dissemination zone extends from and around Mineralized zone B. The assay results of the samples taken therein show that the representative mineral in this zone is Cu with the maximum metal content of 0.03 %. The network vein zone corresponds to Mineralized Zones A, C, D and E. The representative mineral in these zones is also Cu. The maximum Cu contents are 0.66 % in Zone A and 0.03 % in Zone D.

The Phase II geophysical survey revealed the conditions of occurrence of sulfide minerals in the lower part of the mineralized zones. The geological and drilling surveys conducted in the mineralized zones in which Phase I had revealed the conditions of mineral occurrence horizontally and vertically, as well as the states of paragenesis and alteration of constituent minerals microscopically. Since the results of the Phase II drilling indicate that the lower limit of the network vein zone was penetrated and that of the disseminated zone was almost reached in this drilling, it may be assumed that the center of mineralization in the El Torneado zone had been subjected to erosion, exposing as a result the lower most part of mineralization on the existing ground surface.

1-2 Osohuayco zone, Balzapamba area

There are two known mineralized zones of different types: one in the northwest and the other in the south. The former is a chalcopyrite-pyrite dissemination and thin vein zone occurring in granodiorite, extending over an area of 100 m x 200 m. Maximum Cu content of the samples taken from the disseminated part is 0.08 %. The latter is a chalcopyrite-pyrite dissemination and small vein zone impregnated in silicified and partly skarnized altered rocks in the tuff bed of the Macuchi Formation. This mineralized zone is primarily distributed in two stripes with a general strike in the direction of NE-SW and a dip of 30°SE. Mineral contents of the samples taken from a lower vein in the northwestern part of the zone are 0.4 g/t in Au, 27.8 g/t in Ag and 2.65 % in Cu. Since the geophysical exploration detected a continuation of high apparent resistivity and high FE (more than 5 %) values with a general dip toward southeast, it is considered that this mineralization extends to a further depth.

The geophysical survey also detected low apparent resistivity and high FE (more than 8 %) values in the northeastern part of the Zone. Although details are yet unknown as this area is covered with weathered soil, this suggests possible existence of an additional concealed mineralized zone in the lower part.

1-3 Chaso Juan area

Mineralization observed in the Chaso Juan area is of the porphyry copper type, and is grouped into four zones: namely, the North zone, the West zone, the South zone, and the Central zone.

In the North zone, mineralized zones are recognized at three locations, each of which extends at a width of 10 to 15 meters and is distributed at an interval of 400 meters. The assay results of the samples taken from one of the three locations are 1.3 g/t in Ag and 0.10 % in Cu.

The West zone is distributed at an approximate width of 25 meters. The assay results of the samples taken from this zone are 0.1 g/t in Au and 1.7 g/t in Ag and 0.24 % in Cu.

In the Central zone, mineral showings are recognized at 11 locations which are distributed sporadically over an area of 600 m x 400 m. The size of the major showing is about 150 meters in length. The assay results are 0.1 g/t in Au, 4.2 g/t in Ag, and 1.41 % in Cu.

The South zone extends over an area of 800 m x 300 m, and is subdivided into the eastern and western parts. The eastern part extends over a length of about 300 m. The assay results of the samples taken therein are 0.1 g/t in Au, 7.6 g/t in Ag, and 1.46 % in Cu. In the western part, there are two stripes of veinlet extending at a width of 1 to 10 centimeters.

From the viewpoint of mineral exploration, the most significant area in the Chaso Juan area is that which extends from the Central zone to the South zone, where the geophysical survey revealed the possible existence of IP anomaly sources, indicating the possibility of the known mineralized zone being larger than is currently recognized.

1-4 Telimbela area

The porphyry copper type mineralization observed in the Telimbela area is the largest in scale in the entire Bolivar area, and its strong mineralization extends to the Macuchi

Formation. Centering around each of the seven mineralized locations within this area, pyrite dissemination and veinlets are widely distributed in granitic rocks. In terms of mineral exploration, abundance of pyrite is quite significant because it means that there had been active hydrothermal activities in this area. Macroscopically, the seven mineralized zones in this area, which are generally arranged in the NE-SW direction, are grouped into the Central, South and North zones.

In the Central zone are distributed Mineralized Zone I and II. The former extends over an area of 500 m x 350 m, and the latter over an area of 200 m x 400 m. The assay results are 1.6 % maximum Cu content in Zone I, and 0.2 g/t, 1.6 g/t and 0.16 % of Au, Ag and Cu in Zone II respectively.

In the South zone are distributed Mineralized Zones III, IV and VII. Zone III extends over an area of 400 m x 900 m, Zone IV over a length of about 150 m, and Zone VII over a length of about 200 m. In every zone, maximum Cu content is 0.05 %.

In the North zone are distributed Mineralized Zones V and VI, which are new zones found in the Phase II survey. The former extends over an area of 400 m x 1,200 m, and the latter over a length of about 400 m. Maximum Cu contents are 0.8 % in Zone V and 1.65 % in Zone VI.

In these mineralized zones, many intrusive rocks are distributed in the direction of NE-SW. In the same direction, there is a geotectonic line continuing from the central part of Ecuador to the northern part and cutting across northern area. This suggests a close correlation between the development of this tectonic line and the igneous and hydrothermal activities in this area.

1-5 La Industria-Yatubi area

Mineralization observed in this area is of two types: namely, hot-spring type Au mineralization and porphyry-copper type mineralization. In the former type of mineralization, a white argillized zone (kaolin) and a silicified zone are distributed in the lower and upper parts respectively. Across the two zones, network veins are recognized, which consist of metallic sinter-acicular minerals-hematite-quartz-kaolin. The assay result shows the maximum Au content of 0.3 g/t. The silicified outcrops are recognized only at the top of mountains (Cerro Barranco Amarillo and Caimito South), the silicified zone turns downward to the kaolinized zone which were observed below the mountaintop. The silicified zone is, therefore, considered to be eroded largely, and the silicified parts at the mountaintop to be the relics of the lower part of the silicified zone.

An alteration zone, which consists of sericitization and weak silicification, is also accompanied by pyrite. This alteration is probably associated with the porphyry copper type mineralization in the northern part of the area.

1-6 Las Guardias area

Mineralization of the porphyry copper type is recognized at 12 locations, all of which are distributed along melanocratic diorite intrusive rocks and a fault in the direction of NW-SE. This direction is in a marked contrast to the NE-SW direction of the mineralization zones and intrusive rocks in other areas.

In the Angas North mineralized zone, mineral showings are sporadically distributed over an area of 250 m x 500 m. Maximum Cu content is 0.35 %. In the North zone, mineral showings are sporadically distributed in the direction of NW-SE over an area of 100 m x 400 m. Maximum Cu content is 0.04 %. These zones are distributed discontinuously.