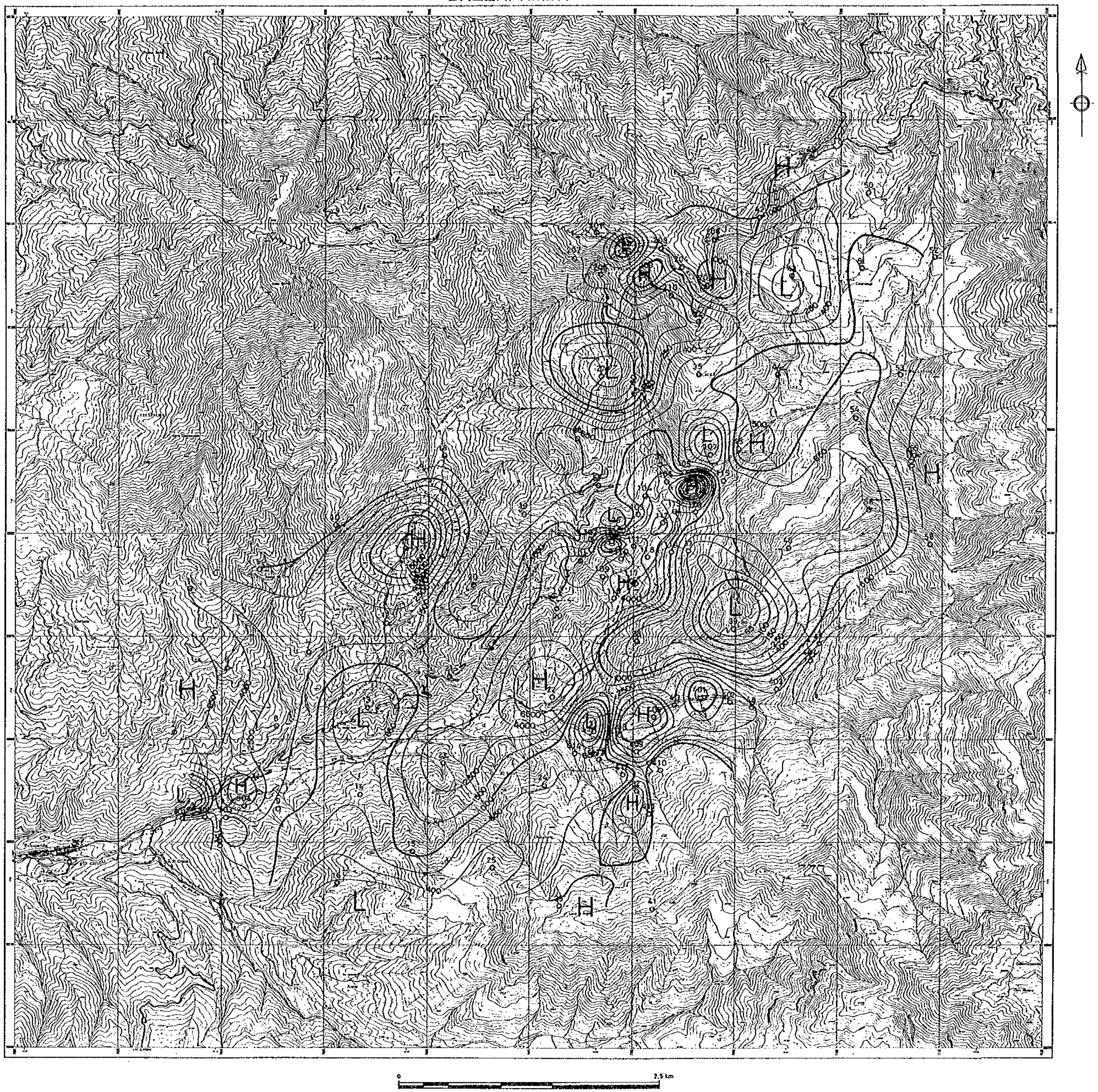
BALZAPAMBA

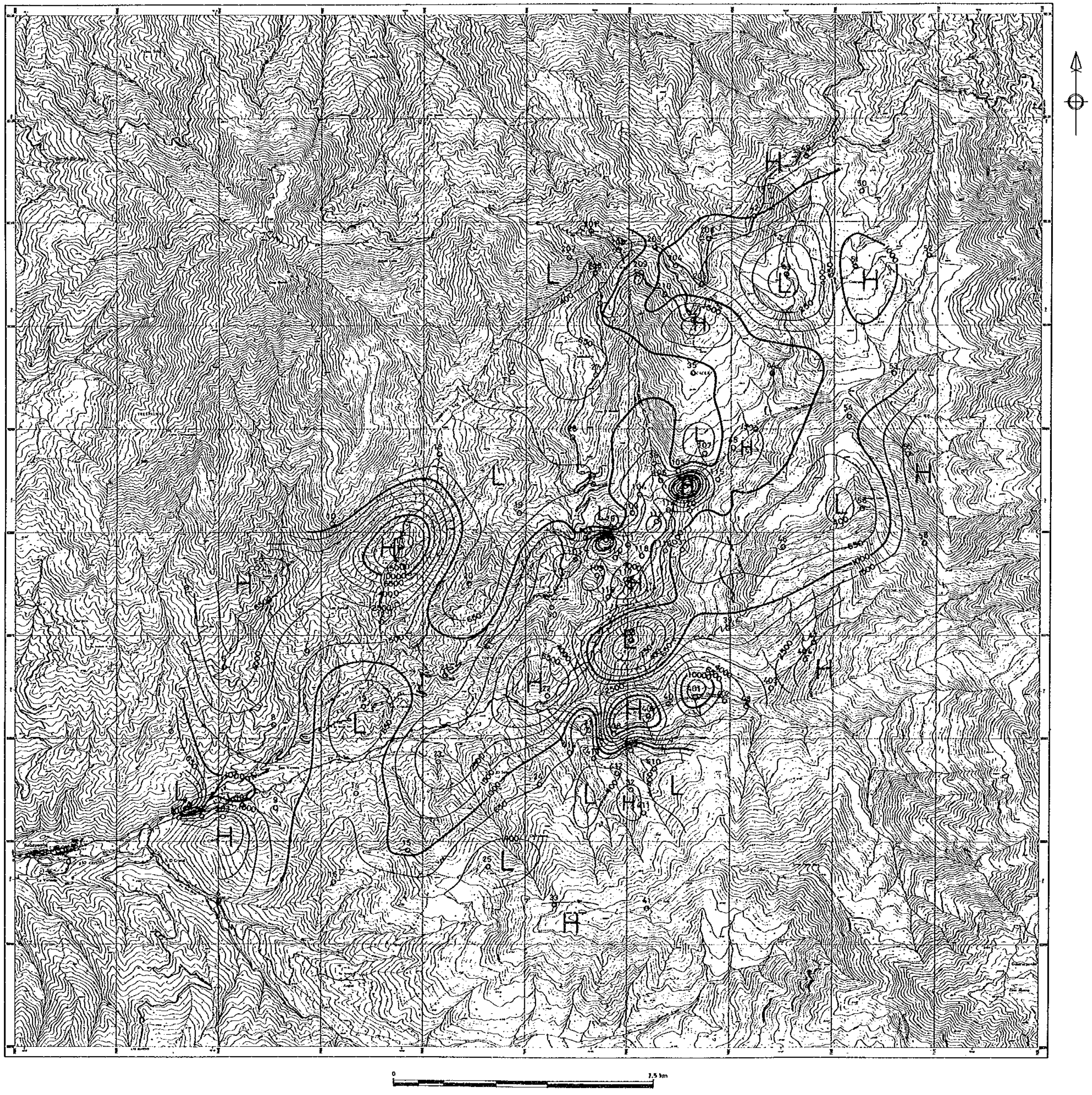


LEGEND

23 ○	Station and No.
66 100 150	Analyzed Resistivity Contour (Ω·m)
H	High Analyzed Resistivity
L	Low Analyzed Resistivity

Fig. II－1－17 Analyzed Resistivity Plan Map (500m depth)

BALZAPAMBA



LEGEND

23 Station and No.

Analyzed Resistivity Contour (Ω·m)

H High Analyzed Resistivity

L Low Analyzed Resistivity

Fig. II-1-18 Analyzed Resistivity Plan Map (1,000m depth)

and further details are unknown because this area was not included in detailed survey areas.

Each of measuring points on the ridge near Bunque Roma including 38, 39, 46, 56 and 58 invariably shows a low resistivity, but presents no indication of mineralized or alteration zones. As has been described in connection with the apparent resistivity maps, this low resistivity is considered to be due to the terrain effect and not related to mineralization or alteration.

Resistivity in granodiorite distribution areas in the western part of the survey area is as low as about 1,000 Ω·m. This is considered mainly attributable to weathering.

Meanwhile, as was observed in the apparent resistivity maps, the distribution of high and low resistivities tends to extend northeast to southwest. This trend is considered indicating the existence of a large geological structure that dominates the whole of this area.

(4) *Analyzed Section*

Figures II–1–19 through II–1–28 show the ten sections made in this survey. Apparent resistivity pseudosection and resistivity structure section are shown in each figure.

Section A (Fig. II–1–19)

This section runs west to east at the center of survey area through the El Tornead mineralized zone.

Low resistivities of about 500 Ω·m are observed at measuring points 29 and 103 as is clear from the apparent resistivity pseudosection. Geology in vicinities of these measuring points consists of granodiorite and its resistivity is estimated at about 5,000 to 10,000 Ω·m based on results of property tests and comparison between geological maps and analyzed resistivity. Consequently, a resistivity of about 500 Ω·m can be considered as a considerably low resistivity for granodiorite. From this, measuring points 29 and 103 are considered subjected to agrillization, offering a great possibility for the existence of the mineralized zone. Particularly, measuring point 29 shows the presence of a very low resistivity layer of about 120 Ω·m in the shallower part. Thus this possibility is extremely high. In fact, concealed mineralization was found by the MJE–3 drill hole in the vicinity of measuirng point 29. Contrarily, measuring points 112 and 113 on their east side, which are considered not yet affected by alteration, show a high resistivity of 5,000 to 10,000 Ω·m.

Elsewhere, at measuring point 11 located in a granodiorite distributed area, analysis shows a layer about 65m thick with a relatively low resistivity of about 400 Ω·m from the ground surface. Although factors contributing to this low resistivity are unknown, it may possibly indicate a part of mineralized and alteration zones that are seen in Las Juntas.

Meanshile, measuring points located in the Macuchi Formation distribution area, including

10, 19, 102 and 120, show a resistivity of nearly 1,000 to 1,500 Ω·m. This value agrees with the estimated resisitivity of the Macuchi Formation which is not altered. Consequently, it is considered that the estimated mineralized zone and alteration zone at measuring points 29 and 103 do not extend westward the Macuchi Formation distributed area but instead extend toward the east side while losing their strength from the boundary with the Macuchi Formation.

At measuring points 46 and 56, a slightly low resistivity for the Macuchi Formation exists in the first layer. In the second layer too, an extremely low resistivity of 1.67 and 88.8 Ω·m is seen. However, since the measuring points had to be established on the very steep ridge, measurement values include the terrain which when analyzed, give as resistivities lower than the actual values. Thus, these low resistivities are not believed related to mineralized or alteration zones.

Section B (Fig. II–1–20)

This is the west to east section running through the Osohuayco mineralized zone.

With measuring points 414 and 31 forming the boundary, granodiorite is distributed to the west of this boundary, while the Macuchi Formation is distributed on the east side. As is the case with section A, the resistivity of granodiorite drops as it runs toward its boundary with the Macuchi Formation. Mineralized zone are observed in vicnities of the boundary. In other words, measuring pints 414 and 31 show a very low resistivity of 150 to 400 Ω·m despite the fact that they are located in the distribution area of granodiorite whose resistivity is estimated from 5,000 to 10,000 Ω·m when fresh. Thus, this reflects the low resistivity due to the occurrence of mineralized zones and alteration zones. Particularly, the resistivity at measuring point 31 is as low as less than 200 Ω·m which is considered indicating a stronger level of alteration.

On the west from measuring points 414 and 31, a thin low resistivity layer exists in the shallower part at measuring points 2 and 8. Also, at measuring point 13, a low resistivity of about 500 Ω·m extends to depths. However, no alteration zone, etc. is observed so that this low resistivity is considered attributable to either weathering or to terrain effect.

Meanwhile, measuring point 408 shows a resistivity level nearly the average for the Macuchi Formation, but measuring point 409 presents a slightly lower resistivity of about 500 Ω·m from the ground surface. This raises the possibility of occurrence of a mineralized zone or an alteration zone.

Section C (Fig. II–1–21)

This section runs nearly south to north.

In this section, measuring points 23, 21 and 20 are located in an area where granodiorite is distributed. Measuring point 15 and north of measuring point 19 cover the Macuchi Formatiom distribution area. However, resistivity in these areas range from nearly 500 to 1,000 Ω·m except for a low resistivity of less than 100 Ω·m at measuring point 207. No distinctive difference is noted between granodiorite and the Macuchi Formation which show much lower resistivity levels than their respective values estimated from the property test of rock samples. In this section C, because no conspicuous alteration zones are found except in vicinities of measuring point 207, the low resistivity of this area atributes to weathering. Based on this fact, it would be reasonable to assume also that such low resistivity reflects the effect of topography on measurement values. In fact, all the measuring points are located on ridges. Particularly, with measuring points 21 and 20, which showed a resistivity lower for granodiorite, the direction of their measured electric field intersected nearly at a right angle with the direction in which the ridge extends. Consequently, the resistivity values obtained are considered much lower than actual values because the electrodes were arranged in the position most vulnerable to the terrain effect.

Meanwhile, the low resistivity obtained at measuring point 207 clearly indicates a strong sericite alteration observed in its vicinities.

Section D (Fig. II–1–22)

This section runs south to north through the Osohuayco and El Torneaso minerazlied zones and the Las Palmas alteration zone. Geologically, granodiorite is distributed from measuring points 405 to 29. On the south and north sides of this granodiorite distribution area, the Macuchi Formation is distributed.

The area on the south of points 41 to 409 in vicinities of the Osohuayco mineralized zone shows 1,000 to 3,700 Ω·m, nearly the average resistivity for the Macuchi Formation from measuring points 414 and 31 show a very low resistivity of 150 to 400 Ω·m despite the fact that Ω·m spread from measuring points 410 and 409 to depths of 411 and 32. This raises the possibility that the mineralized zone and alteration zone observed at 409 are extended to depths of 411 and 32.

The low resistivity measured at points 29 and 108 conform with the El Torneado mineralized zone. This mineralized zone forms a NNE-SSW system, sharply dipping in a southeasterly direction. It is not clear whether the low resistivity zone also dips toward the southeastern side at depths.

Further, in the area north of measuring point 57 where the Macuchi Formation is distributed, a low resistivity corresponding to Las Plamas alateration zone is found at measuring point 208. At other measuring points, too, the resistivity is less than 100 Ω·m and therefore lower than the estimated resistivity of the Macuchi Formation. This is considered to be indication of advanced weathering or alteration.

Section E (Fig. II–1–23)

This section runs south to north and through the Osohuayco, El Torneado mineralized zones and the Las Palmas alteration zone.

Measuring point 401 is located in granodiorite distribution area and shows a resistivity of more than 10,000 Ω·m. All other points are located in the distribution area of the Macuchi Formation which consists of andesite lava, its tuffs and quartz-bearing andesite. The resistivity of these rocks estimated from results of property tests ranges from 1,000 to 1,500 Ω·m and no distinctive difference in resistivity among them is shown.

Measuring point 39 shows no particular alteration and rocks in its vicinities are expected rather metamorphosed into hornfels with a high resisitivity. Consequently, the terrain effect is conceivable for this high resistivity.

Alteration zones north of measuring point 34 are not reflected in resistivity values, so that it is considered that argillization is not so strong. Because there is no measurement point to be noticed with low resistivity, it is considered that mineralization and alteration zones may not extend to this line.

Section F (Fig. II–1–24)

This section is located within the Las Palmas detailed survey area and all measuring points on this section are found in the Macuchi Formation distribution areas. Consequently, the resistivity for each point is considered reflecting the extent of alteration at that point. Particularly, measuring point 202 shows very strong sericite alteration with a resultant low resistivity of less than 150 Ω·m, thereby indicating extremely strong alteration in its vicinities. Also, at measuring point 34, resistivity from the ground surface is as low as 100 Ω·m, which raises the possibility that its vicinities are subjected to alteration. Elsewhere, measuring points 201 and 210 show a resistivity of about 800 Ω·m, a slightly lower value than that for ordinary the Macuchi Formation. Thus, it is not considered that these areas have been subjected to a very strong alteration. On the other hand measuring point 209 shows a high resistivity, probably, because measurements taken in a valley inevitably reflect the terrain effect, leading to a slightly higher calculated values.

Section G (Fig. II–1–25)

This is the NNW-SSE section running through the El Torneado mineralized zone.

Measuring points 28 and 57 are located in the Macuchi Formation distribution areas while measuring points 29, 111 and 118, in granodiorite distribution areas. At measuring point 57, stable measurement values in a high frequency range could not be obtained because it was located beneath the power transmission lines and measurements were affected by great noise. However, the actual resistivity is considered to be about the same as that for measuring point 28. Consequently, the resistivity of the Macuchi Formation in vicinities of measuring points 28 and 57 is estimated at a few hundreds of Ω·m, which is slightly lower than the average resistivity of the Macuchi Formation. Measuring points 111 and 118 show a very high resistivity on the order of several thousands which is comparable with the resistivity of granodiorite. However, measuring point 29 which is located in the same granodiorite distribution area has a low resistivity layer about 120 Ω·m in a shallow zone, indicating strong alteration due to mineralization.

Section H (Fig. II–1–26)

This section is located within the detailed survey area in El Torneado.

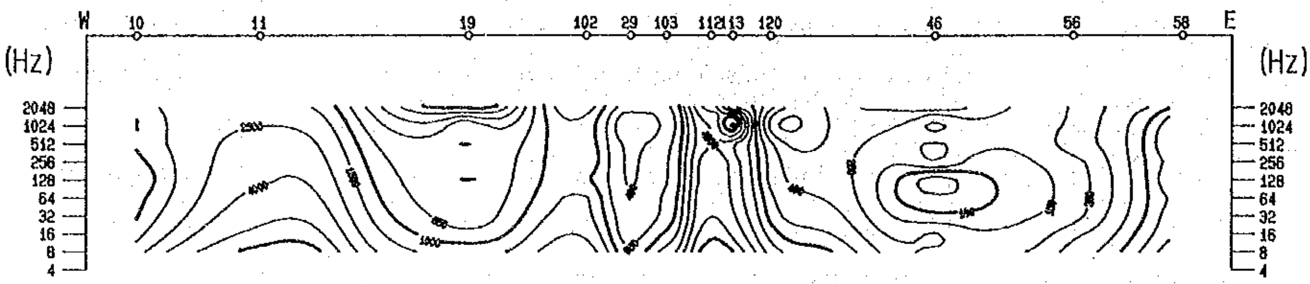
As has been described in the discussion on section A, a low resistivity of about 500 Ω·m is found at measuring points 29 and 103. These points are located in granodiorite distribution areas, and their resistivity level is estimated from 5,000 to 10,000 Ω·m based on results of property tests and other analyses. Consequently, the low resistivity of about 500 Ω·m is considered reflecting substantial argillization and the possibility of occurrence of mineralized zone is also high. Particularly, at measuring pint 29, a zone with a very low resistivity of about 120 Ω·m exists at shallow and therefore this possibility of occurrence of a mineralized zone is extremely high. Elsewhere, at measuring points 101 and 104, which are located in granodiorite distribution areas, resistivity is as high as about 2,500 Ω·m and 5,000 Ω·m, respectively. Thus, the possibility of occurrence of alteration and mineralization zones is low. Alteration or mineralization is also unlikely to exist at measuring points 102, as well as 106, 105, 107 and 45 which are located in the Macuchi Formation distribution areas because their resistivity of about 1,000 to 1,500 Ω·m agrees with its estimated resistivity.

Section I (Fig. II–1–27)

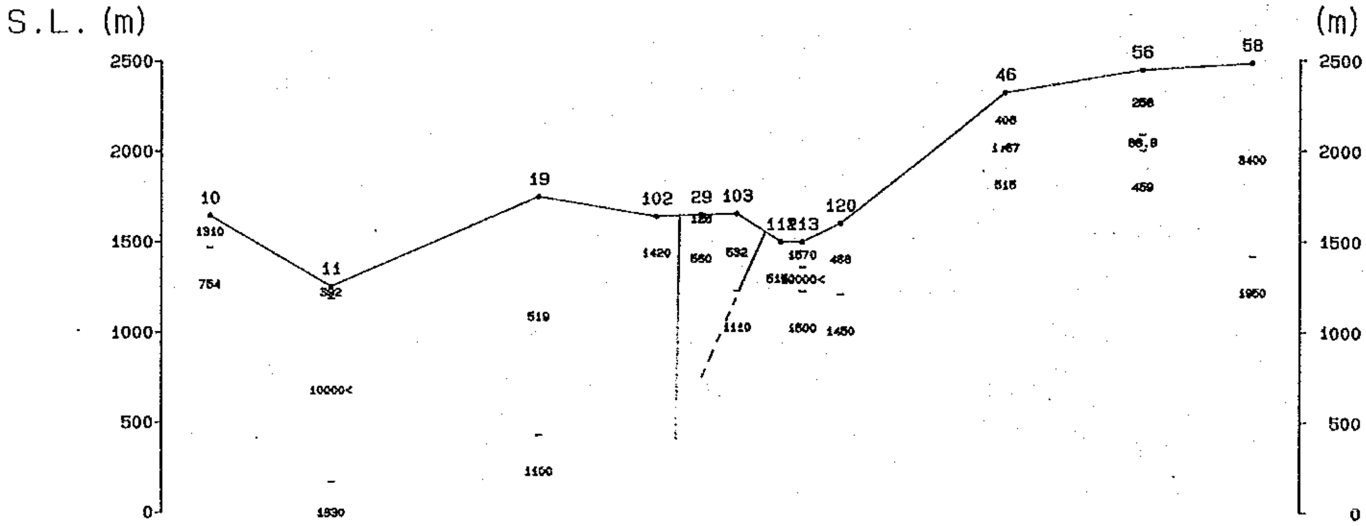
This section runs northwest to southeast in Osohuayco detailed survey area.

According to the apparent resistivity pseudosection, vertical apparent resistivity contours are dominant and strong of contrasts resistivity are seen sharply. Geologically, measuring point 22 is located in a granodiorite distribution area while measuring points 31 to 413, 412, 32, and 411 are found in the Macuchi Formation areas.

An extremely high resistivity in excess of 8,000 Ω·m at measuring point 22, corresponds to the resistivity of granodiorite. Meanwhile, based on results of property tests, etc., the resistivity of the Macuchi Formation not subjected to alteration, is estimated from 1,000 to 1,500 Ω·m. The resistivity at measuring points 32 to 411 virtually agrees with this value.



Apparent Resistivity Section



Analyzed Resistivity Section

LEGEND

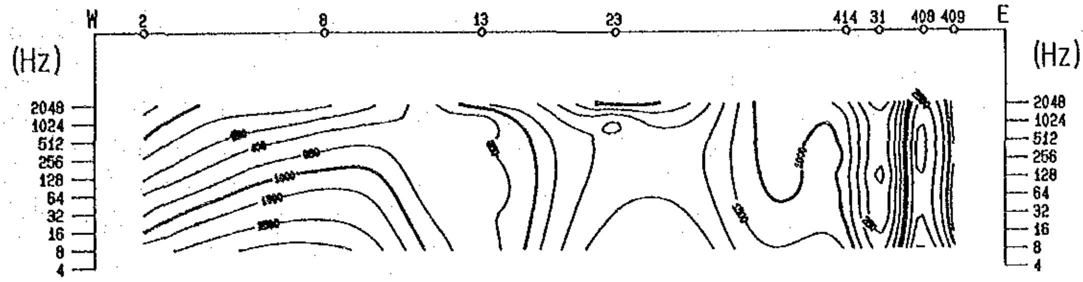
0 1000 m

23 CSAMT Station and No.

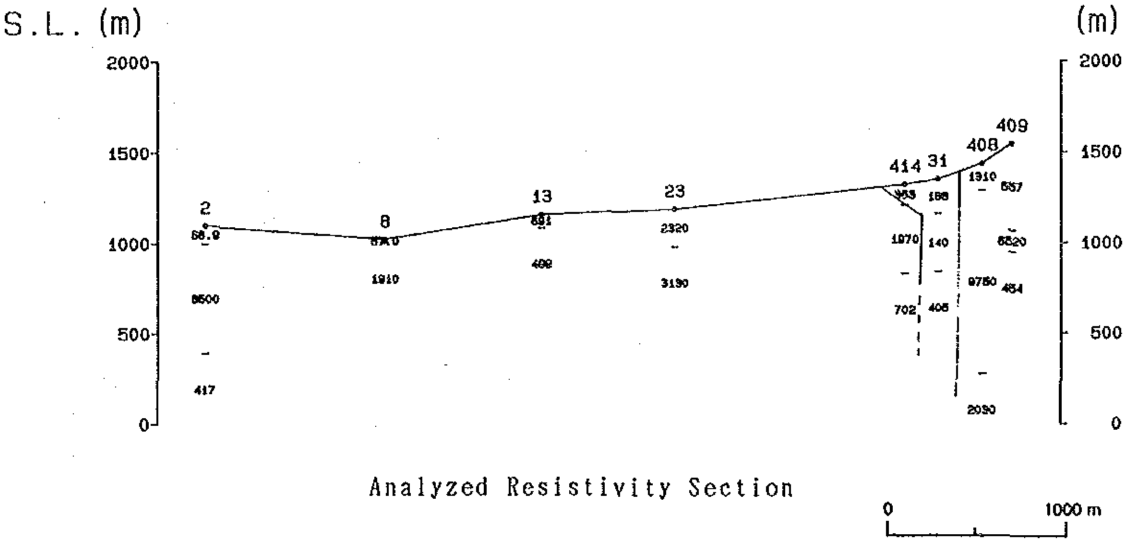
150 100 65 Apparent Resistivity Contour(Ω・m)

120 Analyzed Resistivity (Ω・m)

Fig. II－1－19 Apparent Resistivity and Analyzed Resistivity Sections(Section A)



Apparent Resistivity Section



Analyzed Resistivity Section

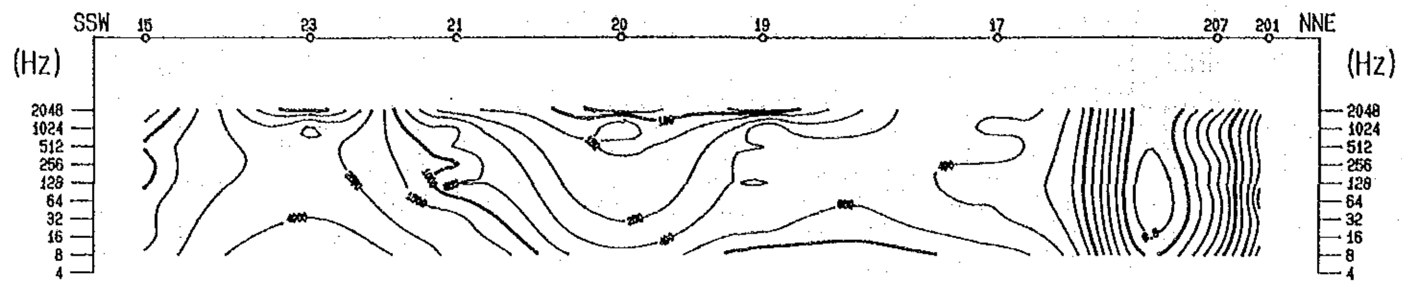
LEGEND

23 o CSAMT Station and No.

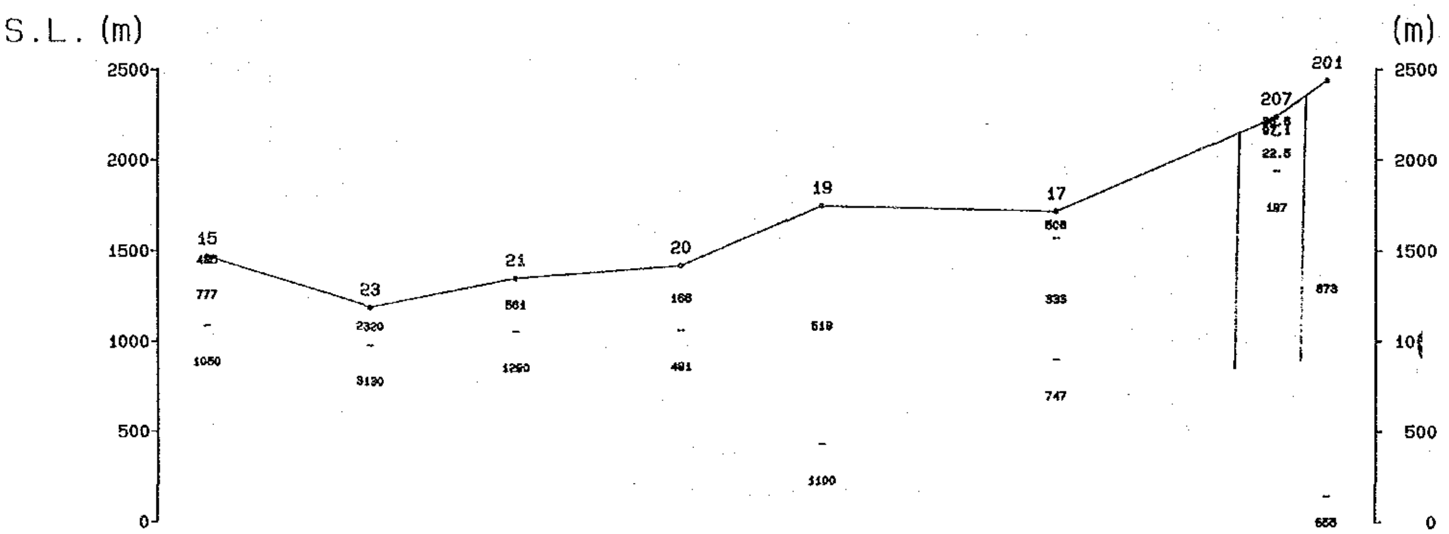
Apparent Resistivity Contour(Ω·m)

120 Analyzed Resistivity (Ω·m)

Fig. II－1－20 Apparent Resistivity and Analyzed Resistivity Sections(Section B)



Apparent Resistivity Section



Analyzed Resistivity Section

0 1000 m

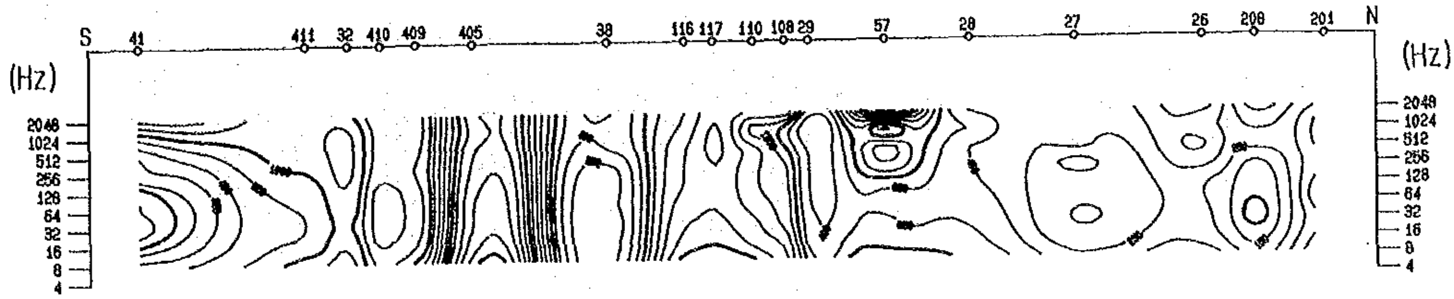
LEGEND

23 CSAMT Station and No.

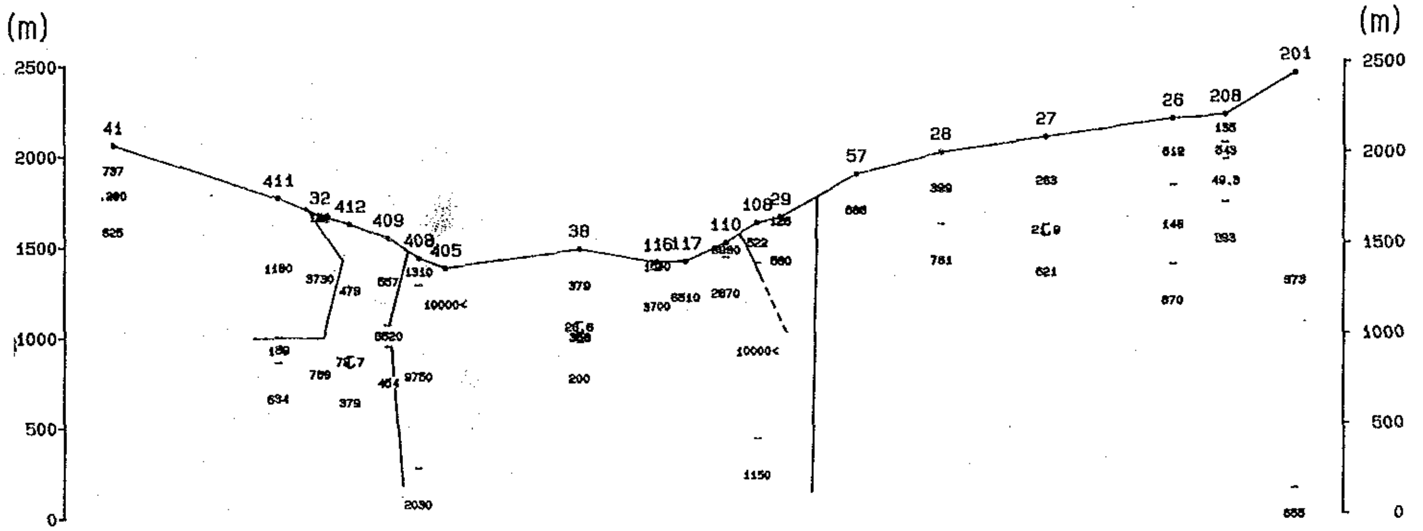
Apparent Resistivity Contour (Ω·m)

120 Analyzed Resistivity (Ω·m)

Fig. II − 1 − 21 Apparent Resistivity and Analyzed Resistivity Sections (Section C)



Apparent Resistivity Section



Analyzed Resistivity Section

0 1000 m

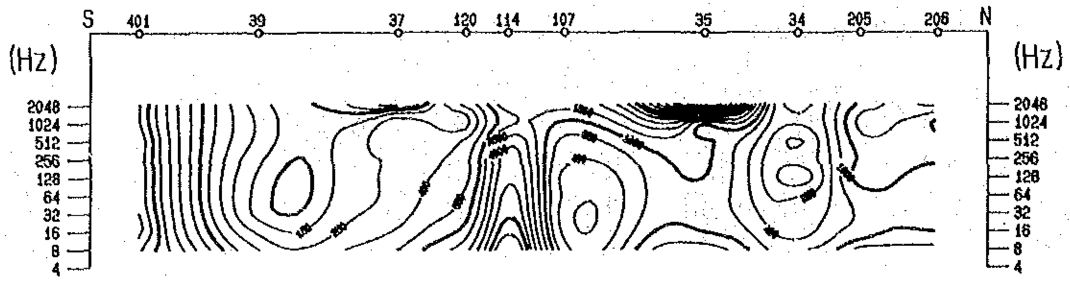
LEGEND

23 CSAMT Station and No.

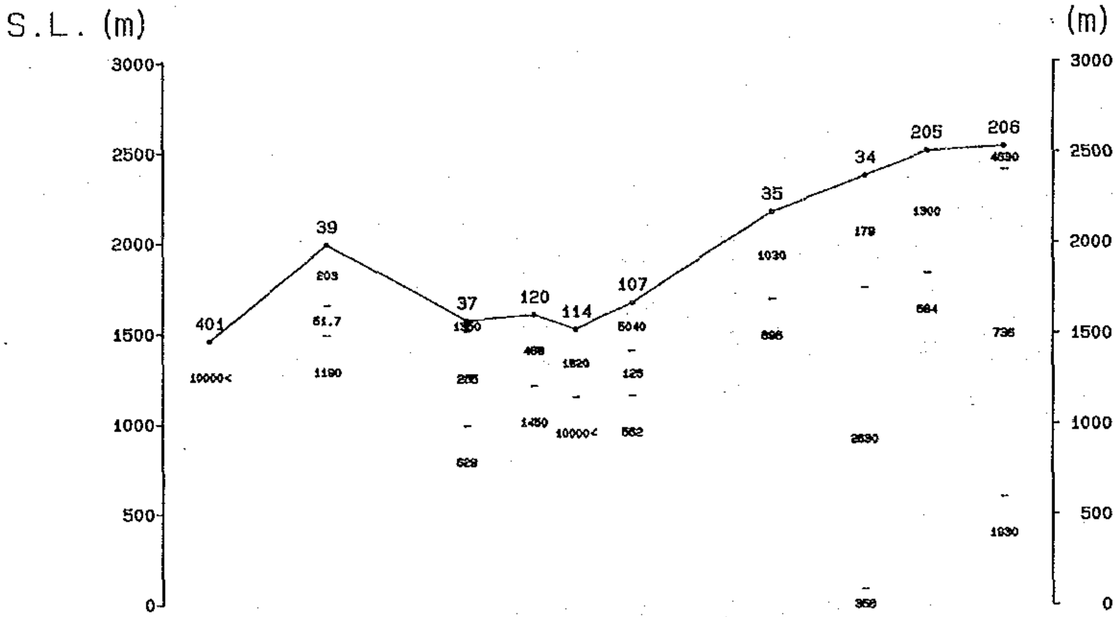
150 100 65 Apparent Resistivity Contour (Ω・m)

120 Analyzed Resistivity (Ω・m)

Fig. II − 1 − 22 Apparent Resistivity and Analyzed Resistivity Sections (Section D)



Apparent Resistivity Section



Analyzed Resistivity Section

0 1000 m

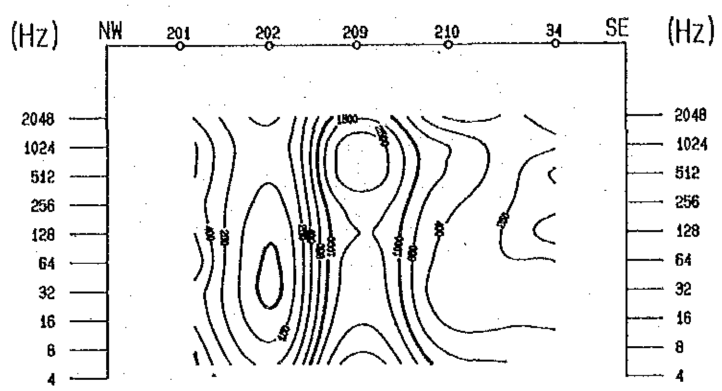
LEGEND

23 CSAMT Station and No.

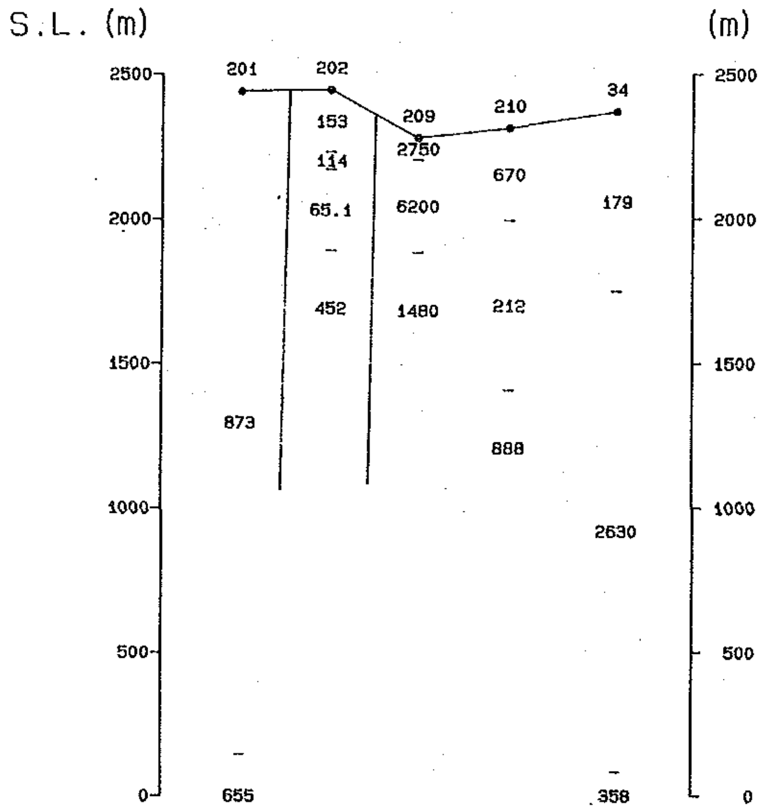
150 100 65 Apparent Resistivity Contour (Ω·m)

120 Analyzed Resistivity (Ω·m)

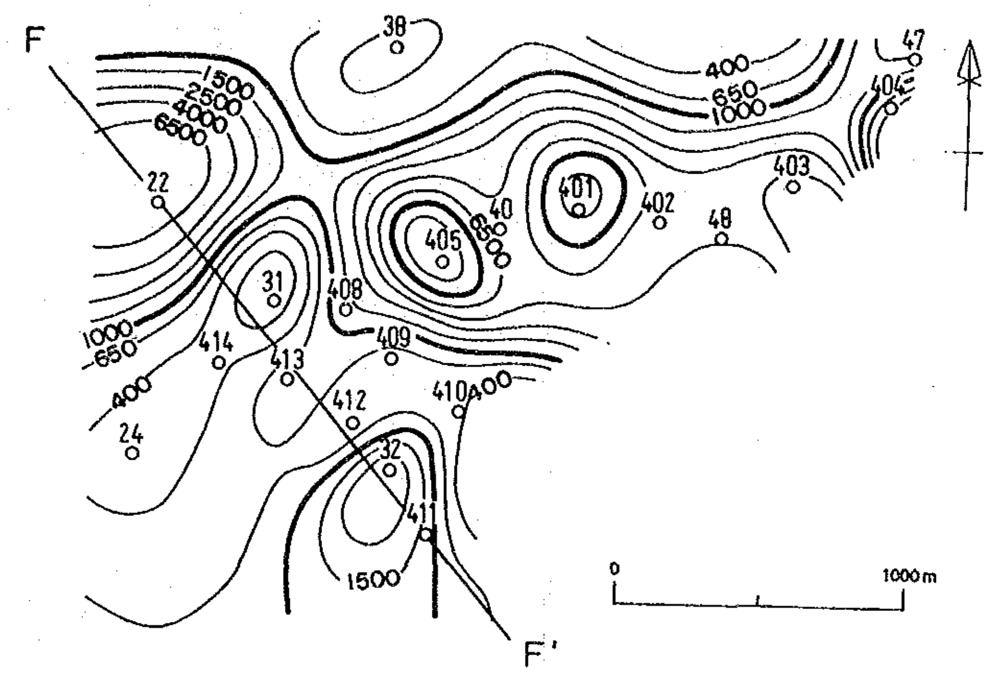
Fig. II－1－23 Apparent Resistivity and Analyzed Resistivity Sections (Section E)



Apparent Resistivity Section



Analyzed Resistivity Section



Apparent Resistivity Plan Map (Las Palmas)

LEGEND

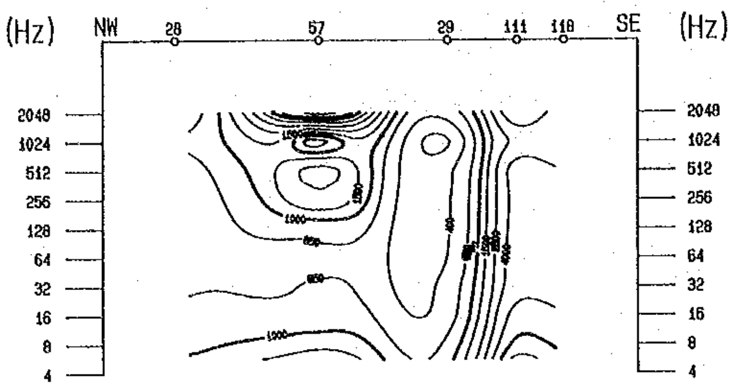
23 CSAMT Station and No.

150 100 65 Apparent Resistivity Contour (Ω・m)

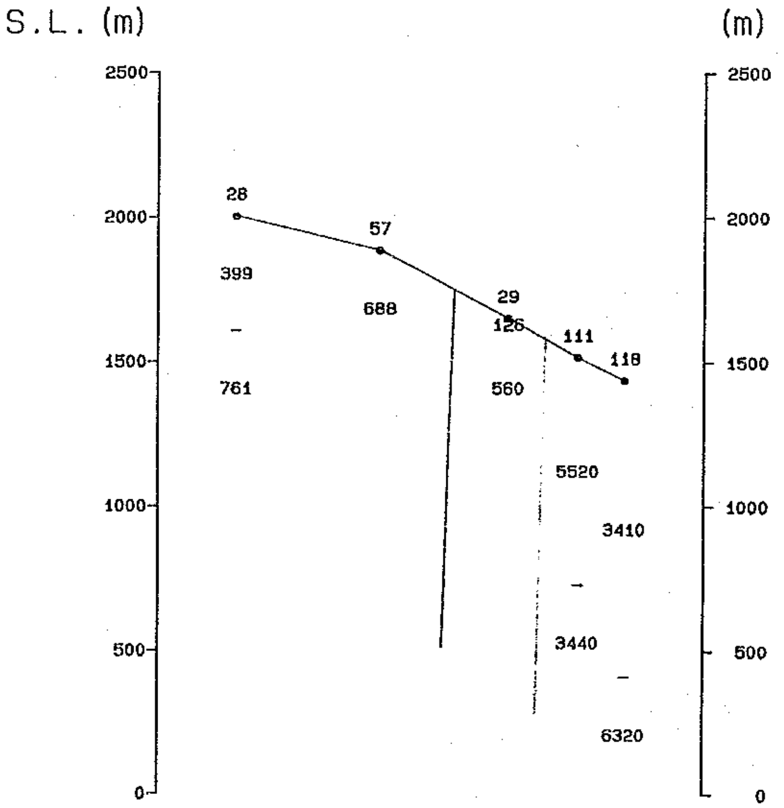
120 Analyzed Resistivity (Ω・m)

F——F' Section Line

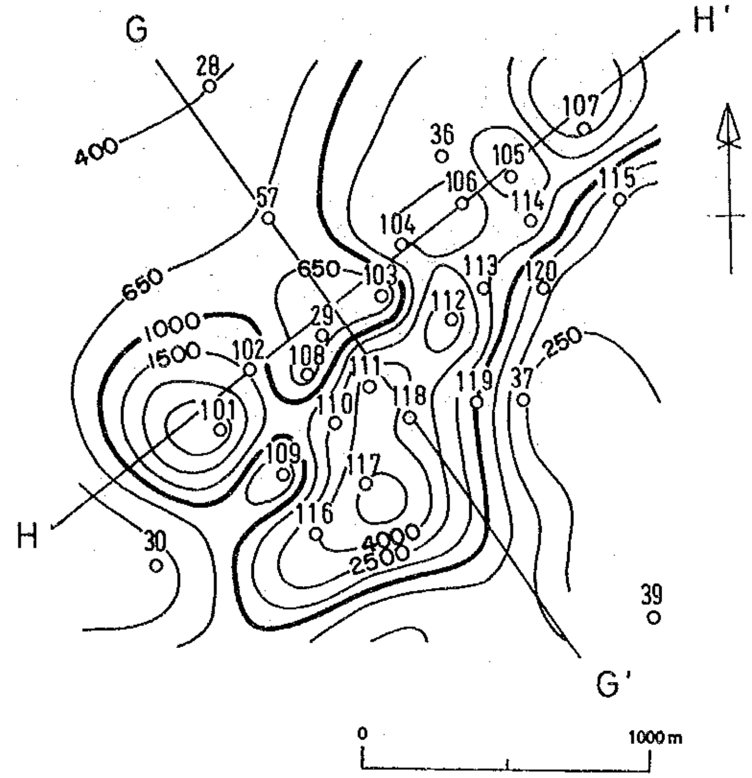
Fig. II－1－24 Apparent Resistivity and Analyzed Resistivity Sectiond(Section F) with Analyzed Resistivity Plan Map(Las Palmas)



Apparent Resistivity Section



Analyzed Resistivity Section



Apparent Resistivity Plan Map (El Torneado)

LEGEND

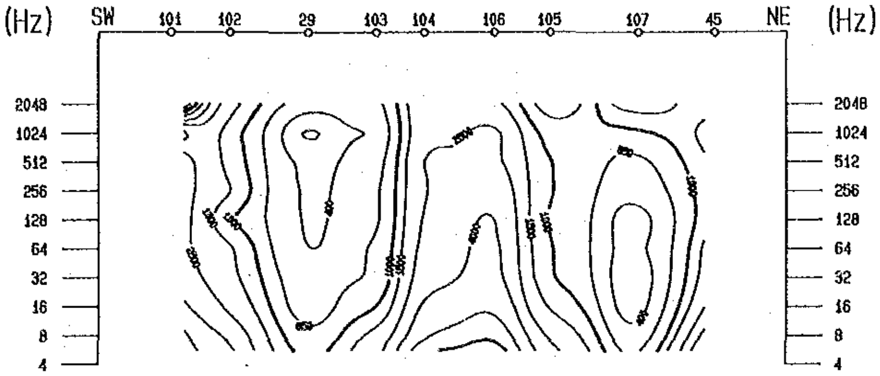
23 CSAMT Station and No.

Apparent Resistivity Contour (Ω·m)

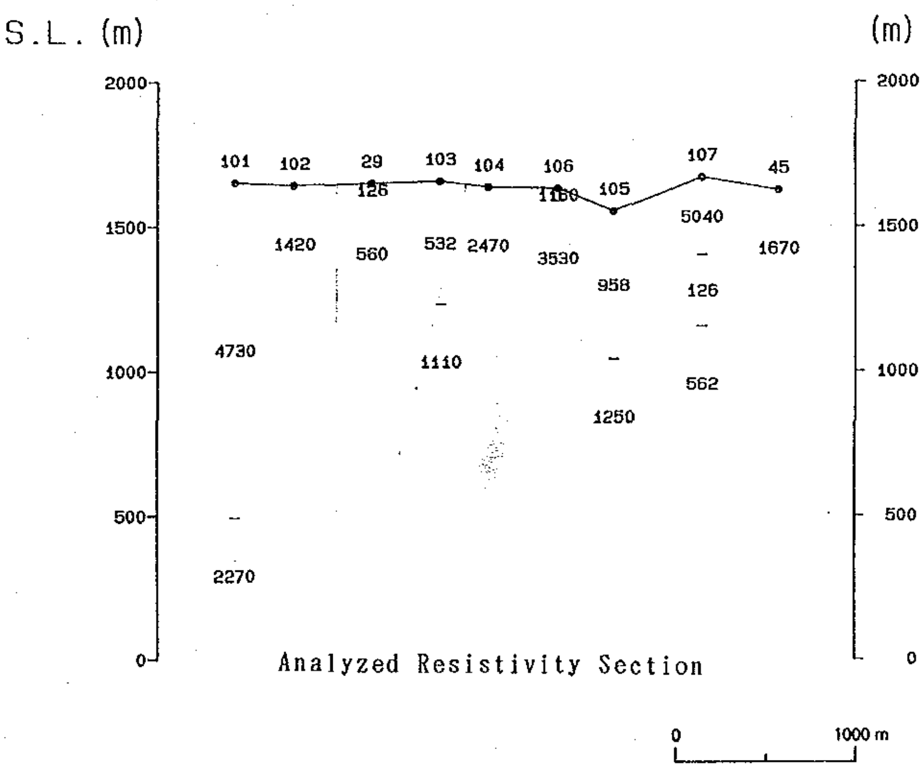
120 Analyzed Resistivity (Ω·m)

G —— G' Section Line

Fig. II－1－25 Apparent Resistivity and Analyzed Resistivity Sections(Section G) with Analyzed Resistivity Plan Map(El Torneado)



Apparent Resistivity Section



Analyzed Resistivity Section

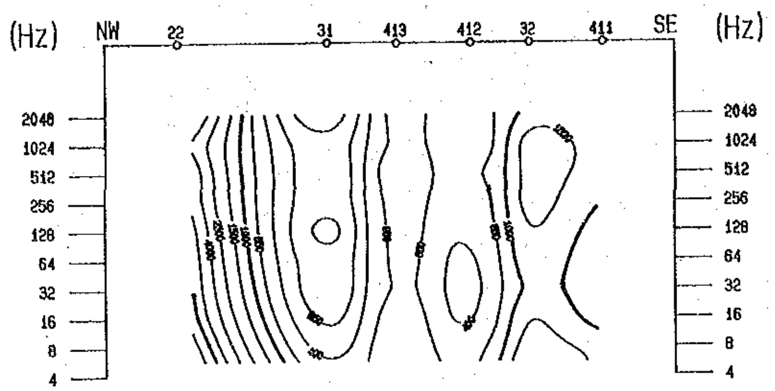
LEGEND

23 CSAMT Station and No.

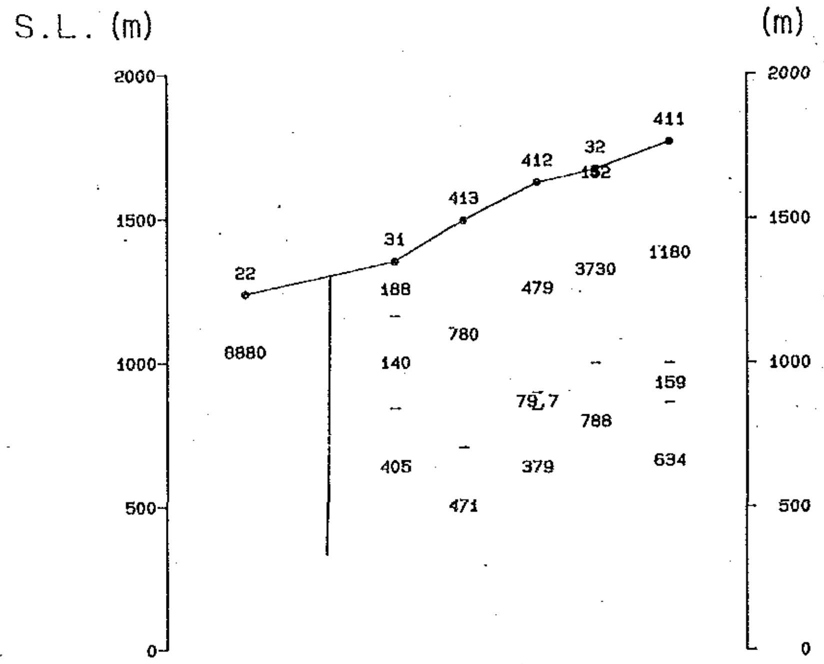
150 100 65 Apparent Resistivity Contour (Ω·m)

120 Analyzed Resistivity (Ω·m)

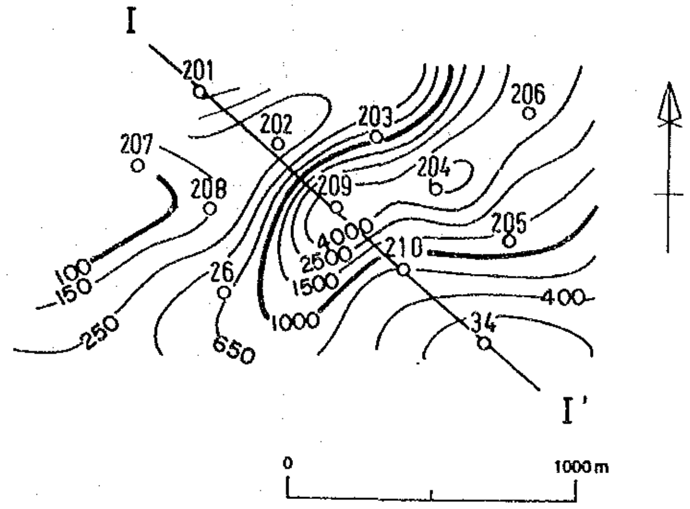
Fig. II－1－26 Apparent Resistivity and Analyzed Resistivity Sections(Section H)



Apparent Resistivity Section



Analyzed Resistivity Section



Apparent Resistivity Plan Map (Osohuayco)

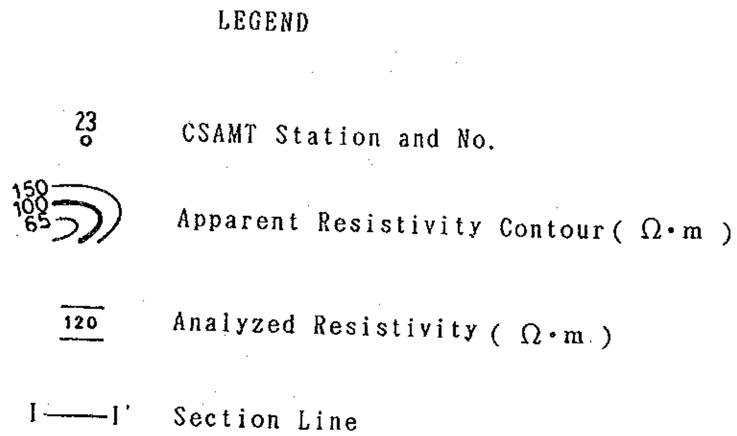
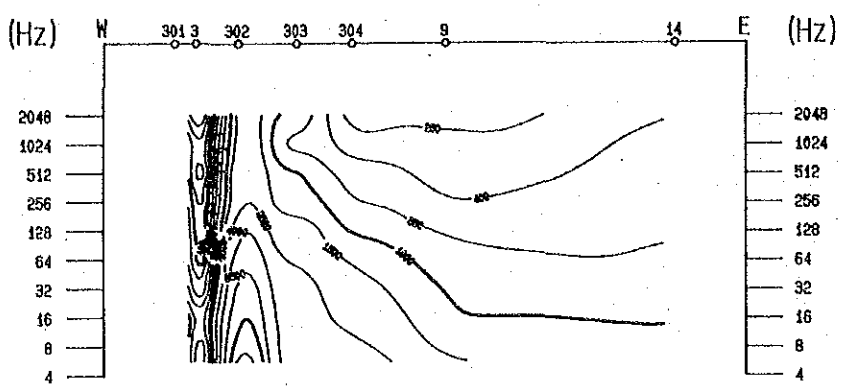
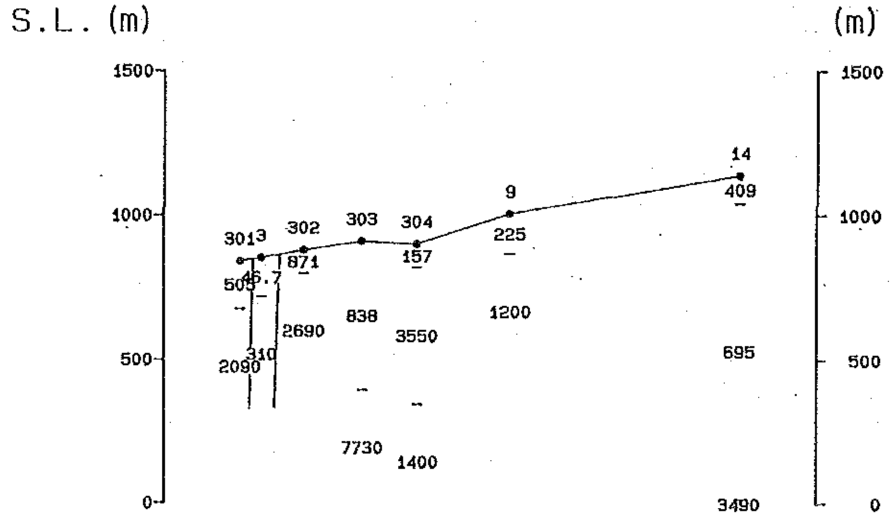


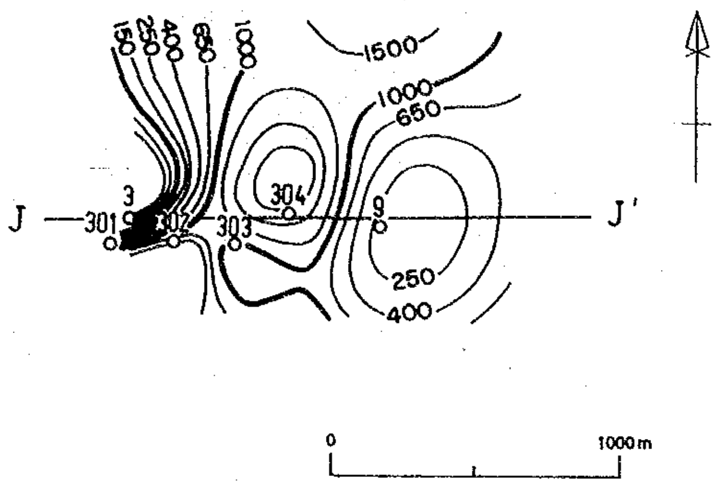
Fig. II－1－27 Apparent Resistivity and Analyzed Resistivity Sections (Section I) with Analyzed Resistivity Plan Map (Osohuayco)



Apparent Resistivity Section



Analyzed Resistivity Section



Apparent Resistivity Plan Map (El Cristal)

LEGEND

23 o — CSAMT Station and No.

150 / 100 / 65 — Apparent Resistivity Contour (Ω·m)

120 — Analyzed Resistivity (Ω·m)

J——J' — Section Line

Fig. II－1－28 Apparent Resistivity and Analyzed Resistivity Sections (Section J) with Analyzed Resistivity Plan Map (El Cristal)

However, the three measuring points of 31, 413 and 412 show a resistivity of less than 1,000 Ω·m, particularly measuring point 31 as low as about 100 to 200 Ω·m. Thus, these values are considerably lower than the generally estimated value.

Measuring point 31 described for section B and measuring point 413 for section D show that their low resistivity is considered due to alteration caused by mineralization. This trend is particularly conspicuous at measuring point 31 which is situated on the boundary between granodiorite and the Macuchi Formation.

Section J (Fig. II–1–28)

This section corresponds to the El Cristal mineralized zone. The apparent resistivity contours are horizontal and gentle, except for vicinities of measuring point 31, therefore the variation of resistivity is small for the pseudosection as a whole.

The west of measuring point 302, the Macuchi Formation is distributed and, to the east of measuring point 303, granodiorite is distributed. Although it does not have so large scale, measuring point 3 shows argillized alteration accompanied by mineralization, with a resistivity of about 50 Ω·m. At other measuring points, areas of a slightly low resistivity are seen on the order of a few hundreds of Ω·m in a thickness of about 100 to 200m from the ground surface, but the deeper zones show a resistivity of several thousands showing no distinctive difference between the Macuchi Formation and granodiorite.

(5) Discussion

Generally, granitic and andesitic rocks are high in resistivity but rocks in the survey areas greatly vary in resistivity (ranging from tens to tens of thousands Ω·m). As reasons for this great variation, such as decrease in resistivity due to argillization associated with mineralization and rise of resistivity due to silicification can be cited. In addition, differences in progress of weathering or development of cracks, and in the nature of ground water filling these cracks are also responsible for the variation of resistivity. The resistivity distribution in the survey area is deeply related to the location of mineral showings. Mineral showings are generally located in low resistivity areas.

The resistivity structure of the survey area consists of two to three layers. These layers greatly vary among measuring points showing a lack of continuity in horizontal direction. In other words, in this area, faults of NNE-SSW to NE-SW and NNW-SSE systems develop. Thus, resistivity discontinuities are believed to be reflecting blocking by these faulting structures.

Meanwhile, in comparison with results of drilling (MJE–3 drill hole: measuring point 29), the first layer (125 Ω·m, 40m thick) corresponds to an argillized zone. In the deeper zones, the resistivity becomes 560 Ω·m. Thus, the resistivity is much lower than the average of 5,000 to 10,000 Ω·m for granodiorite in the survey area. Sulfide contents are not so large that their effects on resistivity seem small. The low resisitivity is considered due to chloritization accompanying alteration and development of cracks. Mineralized zones below a depth of 200m of MJE–3 drill hole show localized argillization and silicification over an extensive area. As a result, it is believed that the resistivity has become 560 Ω·m as a whole. It is very difficult to detect the thin layer of low resistivity below a depth of 200m by CSAMT survey. Although granodiorite which is not altered was confirmed below 300m by boring, however, it is not reflected in resistivity there is a possibility that the point of MJE–3 might not altered. Other drilling holes are difficult to compare because they are deviated from measuring points.

A rather low measuring density in the current survey, brought limitation in the selection of promising zones based on resistivity structure alone. However, as a characteristic of resistivity structure in mineral showings, it was found that mineralized zones and alteration zones are located on the low resistivity side of the boundary formed by a pair of low and high resistivities.

The boundaries of high and low resistivities are also the boundaries of the Macuchi Formation and granodiorite except the Las Palmas alteration zone, and these boundaries are considered to be metamorphosed by contact. Generally, silicification gives a ghigh resistivity and argillization gives a low resistivity. Because mineralization of this area can be observed in both silicification and agrillization, it is considered that the boundaries of high and low resistivity show difference of alterations. Main mineralized zone especially associated with agrillization are observed at the side of low resistivity.

This resistivity structure is seen extending down to depths in both El Torneado and Osohuayco mineralized zones. In the Osohuayco mineralized zone in particular, low resistivity near the ground surface greatly extends to depths on the southeastern side. From this, continuity of mineralization and alteration zone is considered (Fig. II–1–29).

Characteristics of resistivity structure in the mineral showings as described above have been obtained. However, mineralized zones in this area generally show only a small difference in resistivity from host rocks and this makes resistivity analysis difficult. As s strong IP anomaly is observed generally on networked vein and disseminated ore deposits like as this survey area, the SIP and/or IP surveys seems to be a suitable method to understand the detailed distribution of the ore deposit in the area. Regarding exploration from the ground surface alone, resolution will decrease as the depth increases. For this reason, surface exploration particularly combined with use of drill holes is considered more effective.

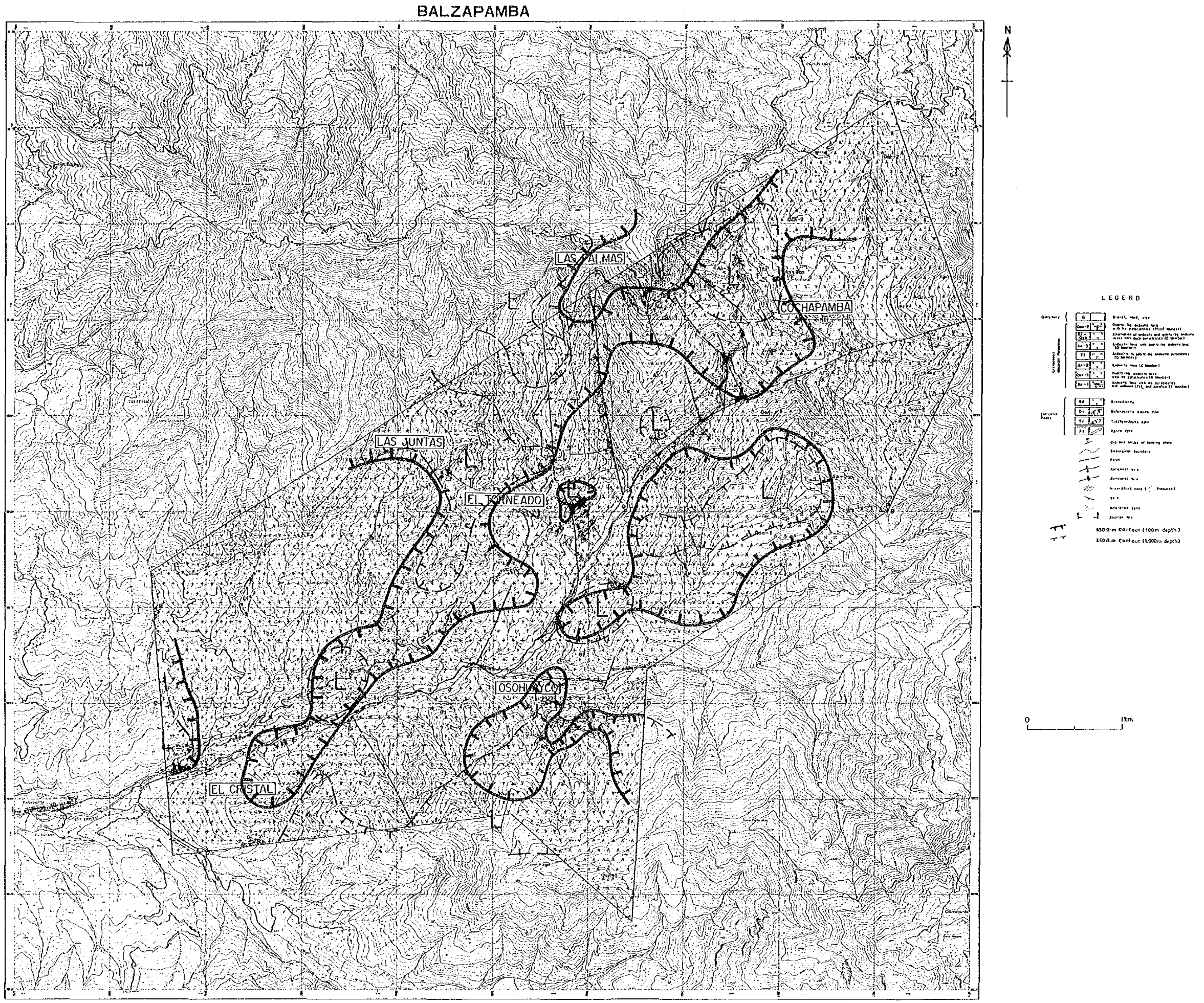


Fig. II－1－29 Interpretation Map of the Low Resistivity Zone and Mineralized Zone of the Balzapamba Area

1–3 Drilling

1–3–1 Purpose of Drilling

The most promising El Torneado mineralized zone in the Balzapamba area was established by conducting geological and geochemical surveys and geophysical survey (CSAMT method). The purpose of this drilling is to clarify the geological structure and occurrence of this mineralized zone, and to study the mechanism of its formation.

1–3–2 Details of Drilling

(1) Area for Drilling

The El Torneado mineralized zone where drilling was conducted is situated about 1km north-east of Santa Lucia settlement which is nearly the center of the Balzapamba area. The drilling site was located on a steep slope of about 1,600m above sea level.

MJE–1 hole was located based on results of geological and geophysical surveys. The position of MJE–2 and MJE–3 holes was decided, taking into consideration results of this drilling as well. The location of all these holes is shown in Fig. II–1–30.

(2) Outline of Drilling Work

For this work, drilling equipment owned by INEMIN including drilling machines and pumps were used together with drilling tools including bits and rods and mud materials brought in from Japan. Drilling work was conducted over an period from September 27 to November 15, 1988. For the drilling machines, Craelius Model D900 was used. Work for site preparations, and equipment dismantling and relocation was performed on a daytime shift only. Drilling work was as a rule carried out for 24 hours a day. For drilling method, overburden was stripped and wire line process was used for improved core recovery and other work efficiency.

Drilling performance for each hole is shown in Table II–1–6.

(3) Delivery of Materials and Equipment, and Site Preparation Work

Materials and equipment supplied from Japan and INEMIN's equipment were delivered to the base in Santa Lucia by trucking. Delivery to the drilling site from the base, dismantling from the site, and relocation from one drilling hole to another were carried out all manually, except for the drilling machines which were self-propelled for transportation. The access road for

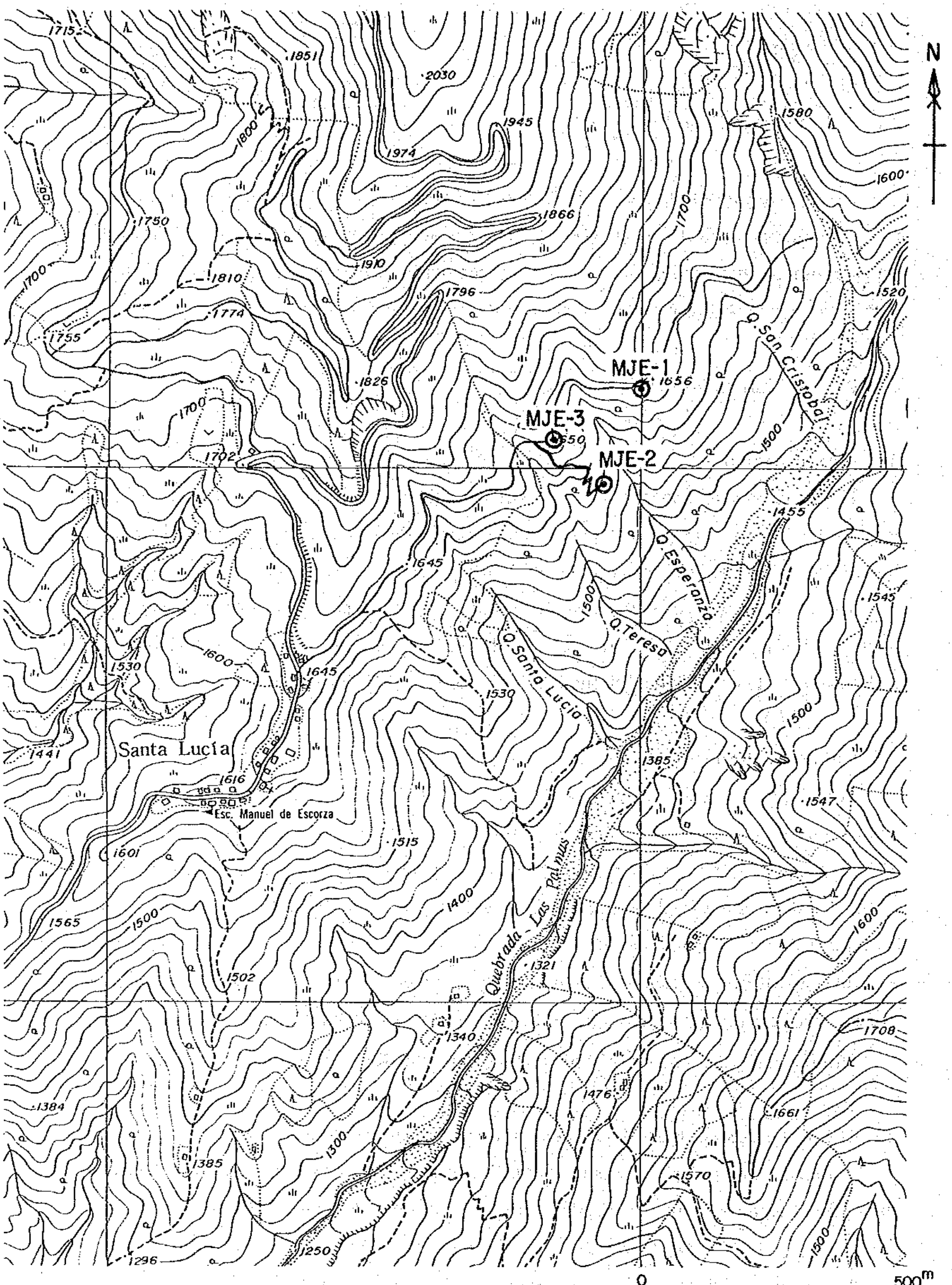


Fig. II－1－30　Location Map of Drill Holes

Table II – 1 – 6 Generalized Drilling Results

Drill Hole No.	Machine Type	Drilling Period	Drilled Length	Core		Number of Drilling Shift			Drilling Speed		Remarks
				Length	Recovery	Drilling	Preparation & Removing	Total	* m/shift	** m/shift	
MJE–1	D900	Sep. 27, 1988 ~ Oct. 10, 1988	m 305.40	m 274.70	% 99.7	36	16	52	5.87	8.48	
MJE–2	D900	Oct. 19, 1988 ~ Oct. 26, 1988	305.40	289.40	100	22	6	28	10.91	13.88	
MJE–3	D900	Nov. 3, 1988 ~ Nov. 15, 1988	303.30	273.70	100	20	11	31	9.78	15.17	
Total	–	–	914.10	837.80	100	78	33	111	8.24	11.72	

Note * Drilled Length per one shift covering total works operared

** Drilled Length per one shift covering net drilling operation

MJE–1,2 were drilled by 3 shift/day (8 hours/shift)
MJE-3 was drilled by 2 shift/day (12 hours/shift)

delivery of materials and equipment was secured by expanding the width of an existing foot path and building part of the road section.

Service water for work was supplied to each drilling hole by constructing a reservoir dam alongside the access road in upstream of Teresa valley and operating a lift pump (1–1/1" diameter polyethylene pipeline).

(4) **Drilling Work**

Table A-8 shows actual drilling work and work stage table for each hole. The progress of drilling work for each hole is shown in Fig. II–1–31∿33 and the details are as follows:

(i) **MJE–1 Hole**

0 ∿ 30.00m (hole diamter 101mm, NQ–NU casing 30.00m)

To drill surface soil and gravel layers, 101mm metal bits were used with bentnite mud water. After reaching rock at 30m, NQ–NU casing was inserted.

30.00 ∿ 237.40m (hole diameter NQWL (75.7mm), BW casing 237.40m)

Under NQWL process, the hole was drilled by using mud water prepared by mixing TK60B with fresh water. The lithology is hard coarse granodiorite. This rock was partly brecciated and white-altered, and also showed dissemination and thin veinlets of chalcopyrite and pyrite. At 31.40m, complete loss of circulation occurred and this was overcome with sealing by Telstop. Subsequently, at 70.99m, circulation was lost again. Although circulation was temporarily recovered, drilling had to be continued with complete loss of circulation from 78.30m downward. At 237.40m, BW casing was inserted.

237.40 ∿ 305.40m (hole diameter BQWL (60.0mm))

Under BQWL process, the hole was drilled with use of TK60B. Full loss of circulation occurred again in the vicinity of 240m, but drilling was continued until it was completed at 305.40m. The lithology is coarse granodiorite. This rock showed disseminated zones and veinlets of chalcopyrite and pyrite.

(ii) **MJE–2 Hole**

0 ∿ 16.00m (hole diameter 101mm, NQ–NU casing 16.00m)

Surface soil and gravel layers were drilled with 101mm metal crown bit. After reaching rock at 16.00mm, NQ–NU casing was inserted.

16.00 ∿ 201.60m (hole diameter NQWL (75.7mm), BW casing 201.60m)

Under NQWL process, drilling was conducted with use of bentnite mud water and TK60B. Drilling was continued through brecciated coarse granodiorite. This rock showed disseminated zones and veinlets of chalcopyrite and pyrite. At 47.70m, circulation was completely lost.

Although sealing by Telstop was applied as a measure against this lost circulation, it again occurred at 54, 60 and 67m. Under complete loss of circulation, drilling was continued until 201.60m where NW casing was inserted.

201.60 ∿ 305.40m (hole diameter BQWL (60.0mm)

Under BQWL process, drilling was made with TK60B. The lithology is coarse granodiorite, with intrusion of trachyandesite. These rocks showed networked veins of chalcopyrite and pyrite. Although complete loss of circulation occurred at 238.50m, drilling was continued until completed at 305.40m.

(iii) MJE–3 Hole

0 ∿ 29.50m (hole diameter 101mm, NQ–NU casing 29.50m)

Surface soil and gravel layers were drilled with 101mm metal crown bit. After reaching rock at 29.50m, NQ–NU casing was inserted.

29.50 ∿ 201.60m (hole diameter NQWL (75.7mm), BW casing 201.60m)

Under NQWL process, drilling was made with use of TK60B. The lithology is coarse granodiorite which was brecciated and white-altered down to 55.40m. Networked veins and veinlets of chalcopyrite and pyrite were observed in this rock. BW casing was inserted at 201.60m.

201.60 ∿ 303.30m (hole diameter BQWL (60.0mm))

Under BQWL process, drilling was made with use of TK60B. The lithology is andesite and its tuffs of the Macuchi Formation, and locally small intrusives of coarse granodiorite and dikes of trachyandesite. These rocks contained networked veins of chalcopyrite and pyrite. Circulation was completely lost shortly after drilling was resumed by switching to BQWL. This situation was never recovered and drilling was continued in this condition until completed at 303.30m.

(5) Examination of Drill Cores

Drill cores were examined at both the drilling site and Santa Lucia work station in parallel with drilling work for each hole. Results of this examination were compiled into columnar sections on a scale of 1 to 200. Samples were collected after completion of drilling work for each hole. These samples were obtained after securing samples for preservation by cutting the drill core into half. Samples intended for ore assay were collected by continuously sampling for 1m in the position where a proper evaluation of each mineralized zone can be made.

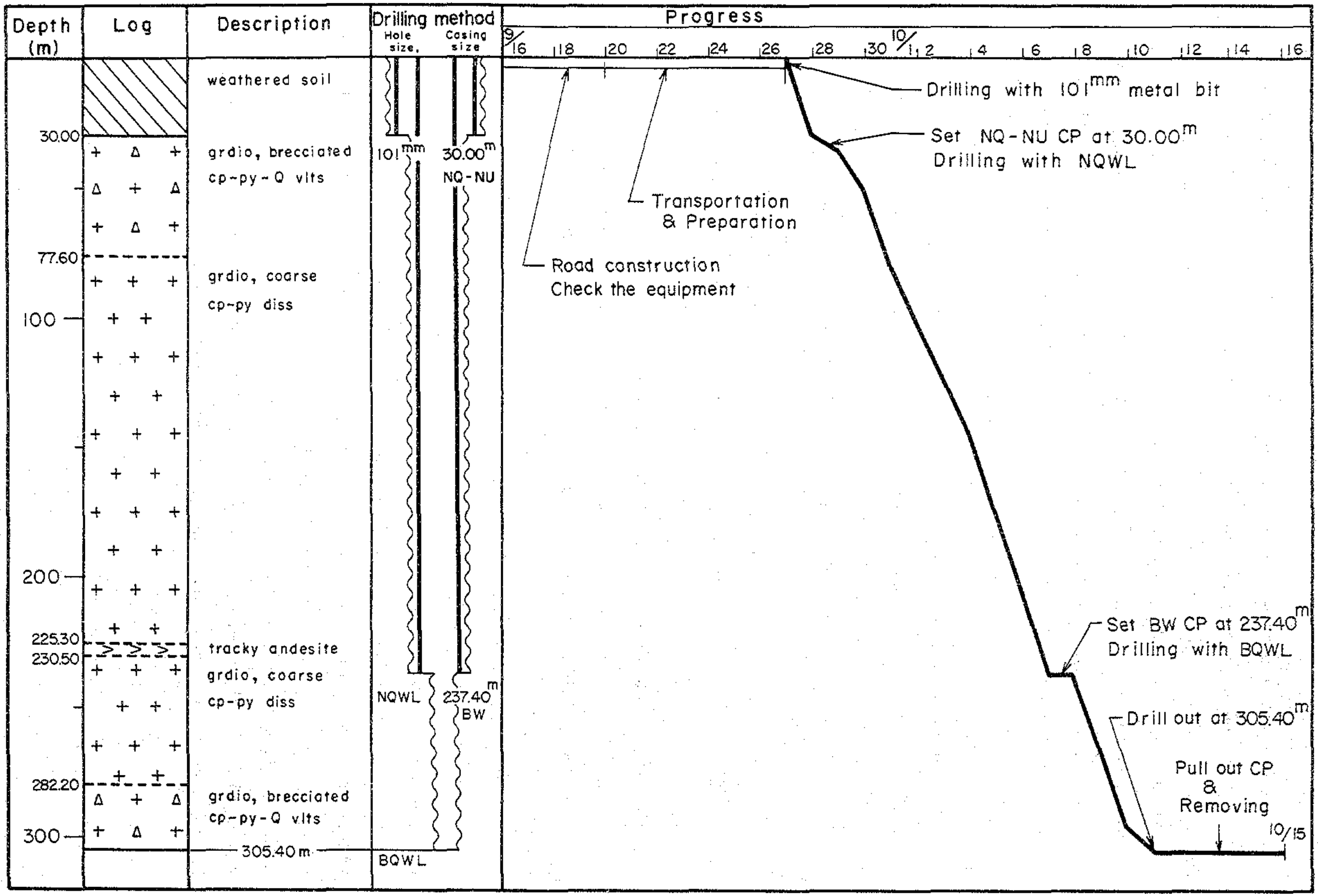


Fig. II-1-31 Progress Record of Hole MJE-1

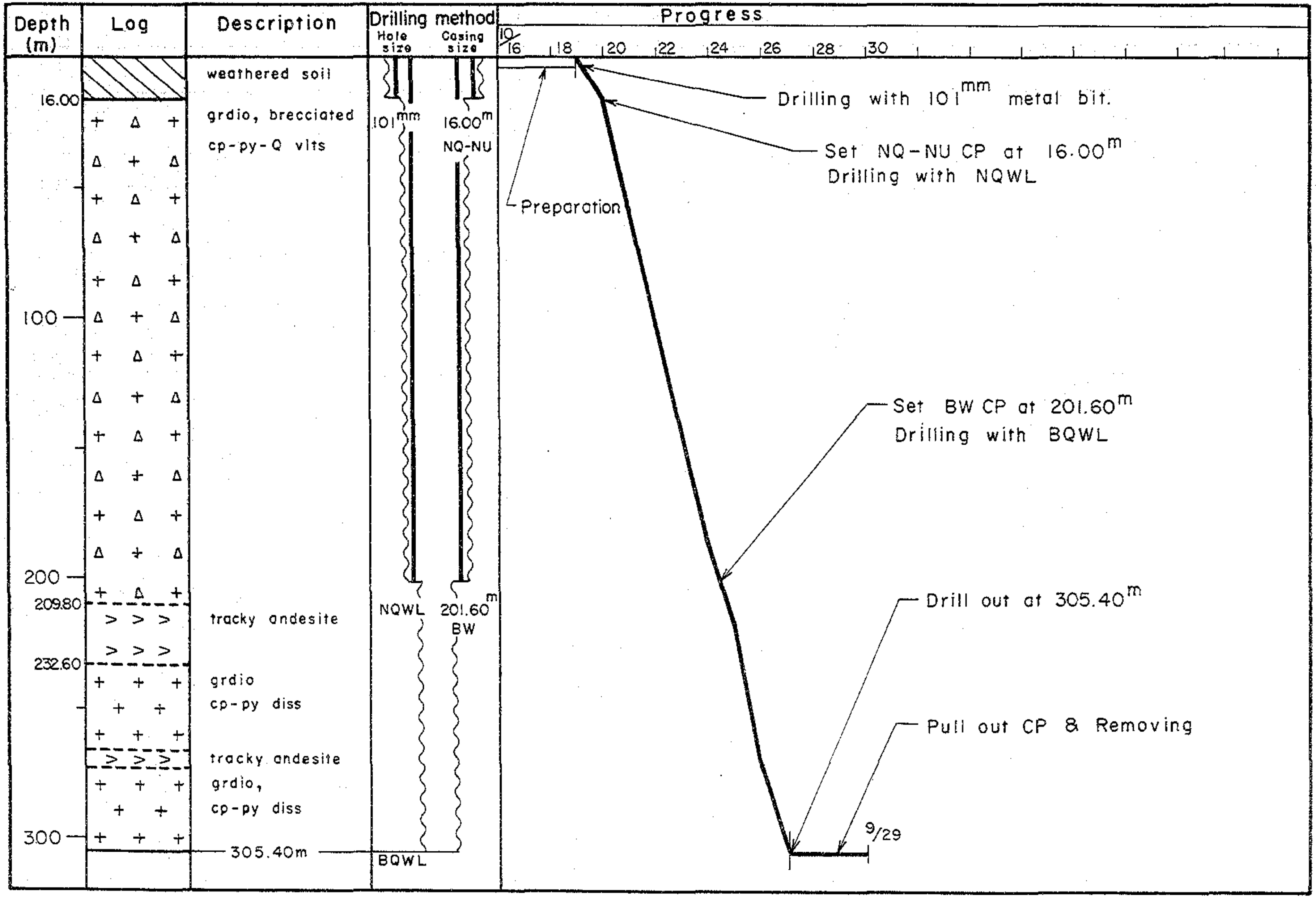


Fig. II－1－32 Progress Record of Hole MJE-2

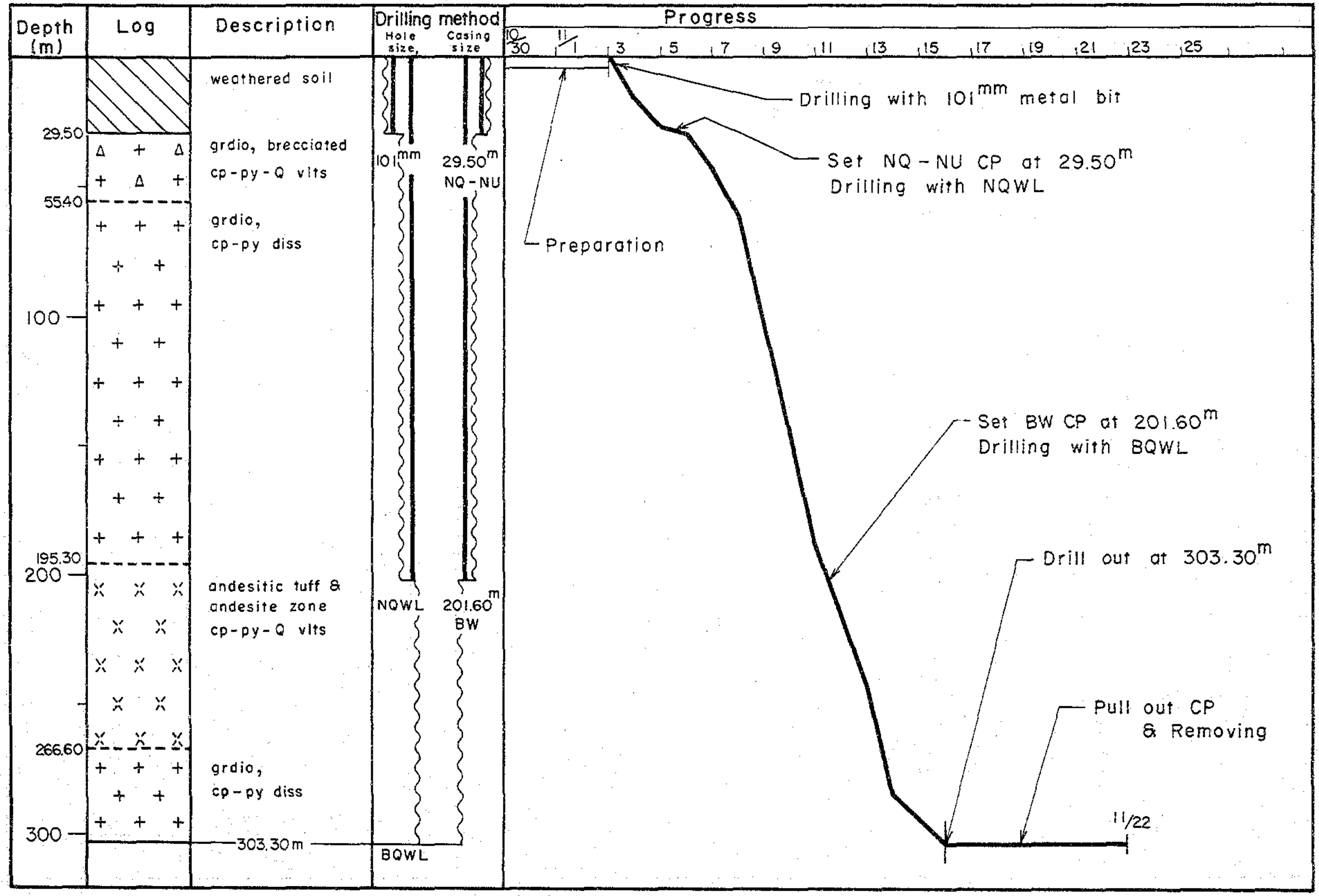


Fig. II − 1 −33 Progress Record of Hole MJE-3

1–3–3 Results of Survey

Drilling was conducted on a priority principle in the mineralized zone A that was found most promising as a result of geological and geophysical surveys. This zone is situated in the west of the survey area and is about 50m in width and 200m plus in extension at its outcrops (Fig. II–1–34,35). The mineralized zone, at outcrops of both Teresa and Esperanza valleys, consists of networked veins of sulfide minerals including chalcopyrite, molybdenite, and pyrite, and gangue minerals including chlorite, sericite, secondary biotite, epido and quartz, as well as disseminated zones of above sulfide minerals. For alteration, host rocks are affected by white alteration (converted mainly into sericite) and silicification. Results of geophysical survey (CSAMT method) show low resistivity indications centering in this mineralized zone, and continuity under outcrops was expected.

(1) MJE–1 Hole

(i) Location, Inclination and Depth

Location : Latitude 9808.14N, longitude 708.00E, altitude +1,652m

Inclination : –90°

Depth : 305.40m

(ii) Purpose

This drilling was conducted to find the spread of the northeastern extension of mineralized zone A and occurrence status in this zone.

(iii) Geology and Mineralization in Drilling Hole (Plate II–1–19)

– 0 ∿ 30.00m

Masa of coarse-grained granodiorite occurs, mixed with white clay in places.

– 30.00 ∿ 34.80m

Lithology is coarse-grained granodiorite which is affected by weak chloritization and brecciation. The interstices of breccias are filled with secondary biotite–(chlorite)–quartz. Fine-grained chalcopyrite and molybdenite are locally disseminated in host rock in small quantities. They mainly occur in the portion of mafic minerals. Pyrite is locally present, disseminated in host rock, pyrite veins (mostly in veins of about 0.5cm wide), and chlorite–(sericite)–quartz veins.

– 34.80 ∿ 36.10m

Lithology is characterized by white clay zones. The 34.80 ∿ 35.00m zone consists mostly of sericite but chlorite-quartz veins mix with sericite in the core between 35.00 and 36.10m. Small quantities of fine-grained pyrite are disseminated throughout the zone.

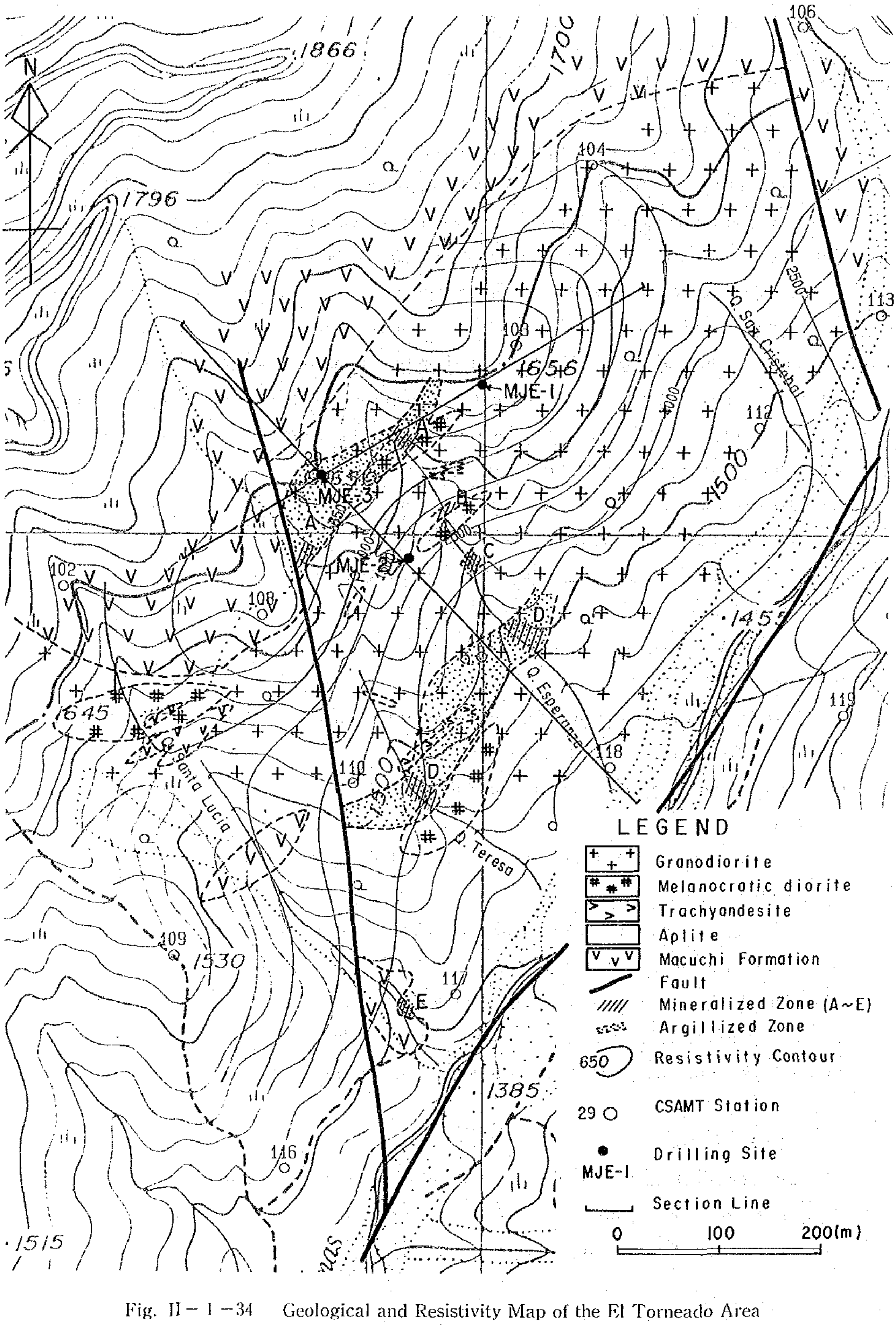


Fig. II－1－34 Geological and Resistivity Map of the El Torneado Area

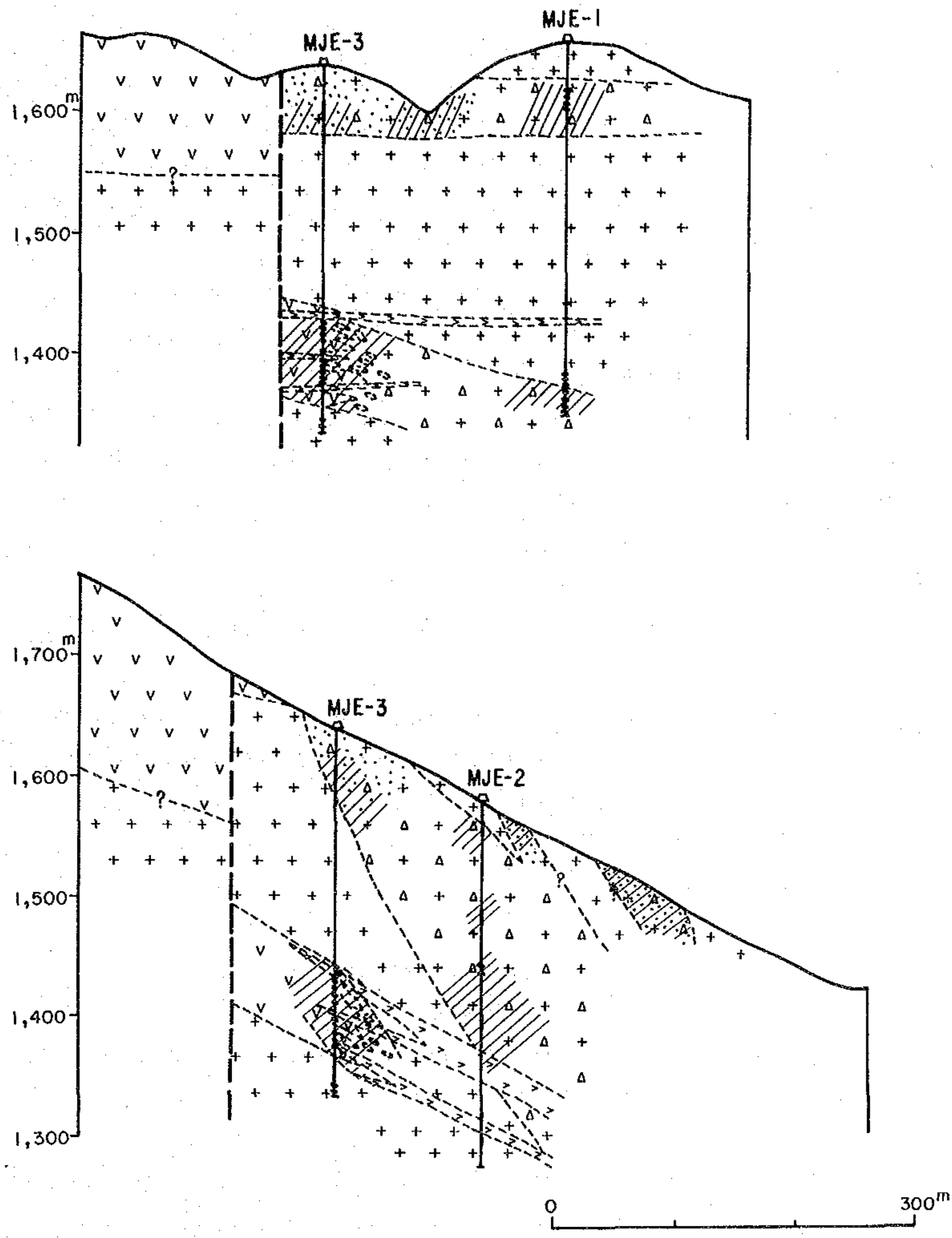


Fig. II－1－35　Geological Section of Drill Holes

– 36.10 ∿ 110m

Rock facies consists of granodiorite presenting appearance of breciation. Networked veins containing sulfide minerals occur in the interstices of the breccia. The width of individual networked veins is about 1 to 4cm. As for alteration of host rock, it is affected by chloritization as a whole while silicification and secondary biotite alteration are observed in the bordering areas of veins. Chalcopyrite and pyrite occur in host rock and veins. Presence of pyrrhotite, molybdenite, scheelite and magnetite in veins is observed in places. Microscopic observation of samples obtained from a depth of 92.60m shows that chalcopyrite cuts pyrrhotite as a form of veins and also that part of pyrrhotite has been altered to secondary pyrite (Photo A–2). In addition, fine-grained sphalerite is recognized.

In the 36.10 ∿ 54.50m zone, relatively large chalcopyrite abounds. There were 13 chacopyrite pieces more that 5mm in diameter. Analysis of four ore samples obtained in this section shows an average grade of 0.07% Cu and 0.05% W.

In the 54.50 ∿ 77.60 zone, the number of large chalcopyrite gradually drops and dissemination in host rock also decreases. On the other hand, molybdenite increases, mainly occurring in quartz veins. Analytical results of typical ore samples show 0.01% Cu and 0.06% W.

– 110 ∿ 82.20m

The lithology is coarse-grained granodiorite in which both mineralization and alteration are extremely weak. Dissemination in host rock is only fine-grained pyrite. Small quantities of chalcopyrite are observed, along with chlorite, in veins and cracks. From the vicinities of 261.80m, sulfide minerals and chlorite veins gradually increase. Both chalcopyrite and pyrite are present in chlorite–(epidote)–quartz veins, or in host rock as a dissemination. Calcite veins locally exist.

Analytical results on two ore sample pieces obtained from the 261.80 ∿ 282.30m section show an average grade of 0.06% Cu and 0.06% W.

Trachyandesite dikes out granodiorite in the 222.20 ∿ 222.60m and 225.30 ∿ 230.50m sections. Pyrite is weakly disseminated in these dikes.

– 282.20 ∿ 305m

Rock facies consists of brecciated granodiorite, and the interstices of breccias are filled with irregular networked veins. Composition minerals in these veins are chalcopyrite, pyrite, chlorite, epidote, secondary biotite and quartz. Relatively large chalcopyrite gradually increase. Scheelite and molybdenite are locally observed in veins. Host rock is affected by weak chloritization, and host rock around veins is silicified. Chalcopyrite and pyrite are disseminated in host rock. In areas deeper than 298.90m, networked veins begin to increase and there is a sharp increase in the number of relatively large chalcopyrite. Analytical results on ore samples obtained from this region show 0.05% Cu and 0.06% W (average of two samples) for 282.20 ~ 298.90 section and 0.17% Cu and 0.01% Mo and 0.06% W (ore grade for one representative sample) for 298.90 ∿ 305.40m section.

(2) MJE–2 Hole

(i) **Location, Inclination, and Depth**

Location : Latitude 9,807.97N, longitude 708.93E, altitude +1,575m

Inclination : –90°

Depth : 305.40m

(ii) **Purpose**

This drilling was conducted to define the spread of the northeastern extension of the mineralized zone A and occurrence in this area.

(iii) **Geology and Mineralization of Drill Hole (plate II–1–20)**

– 0 ∿ 16.00m

Masa of coarse-grained granodiorite origin, with mixture of white clay in places

– 16.00 ∿ 38.00m

Coarse-grain granodiorite is altered to sericitized zone in irregular networked patterns. Secondary biotite-chlorite-quartz networked veins containing sulfide minerals cut into this alteration zone. Molybdenite dominates sulfide minerals, followed by pyrite and chalcopyrite in that order. These sulfide minerals mainly occur in veins but molybdenite and pyrite are also locally found in sericitized zones. Scheelite is locally present in veins. The zone where ore minerals are abundant is the 16.00 ∿ 26.00m section. Analytical results of two ore samples collected from this section show an average grade of 0.8 g/t Ag, 0.04% Cu, 0.16% Mo and 0.06% W.

From the vicinity of 27.50m downward, sericitization becomes extremely weak.

– 38.00 ∿ 209.80m

Rock facies consists of coarse granodiorite which is intersected with networked veins, presenting brecciated structure as a whole. Trachyandesite veins are found in the 38.50 ∿ 40.10m, 120.60 ∿ 121.70m and 125.80 ∿ 126.90m sections. These zones are also mineralized. As for alteration, weak chloritization and secondary biotite alteration are noted throughout host rock.

Areas in this range where chalcopyrite abundantly occurs are the 88.50 ∿ 97.00m, 108.20 ∿ 109.40m, 114.00 ∿ 115.40m, 134.50 ∿ 143.00m, 153.70 ∿ 156.00m, 165.00 ∿ 188.00m, and 197.80 ∿ 203.50m sections. Mineralized zones in these sections are chalcopyrite–(molybdenite)–pyrite–epidote–secondary biotite-quartz networked veins.

Scheelite and magnetite are partly observed in veins. Host rock shows local dissemination of fine-grained chalcopyrite and pyrite. Alteration around vein consists of silicification and chloritization with partial sericite alteration. Microscopic observation of samples collected from a depth of 177.55m shows presence of veined chalcopyrite in cracks of pyrite. Fine-grained spalerite is also noted. Analytical results of ores from this range as follows:

88.50 ∿ 97.00m : 0.5 g/t Ag, 0.13% Cu, 0.05% Mo (grade of one representative sample)

134.50 ∿ 143.00m : 0.05% Cu, 0.02% Mo, 0.05% W (average of two samples)

165.00 ∿ 188.00m : 0.07% Cu, 0.02% Zn, 0.06% W (average of four samples)

197.80 ∿ 203.50m : 0.21% Cu, 0.01% Zn, 0.04% W (one representative sample)

– 209.80 ∿ 232.60m

Tachyandesite. This rock partially has barren quartz veins in a few mm and chlorite-quartz veins containing pyrite with very small quantities of chalcopyrite. Very small quantities of chalcopyrite and pyrite are also disseminated.

– 232.60 ∿ 266.20m

Coarse-grained granodiorite. Fine-grained chalcopyrite and pyrite are disseminated throughout this rock. Chalcopyrite-pyrite-chlorite-quartz veins locally occur. In the 257.00 ∿ 266.20m section, chalcopyrite and pyrite increase, and molybdenite is locally present. Analytical results on ores in this area show 0.03% Cu, 0.01% Zn and 0.05% W (average of two samples).

– 266.20 ∿ 273.40m

Trachyandesite. This rock has a weak dissemination of chalcopyrite and pyrite.

– 273.40 ∿ 305.40m

Coarse-grained granodiorite. This rock has a weak dissemination of chalcopyrite and pyrite. Partially, their films are noted in cracks. The 276.30 ∿ 287.30m section is abundant with sulfide minerals. Analytical results of ores from this area show 0.03% Cu, 0.01% Zn, and 0.06% W (average of two samples).

(3) MJE–3 Hole

(i) Location, Inclination, and Depth

Location : Latitude 9,808.05N, longitude 707.84E, altitude +1,647m

Inclination : –90°

Depth : 303.30m

(ii) **Purpose**

This drilling was conducted to define the spread of the mineralized zone A and the concealed mineralized zone which was confirmed by drilling MJE–1 hole and to understand occcurrence in these zones.

(iii) **Geology and Mineralization of Drill Hole (Plate II–1–21)**

– 0 ∿ 29.50m

Weathered granodiorite masa and sericite clay. Sericitized zone occurs from the vicinity of 20m.

– 29.50 ∿ 55.40m

Rock facies consists of coarse-grained granodiorite intersected in networked patterns with chlorite-secondary biotite-quartz veins bearing sulfide minerals and presents appearance of brecciated rock. Ore minerals include molybdenite, chalcopyrite, pyrite, scheelite, and magnetite. In the veins, a number of molybdenite 2 ∿ 5mm long and pyrite about 1cm across are present with small quantities of fine-grained chalcopyrite. Host rock has a dissemination of fine-grained chalcopyrite and pyrite.

Alteration of host rock is mainly sericitization. Alteration at the surroundings of veins shows silicification and chloritization. Analytical results of ores show as follows:

29.50 ∿ 45.80mm : 0.3 g/t Ag, 0.06% Cu, 0.09% Mo (average of three samples)

49.90 ∿ 54.00m : 0.06% Cu, 0.13% Mo (grade of one representative sample)

– 55.40 ∿ 195.30m

Rock is coarse-grained granodiorite in which veinlets and dissemination of chalcopyrite and pyrite are locally observed. Alteration consists of weak chloritization.

Analytical results of ore samples obtained from the area in the 55.40 ∿ 65.20m section where chalcopyrite occurs relatively in large quantities show 0.05% Cu and 0.06% Mo (average of two samples).

– 195.30 ∿ 263.00m

Rock facies consists mainly of andesite and its tuffs of thermally metamorphosed the Macuchi Formation with partial intrusion of coarse-grained grandodiorite and trachyandesite. In these rocks, epidote-secondary biotite-quartz veins containing sulfide minerals exist in networked patterns. The width of veins ranges from a few cm to about 120cm. Sulfide minerals in veins occur in relatively large lenses or amoebiform. Pyrite concentrates of coarse-grained crystals of 0.5cm are partially present in some places. Chalcopyrite is in fine grains but partially occurs in as large size as 1cm. Pyrrhotite and scheelite are present in small quantities in these veins. These veins are cut by pyrite-quartz and barren quartz veins. Small quantities of magnetite are observed in them. Vein alteration consists of chloritization and silicification. Analytical results of ore samples obtained in the area of this zone where chalcopyrite occurs in relatively larger quantities are as follows:

235.50 ∿ 236.50m : 0.10% Cu; 246.00 ∿ 248.30m : 0.14% Cu; 251.50 ∿ 252.00m : 0.36% Cu.

Microscopic observation of samples obtained from 235.50m shows that secondary pyrite is formed in pyrrhotite in a vermicular pattern. Furthermore, chalcopyrite exists in pyrite as a scattered pattern (Photo A–2).

– 263.00 ∿ 273.00m

Rock consists of melanocratic diorite. It has a dissemination of fine-grained pyrite and chalcopyrite. For alteration, the rock is affected by silicification.

– 273.00 ∿ 303.30m

Rock is coarse-grained granodiorite. It has a dissemination of fine-grained chalcopyrite and pyrite. Alteration consists of weak chloritization. Analytical results of ore samples obtained from this area show 0.13% Cu (average of two samples).

1–3–4 Discussion

Drilling of the three holes this year defined the spread of mineralized zone A and confirmed the existence of another concealed mineralized zone below. The mineralized zone A is a networked vein mineralized zone and is dipped 60° in the southeast direction to continue to the deeper part. The deeper part of the mineralized zone is greater than the upper part in scale as a whole. The paragenesis of ore minerals in the mineralized zones do not show uniform but instead present different aspects depending on place. Pyrite is omnipresent throughtout the mineralized zone in the brecciated granodiorite but concentration of chalcopyrite is localized. Macroscopically, molybdenite occurs more in the outside or upper part of mineralized zones. For alteration, sericitization conspicuously develops in vicinities of the ground surface. In the lower portion, alteration around vein which includes chloritization and silicification are dominant.

The lower concealed mineralized zone is a networked vein mineralized zone in which host rocks are granodiorite, andesite and its tuffs of the Macuchi Formation, and trachyandesite dikes. Veins are mostly formed by paragenesis of chalcopyrite-pyrite-epidote-secondary biotite-quartz but pyrrhotite is also locally observed.

Scheelite is noted in quartz veins and sericitized zones of the mineralized zone A and lower concealed mineralized zone. Dessemination of chalcopyrite and pyrite exist in granodiorite. The desseminated ores occur in the above networked vein mineralized zones, their vicinities, or independently. For their alteration, secondary biotite is most common. In networked mineralized zones and host rocks in vicinities, chalcopyrite-pyrite-chlorite exist in cracks and intersect secondary biotite disseminated ore zones, together with chalcopyrite-pyrite-epidote-quartz networked veins. Hydrothermal activities in the Bolivar area could roughly be divided into three phases. 1st phase: hydrothermal activities accompanied by precipitation of sulfide minerals; 2nd phase: hydrothermal activities accompanied by precipitation of hematite and acid alteration; 3rd phase: hydrothermal activities accompanied by acid alteration involving no metallic elements at all. Mineralization in El Torneado has taken place as a result of hydrothermal activities in the 1st phase. In El Torneado, its mineralization can be further divided into the two stages of disseminated mineralization and networked vein mineralization because of the fact that the networked vein mineralized zone cuts disseminated mineralized zone. In the networked vein mineralized zone, it is observed that sulfide minerals-chlorite-quartz networked veins cut the sericitized zone of host rock, and also later period quartz veins accompanying molybdenite cut chalcopyrite-pyrite-chlorite veins and magnetite coexists with sulfide minerals in networked veins. These facts indicate that a plural number of hydrothermal activities were involved in networked vein mineralization and that there were changes in chemical composition of hydrothermal water as well as changes from reduction environment to oxidation environment.

The following relationships exist between mineralization and igneous activities:
(1) Coarse-grained granodiorite of the host rock of the mineralized zone is 25.7 ± 0.9Ma in isotopic age as determined by K–Ar method, and trachyandesite which intrudes into this rock has also been mineralized. (2) Of the hydrothermal activities in three phases, hydrothermal activities accompanied with alteration by acid hydrothermal solution in the 2nd and 3rd stages occurred in Las Palmas. The activities have altered the Lourdes Volcanic Rocks of the Piocene-Pleistocene distributed in the San Miguel area. From these facts, it is considered that the mineralization in El Torneado occurred due to hydrothermal activities in the Miocene after igneous activities of the Oligocene.

Chapter 2 Other Areas

2–1 Geological and Geochemical Surveys

2–1–1 Purpose of Survey and Survey Method

The semi-detailed geological and geochemical surveys were carried out in the specified eleven areas of Chaso Juan, La Industria-Yatubi, Tres Hermanas, Telimbela, San Miguel, Las Guardias, Sicota, Tambillo, Tablas Pamba, Balaron and Chilcales Alto. They were selected as more prospective areas on the basis of their geochemically anomalous characteristics which were obtained during the reconnaissance geochemical stream sediments sampling covering the whole of the project area, followed by the selective soil and rock chip sampling in some of the areas.

The purposes of this present semi-detailed surveys are to clarify the nature and sources of the known geochemical anomalies, and to evaluate ore potentiality for further detailed exploration work in each area.

The geological traverses were conducted along the selected routes designed prior to the commencement of the actual fieldwork based on the results of the previous undertakings. All the field observations were recorded as the geological route maps on the maps at a scale of 1:5,000 prepared by enlargement of the newly produced 1:10,000 topographic map sheets of the Las Guardias area, the existing 1:25,000 map sheets covering the La Industria-Yatubi area, and the 1:50,000 map sheets overlying the remaining nine survey areas. These observations were elaborately compiled and interpreted together with the previous work results, then presented as the individual geological maps at a scale of 1:10,000. During the compilation work, helpful use was made of available aerial photographs. The necessary number of the samples for laboratory studies were carefully collected. The locations of these samples are shown in Fig. A-1, and the results of the laboratory studies were described in Chapter 1 and Appendixes.

In parallel to the geological traverses, a total of 34 rock chip samples were collected from outcropping bedrocks in or near mineralized zones for geochemical study on behavior of metallic elements. These samples were quantitatively analyzed by the inductively coupled argon plasma emission spectrochemical analysis (ICP) for the selected seven elements of Ag, Cu, Pb, Zn, Mo, Co and Ni in Japan, then all of the analytical results were carefully interpreted together with those of 33 samples in the Balzapamba area for the purpose of discriminating the elements related to mineralization and their dispersion from the mineralized zone toward the host rock. The results of the previous geochemical surveys, particularly the analytical data of the rock chip sampling of the Telimbela area (Cu, Pb, Zn and Mo of 85 samples) and the San Miguel area (Cu and Zn of 54 samples), were used for reference in the present geochemical data interpretation.

During the geological survey, the magnetic susceptibility measurement was also undertaken in the use of portable magnetometer on the representative mineralized and non-mineralized outcrops along the principal traverse routes to clarify the interrelation between magnetic susceptibility and mineralization or related alteration.

2–1–2 Chaso Juan Area

(1) Location

The Chaso Juan area is situated about 40 Km north in spatial distance from the Balzapamba area. The access by road can be done from Balzapamba via Babahoyo and Ventanas, and takes about 3 hours by car.

(2) Geology

The area is underlain by volcanic rocks of the Macuchi Formation and granific rocks which was emplaced in the Macuchi Formation (see Plate II-2-1, Fig. II-2-1 and Fig. II-2-2).

The volcanic rocks (An) is composed of dark green mafic hornfels, and is exposed mainly in the western part of the area. The lithological characteristics of this volcanic member appear to be similar to those of the Member A of the Macuchi Formatin in the Balzapamba area.

The charactristics of the typical sample under the microscope are as follows:

Altered hornfels (B1093)

Locality : Western extremity (lower reaches of Mulidiahuan river)

Texture : Porphyritic

Constituent minerals : Plagioclase > hornblende, pyrite (stringers)

Alteration minerals : Quartz, albite, chlorite > actinolite > epidote, montmorillonite

The larger intrusive mass of the granitic rocks is exposed from north to south of the area and it consists mainly of hornblende-biotite granodiorite (Gd) with lesser amounts of melanocratic diorite (Di) and dyke-shaped quartz diorite (Qd). The hornblende-biotite granodiorite is dated as 20.9±0.7 Ma by the K-Ar method.

The microscopic characteristics of the representative sample of the hornblende-biotite granodiorite are as follows:

Hornblende-biotite-granodiorite (B1092)

Locality : Central part of the area

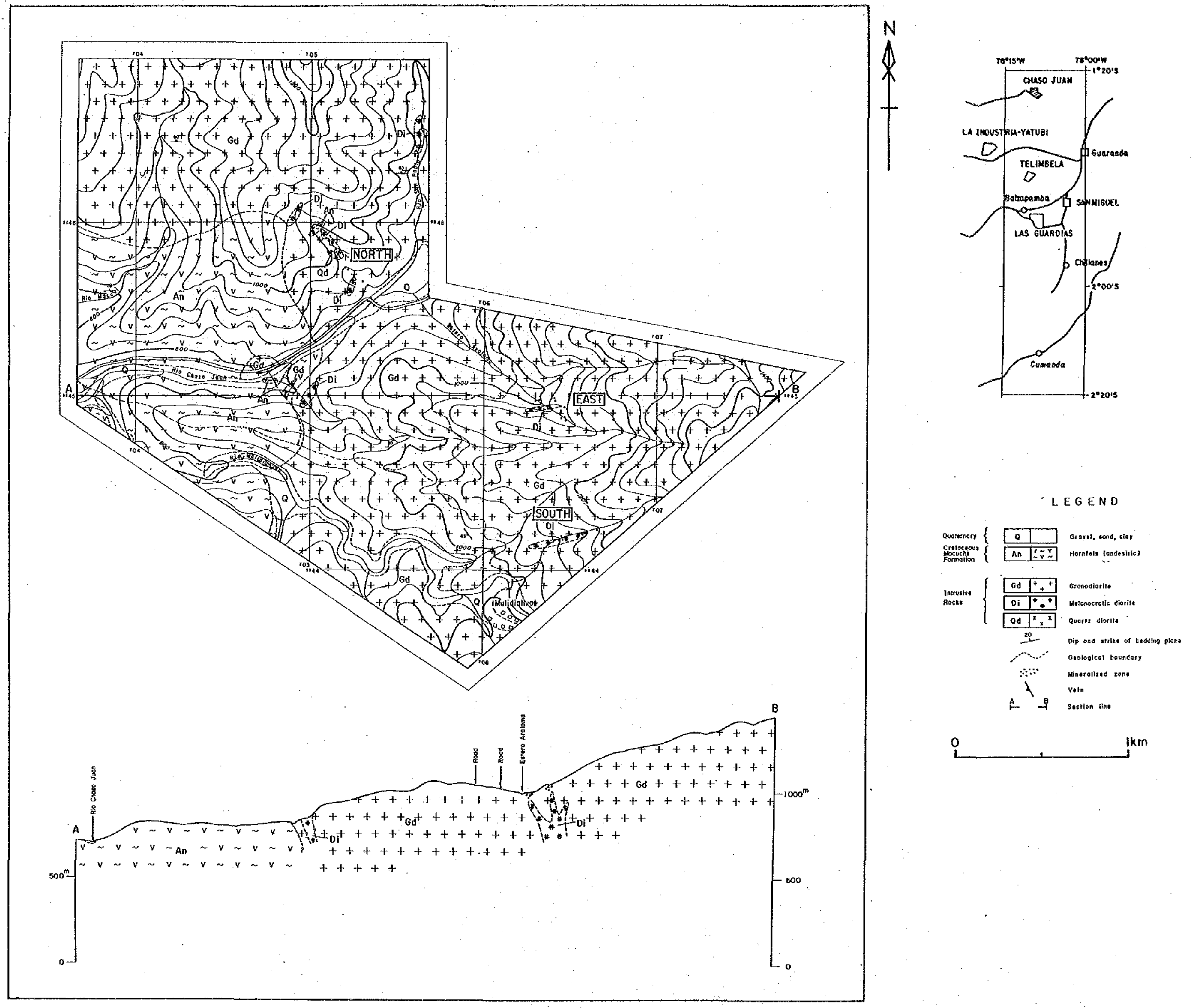
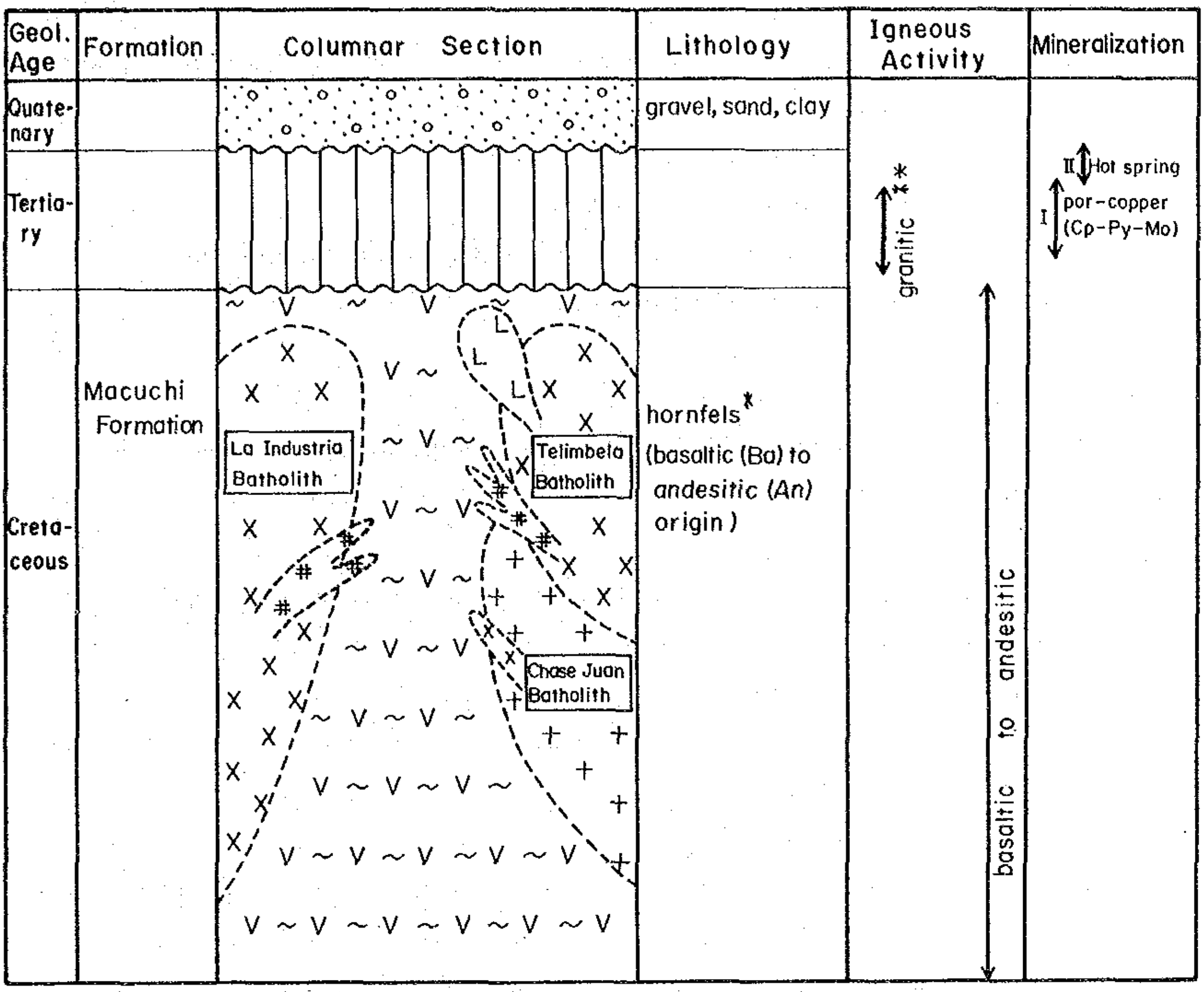


Fig. II－2－1　Geological Map and Distribution of Mineral Showings of the Chaso Juan Area



Granodiorite

Quartz diorite

Melanocratic diorite

Quartz porphyry

(Above-mentioned these rocks do not show the geological time of their intrusion but their occurrence)

*	Chaso Juan	: Andesitic	(Th ≒ 400m)
	La Jndustria	: Andesitic	(Th ≒ 60m)
	Telimbela	: Basaltic andesitic	(Th ≒ 1,000m)

**	Chaso Juan	: 20.9 ± 0.7 Ma
	La Jndustria	: 25.5 ± 0.9 Ma
	Telimbela	: 19.4 ± 0.6 Ma

Fig. II – 2 – 2 Generalized Stratigraphic Columnar Section in the Chao Juan, La Industria -Yatubi and Telimbela Areas

Texture : Equigranular, holocrystalline

Constituent minerals : Plagiochase > quartz, biotite > hornblende > K-feldspar, apatite, opaque minerals

Alteration minerals : Albite, sericite, chlorite, leucoxene

Biotite is partially altered to chlorite

Any remarkably geological structure has not been recognized in the area, but mineralized zones seem to be aligned in NW-SE and N-S directions.

(3) **Mineralization**

In the north, east and south of this Chaso Juan area, porphyry-copper type mineralization is observed in the peripheral area of grandiorite considered batholith. As features of mineralization, following could be cited:

1) Chalcopyrite/pyrite ratio of the mineralized zone which consists of chalcopyrite-pyrite-molybdenite disseminated and networked vein zones is higher than the mineralized zones in the Telimbela and Balzapamba areas, and in the Las Guardias area to be described later, and small amount of pyrite are observed. This fact agrees with the results of IP survey in the past that no FE anomaly was detected in the area where mineralized zones are distributed.
2) Chalcopyrite is in coarse grains.
3) Alteration of host rock is characterized by secondary biotitization but results of X-ray diffractive analysis identified K-feldspar in the eastern mineralized zone. K-fedspar is recognized as an alteration mineral of surroundings of veins in networked vein mineralized zones in the El Torneado mineralized zone, Balzapamba area. Furthermore, scheelite is observe in networked vein mineralized zones in El Torneado. In the southern mineralized zone of this area too, survey conducted in the past reported occurrence of scheelite. Thus, the possibility of mineralization similar to the one in El Torneado can be expected in this area as well.
4) For direction of individual veinlets, both NW-SE and NE-SW systems have been confirmed. Mineralized zones distributed are of N-S system. The existence of this N-S system is also supported from the fact that past IP survey detected a low resistivity zone N-S system which runs from the west end of the eastern mineralized zone to the southern mineralized zone and that anomalous zones of magnetic susceptibility show N-S system. This direction also agrees with the direction generally followed by granitic rocks distributed in the Bolivar area as an interesting fact. Description of individual mineralized zones is as follows:

Three remarkable porphyry copper-type mineralized zones have been located in the north, east and south of the Chaso Juan area, and northern immediate outside the area a highly gossanized quartz-limonite network zone is also observed.

The north mineralized zone occurs in granodiorite and coexisting small melanocratic diorite bodies exposed along with a northwestern tributary of San Pablo river, about 1 Km west of Chaso Juan village. It is characterized by three aggregates with 10-50 m long of dissemination and network of chalcopyrite-pyrite-molybdenite, spreading out discontinuously for about 400 long of the tributary. The assay result of the ore sample gave the contents of 1.3g/t Ag and 0.10% Cu. The alternation mineral assemblage is predominantly of quartz-secondary biotite-(sericite).

The east mineralized zone can be observed in the middle to upper reaches of Araloma valley and its tributaries, and occurs as discontinuous four mineral showings of dissemination and network of chalcopyrite-pyrite-molybdenite in granodiorite alongwith about 1 Km long of Araloma valley. The analytical results of the representative sample showed the assay of 1.7 g/t Ag and 0.26 % Cu. The mineral assemblage of quartz-K-feldspar-secondary biotite-(sericite-chlorite) is most common in hydrothermal alteration zone.

The south mineralized zone is situated about 600 m north-northwest to north-northeast of Mulidiahuan village, where granodiorite associated with small intrusions of melanocratic diorite are widespread. The south mineralized zone is comprised of three principal dissemination and network showsings of chalcopyrite and pyrite with variable amounts of molybdenite, and these showings are intermittently cropped out within about 700 m long of the small tributary of Mulidiahuan river. The previous worker reported the occurrence of scheelite in this mineralized zone, but no scheelite has been recognized at all during this survey.

The analytical results of 7.6 g/t Ag and 1.46 % Cu were obtained the most typical mineral showing. As a result of microscopic observation of sample No. A1113, disseminated chalcopyrite $>$ magnetite are recegnized. The hydrothermal alteration is emphasized by quartz, secondary biotite and minor amount of chlorite. The assay result of chalcopyrite-limonite vein sample, which occurs as vein of 10cm in width at west and of the south mineralized zone, shows 1.5g/t Au, 160.9g/t Ag and 9.03% Cu.

In addition, an intensely gossanized network zone of quartz veins abundant in limonite, having the dimensions of 150 m long and 30 m wide, occurs in granodiorite at the northern immediate outside thearea, 1.3 Km north of Chaso Juan village. This network zone is being mined intermittently to extract gold on a very scale, but the analytical result of a typical quartz-limonite sample gave no content of gold.

(4) **Results of Magnetic Susceptibility Measurement and Geochemical Survey**

The interpretation results of the magnetic susceptibility measurement and the geochemical survey together with the locations of the mineralized zones are represented in Fig. II-2-3.

The extensive low anomalous zone of the magnetic susceptibility is detected over the east and south mineralized zones, though very local in the north mineralized zone. In this moment the measurement is quite limited to the principal survey routes, then could not cover the whole extent of the mineralized zones. However, the anomalous zone obtained from the east and south mineralized zones is considered to compete in size and intensity with that detected over the El Torneado mineralized zone in the Balzapamba area.

The geochemical samples were collected only from the east mineralized zone. The careful processing of the analytical data resulted in the detection of high factor scores of Factor 2 (Ag-Cu) and moderate factor scores of Factor 4 (Mo), and also the fact that the contents of Cu tend to clearly decrease outward from the mineralized zones is confirmed.

2–1–3 **La Industria-Yatubi Area**

(1) Location

The area is placed about 25 Km northwest of Balzapamba, and can be reached from Balzamba via Babahoyo and it takes about 2 hours and a half by car through 125Km of the road distance.

(2) Geology

The La Industria-Yatubi area is almost entirely underlain by a batholithic mass of felsic plutonic rocks and extremely minor amounts of volcanic rocks of the Macuchi Formation (Plate II-2-2, Fig. II-2-2 and Fig. II-2-4).

The felsic mass is composed mostly of quartz diorite (Qd) and a small amount of granodiorite (Gd) is observed in places. The quartz diorite cropping out along the middle reaches of San Antonio valley, the northeastern part of the area, is subjected to strong silicification and argillization. In addition, the quartz diorite is intruded NNW-SSE trending dykes of melanocratic diorite in the northwestern and northeastern parts of the area. A K/Ar dating of the quartz diorite gave 25.5±0.9 Ma.

The microscopic observations of representative samples are as follows:

Biotite-hornblende quartz diorite (C1079)

Locality : Southeastern margin of the area

Texture : Equigranular, holocrystalline

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

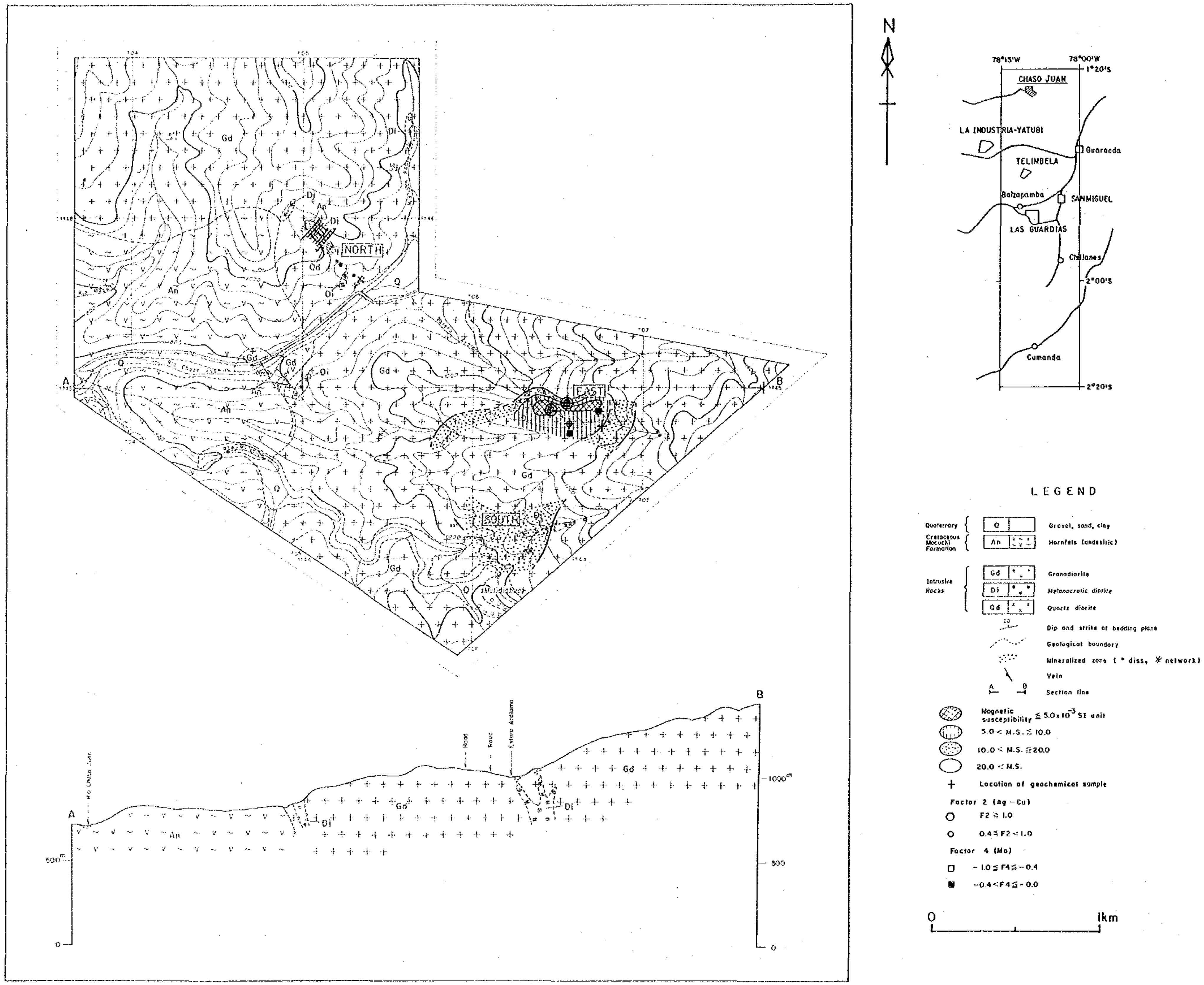


Fig. II – 2 – 3 Synthetic Interpretation Map of the Mineralization, Magnetic Susceptibility and Geochemical Date of the Chaso Juaso Area

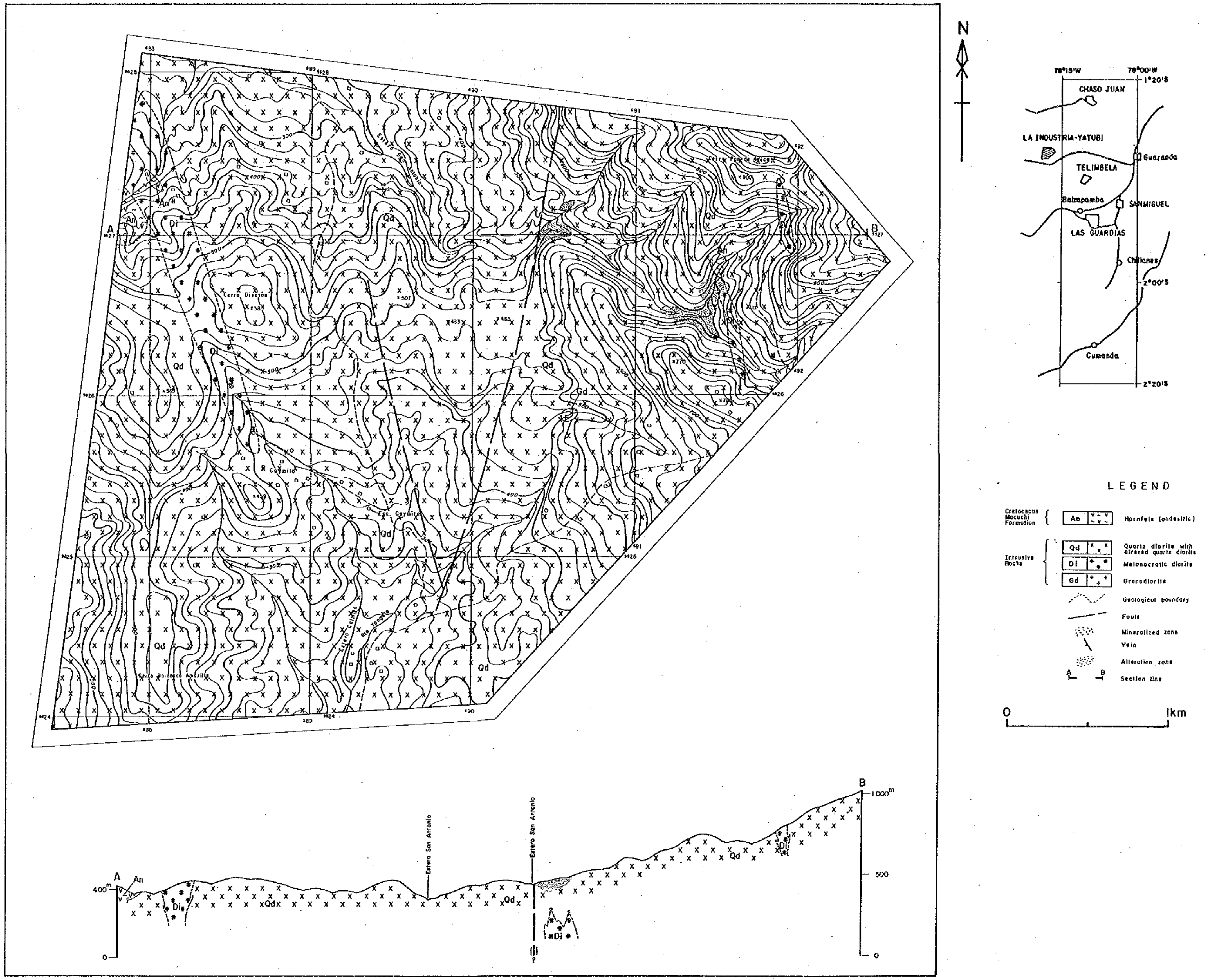


Fig. II－2－4 Geological Map and Distribution of Mineral Showings of the La Industria -Yatubi Area

Alteration minerals : Sericite > secondary biotite, chlorite > epidote, leucoxene, montomorillonite

Biotite is partially altered to chlorite and sericite.

Biotite-hornblende quartz diorite (D1062)

Locality : 500 m south of Cerro Diento

Texture : Equigranular, holocrystalline

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

Alternation minerals : Chlorite > albite, sericite > epidote, leucoxene

Biotite is partially altered to chloric and epidote.

Three narrow exposures, possibly localized xenoliths, of the volcanic rocks (An) belonging to the Macuchi Formation can be observed in the western margin (two exposures) and the eastern part (one exposure) of the area. These consist of darkgreen andesitic rocks and are completely metamorphosed to hornfels.

The geological structure in the area is dominated by NNW-SSE and NNE-SSE tending structures represented by two distinct faults and dykes of melanocratic diorite.

(3) Mineralization

The geological investigation has revealed the occurrence of bimodal mineralizations; porphyry copper type and hot spring type, in the La Industria-Yatubi area.

The porphyry copper type mineralization occurs as four zones with each strike long of 100-300 m in quartz diorite along the middle stream of San Antonio valley and its tributaries. One of which is dissemination of chalcopyrite and pyrite, and other three are of predominantly pyrite in argillized-silicified zone. The former assayed 0.05 % Cu. A X-ray diffraction analysis of the sample from the altered zone showed the alteration mineral assemblage of quartz-chlorite.

The hot spring-type mineralization is suggested by presence of unnumbered floats ranging from 3 cm to 5 m in diameter of strongly gossanized hematite-limonite-quartz network. These floats can be seen with the extent of 600 m E-W x 700 m N-S in the southwestern part of the area. The analytical results of the representative samples showed the contents of 0.3g/t Au, 16.3g/t Ag and 0.03% Cu.

In addition, there are some localized mineralized zones; E-W trending limonite-quaetz veins in the north, weak disseminations of chalcopyrite in the northwest, and quartz-kaolinite-halloysite alteration zones containing coarse grains of pyrite in the west.

(4) Results of Magnetic Susceptibility Measurement and Geochemical Survey

Fig. II-2-5 shows the results of the interpretation of the magnetic susceptibility measurement, geochemical survey and locations of the mineralized zones confimed.

Two low anomalous zones of the magnetic susceptibility are detected over the northeast mineralized zone and one on the network zone in the southwest.

The geochemical samples were collected only from chalcopyrite-pyrite disseminations and their host rocks of the northeast mineralized zone. The processing of the analytical values detected moderate factor scores of Factor 2 (Ag-Cu) and suggested that the Cu contents tend to decrease outward from the mineralized zone. Moderate factor of Factor 3 (Pb-Zn-Cu) are also obtained. From this result it is envisaged that the northeast mineralized zone has a less possibility of the presence of different mineralization in type and stage from that of porphry copper type.

2–1–4 Tres Hermanas Area

(1) Location

The Tres Hermanas area lies about 12 Km east of the La Industria, about 20 Km north-northwest of Balzapamba. It is accessible from Balzapamba via Babahoyo and takes about 3 hours by car.

(2) Geology

The area is lithologically dominated by three units of volcanic rocks classified as the Macuchi Formation (Plate II-2-3, Fig. II-2-6). These are basalt lava (Ba), basaltic andesite (Ban) and fine-grained tuff. The thickness of the Macuchi Formation in the area is estimated to be more than 940 m. The fine tuff layers trend N-S to NNW-SSE and dip 20 to 35°E.

(3) Mineralization

A weak and local mineralized zone consisting of dissemination with stringers of chalcopyrite and pyrite occurs in the basaltic andesite unit cropping out in the southern central part of the area. The representative sample gave the contents of 0.1 g/t Au, 4.6 g/t Ag and 0.03 % Cu.

The magnetic susceptibility values range from 21 to 86 x 10^{-3} SI units on the basaltic andesite zone and 1 x 10^{-3} SI unit on the fine tuff zone. The demagnetization related to mineralization has not been observed in and around the mineralized zon .

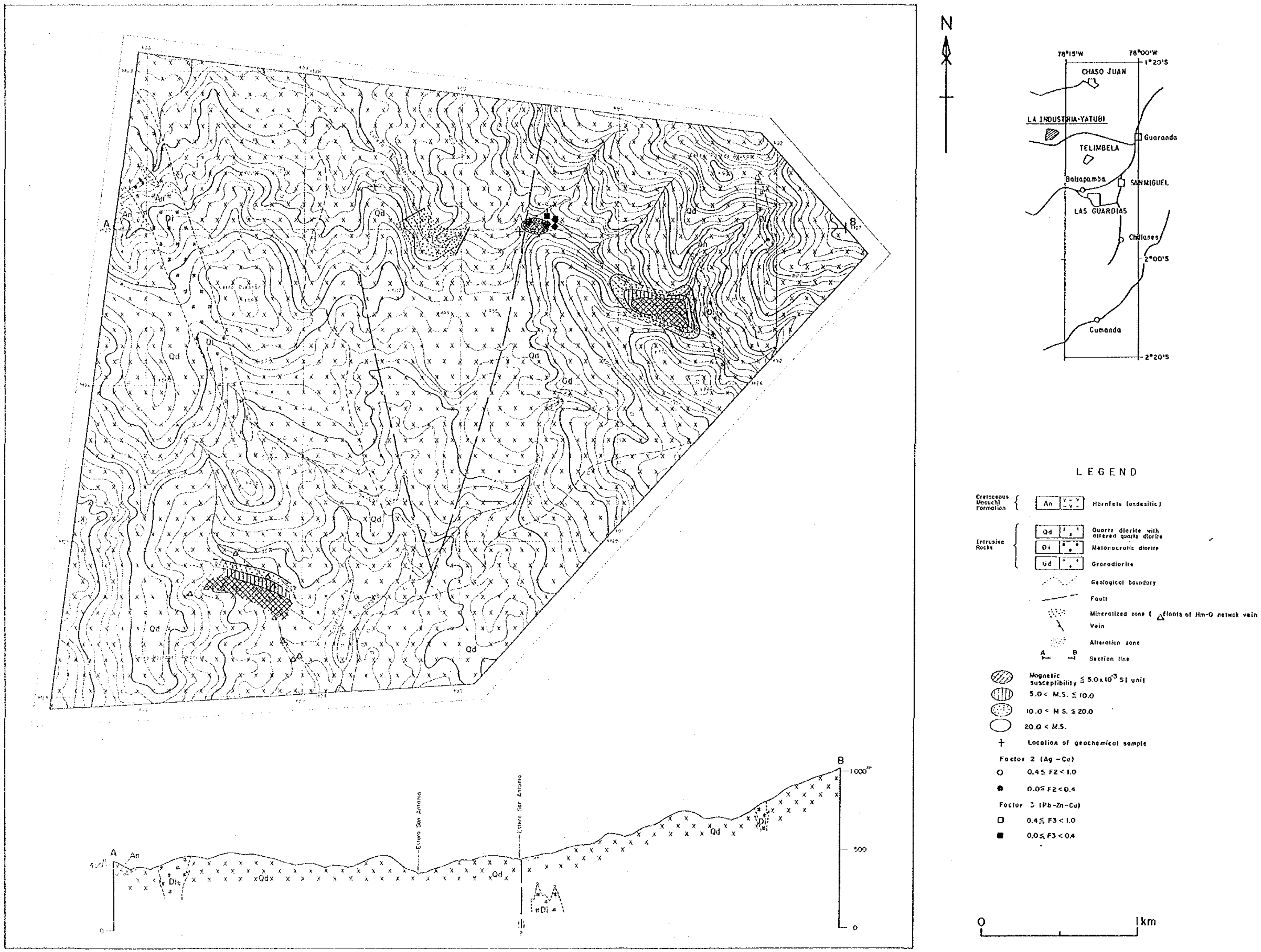


Fig. II − 2 − 5 Synthetic Interpretation Map of the Mineralization, Magnetic Susceptibility and Geochemical Date of the La Industria-Yatubi Area

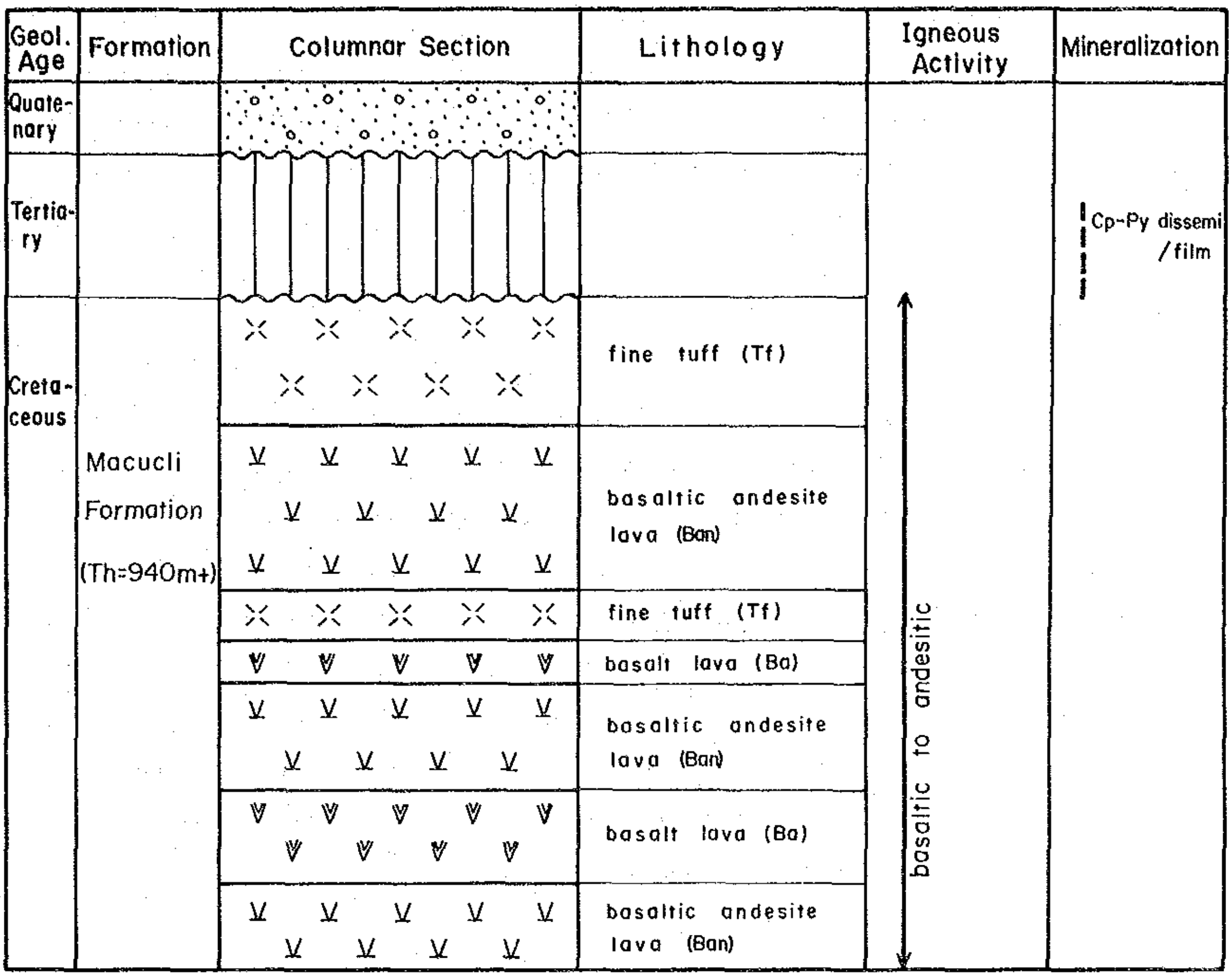


Fig. II－2－6 Generalized Stratigraphic Columnar Section in the Tres Hermanas Area

2–1–5 Telimbela Area

(1) Location

The area is situated only 15 Km north of Balzapamba, but due to steep and rugged topography, it can be reached about 135 Km road distance from Balzapamba via Babahoyo and Catarama with about 3 hours traveling by car.

(2) Geology

The Telimbela area is underlain by volcnic rocks of the Macuchi Formation and felsic plutonic to hypabyssal intrusive rocks (Plate II-2-4, Fig. II-2-2, Fig. II-2-7).

The volcanic rocks (An) of the Macuchi Formation are distributed in the central to northern part of the area and are comprised mainly of basaltic andesite to andesite flows which are largely metamorphosed to hornfels.

The felsic intrusive rocks are croppsed out mainly in the southern part of the area and are composed of batholithic mass of hornblende–biotire quartz diorite (Qd), stock-shaped quartz porphyry (Qp) which is the latest intrusive rock in the area, and dykes of melanocratic diorite (Di) and porphyritic quartz diorite (PQd). The dykes are 20~50 m in wide and trend NE-SW direction. The hornblende-biotite quartz diorite is dated as 19.4±0.6 Ma by the K/Ar method.

The characteristics under the microscope are as follows:

Biotire-hornblende quartz diorite (B1166, float)

Locality : Telimbela river near Telimbela village

Texture : Equigranular, holocrystalline

Constituent minerals : Plagioclase > quartz, biotite, hornblende >> K-feldspar, apatite, sphene, opaque minerals

Alteration minerals : Chlorite > sericite, epidote, calcite, leucoxene

Quartz prophyry (B1154)

Locality : Telimbela river, about 300 southwest of Telimbela village

Texture : Porphyritic

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

Alteration minerals : Chlorite, epidote > albite, sericite

Plagioclase is slightly altered to albite and epidote, and some of biotite crystals are chloritized and epidotized.

Structurally the area is emphasized by a NNE-SSW trending fault running near the western boundary of the area and the NE-SW trend indicated by the dykes and longitudinal axis of the main mineralized zone.

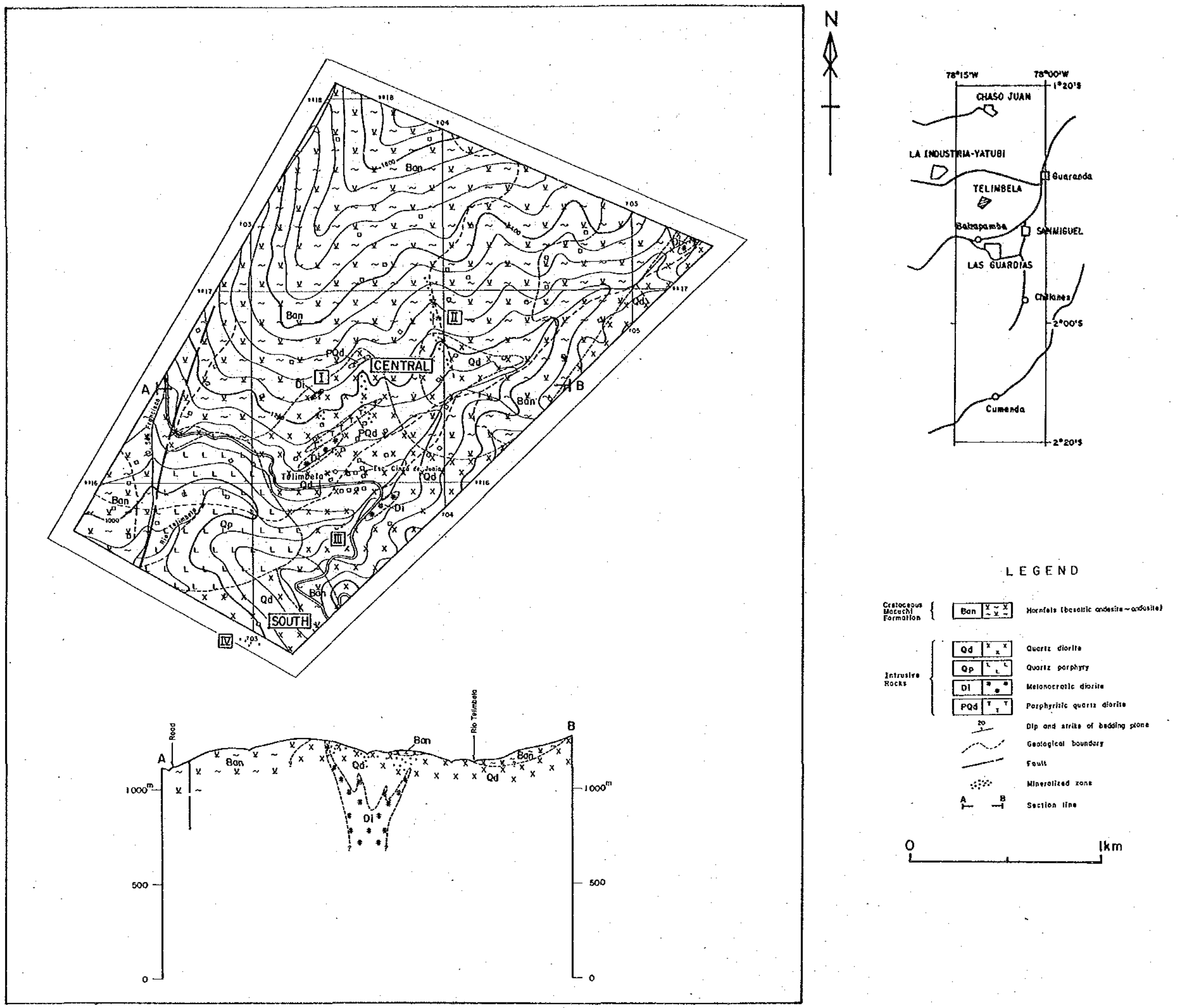


Fig. II－2－7　Geological Map and Mineral Showings of the Telimbela Area

(3) Mineralization

In the central and southern parts of this Telimbela area, mineralization of porphyry-copper type is observed in the peripheral portions of quartz diorite considered batholith and in the Macuchi Formation. As features of this mineralization, following can be cited:

1) This mineralized zone consists of chalcopyrite-pyrite-molybdenite disseminated and networked vein zones. Both disseminated zones and networked veins are noted in quartz diorite. However, mineralized zones of the Macuchi Formation contain many network veins. This is the same as the concealed mineralized zone in the El Torneado and Osohuayco mineralized zones, Balzapamba.
2) Granualarity of chalcopyrite is finer than that in the El Tornead o mineralized zone, Balzapumba, and mineralized zones in Chaso Juan and Las Guardias to be described later, and the the chalcopyrite-pyrite disseminated zone is also wider. This fact agrees with the detection of FE anomaly in the entire mineralized zone in past IP survey.
3) Alteration of host rock is characterized by silicification, secondary biotitization and sericitization but results of X-ray diffractive analysis identified K-feldspar in the northern mineralized zone. K-feldspar is recognized as a vein surrounding alteration mineral in networked vein mineralized zones of the El Torneado mineralized zones, Balzapamba. Past survey results show presence of a brecciated zone in the north of the northern mineralized zone. If this brecciated zone is similar to the brecciated structure in the El Torneado mineralized zone, this Telimbela area offers the possibility of mineralization like El Tornead.
4) For distribution, both the northern and southern mineralization zones extend in NE-SW direction. This NE-SW system coincides with the direction of FE anomaly which was detected in past IP survey covering both mineralized zones and the direction of magnetic susceptibility anomaly zone confirmed in the current survey. It is also interesting to note that this direction also agrees with the direction of principal fracture patterns in the Bolivar area. Description of individual mineralized zones is as follows:

During the present survey, four porphyry copper-type mineralized zones, termed as Zones I, II, III and IV, have been located in the northern and southern vicinities of Telimbela village.

The Zone I, the largest and the most potential of which, is situated 100~500 m north of the village, and occurs as dissemination and network of chalcopyrite, pyrite and variable amount of molybdenite in quartz diorite associated with melanocratic diorite and porphyritic quartz diorite dykes. The mineralization spreads over an extent of 500 m in NE-SW and 300 m in NW-SE. The analytical results of ore samples gave the contents of 1.60% Cu. Microscopic observation of Sample No. B1142 shows that pyrite-magnetite 〉 chalcopyrite occurs in gangue minerals as dissemination and network.

Within this Zone, quartz-K-Peldspar-secondary biotite-sericite-chlorite is the most common assemblage of hydrothermal alteration.

The Zone II, which is considered to be the northeastern extension of the Zone I, lies on 250 ~300 m northeast of the Zone I and has an area of approximately 200 m x 200 m. The mineralization is predominantly represented by dissemination and network of chalcopyrite, pyrite and minor amount of molybdenite formed in quartz diorite and surrounding volcanic rocks of the Macuchi Formation. The assay of some samples collected is 0.04% Cu. Alteration minerals are mainly quartz, chlorite and subordinate amount of sericite.

The Zone III is exposed along a small tributary of Telimbela river, 300~600 m south to Telimbela village, where quartz diorite is widely cropped out. The mineralized zone consists mainly of disseminated or thinly veined pyrite accompanied with rare amount of chalcopyrite in places, and spreads over an extent of about 450 m N-S and 200 m E-W. A typical disseminated pyrite sample gave the contents of 0.01% Cu.

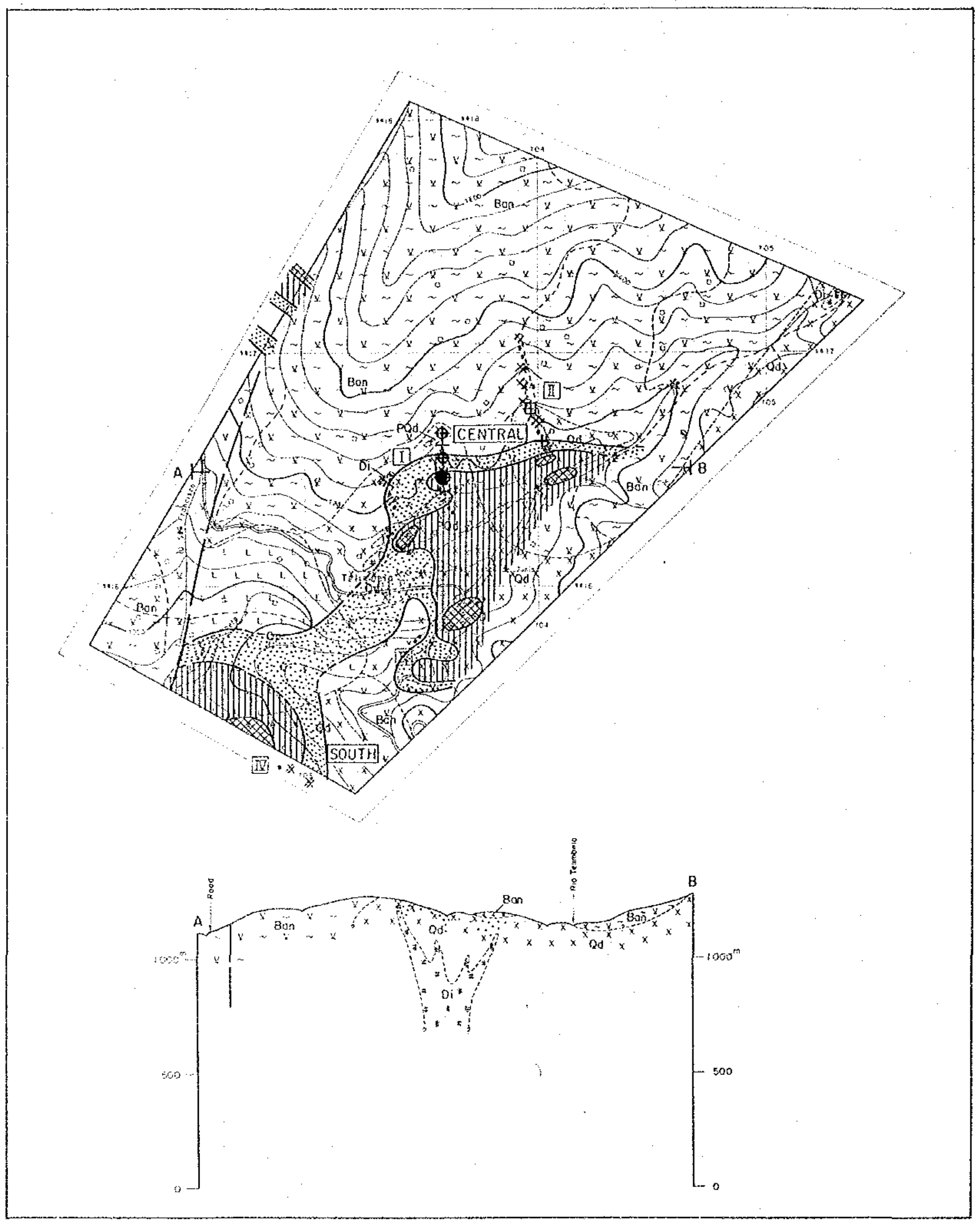
The Zone IV can be found at the southern boundary of the area, about 1 Km south-southwest of Telimbela village, in which several dissemination and/or network zones containing chalcopyrite and pyrite with minor amount of molybdenite occur in quartz diorite and these mineral showings are distributed within a distance of about 150 m along Mususan valley, a large tributary of Telimbela river. The representative samples assayed 0.05% Cu. The X-ray diffraction analysis determined a common alteration mineral assemblage of quartz-chlorite-(sericite). In terms of its mode of occurrence and location, the Zone IV seems to be the southwester extension of the Zone III.

(4) Results of Magnetic Susceptibility Measurement and Geochemical Survey

The results of the magnetic susceptibility measurement and geochemical survey together with the localities of the mineralized zones are shown in Fig. II-2-8.

The extensive low anomalous zone of the magnegic susceptibility was detected over the mineralized zones, and its extent is almost twice that of the El Tornead mineralized zone in the Balzapamba area. In the Zone II, the magnetic susceptibility of the volcanic rocks of the Macuchi Formation clearly decreases in its values from 83 to 36×10^{-3} SI units toward the main mineralized zone. This evidence may indicate the demagnetization caused by mineralization.

The geochemical study was carried out on the Zones I and II. As the result of the analytical data processing, high factor scores of Factor 1 (Ag-Cu) and moderate factor scores of Factor 4 (Mo) were obtained.



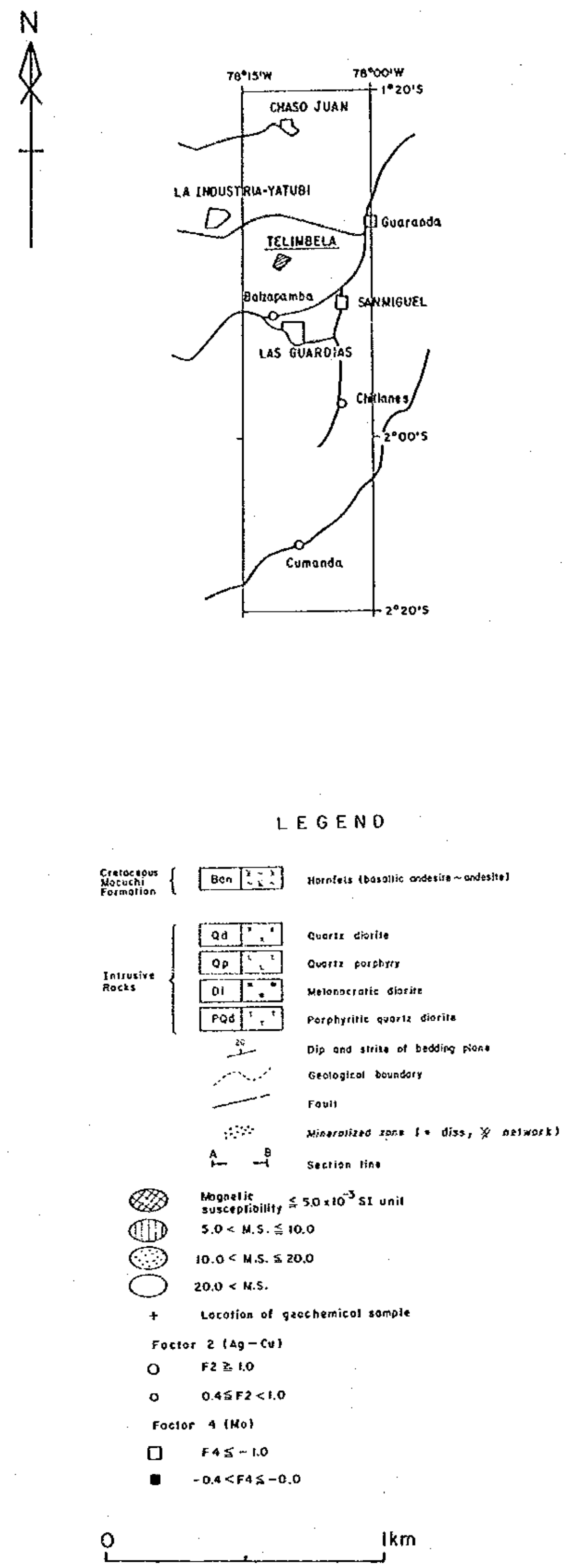


Fig. II − 2 − 8 Synthetic Interpretation Map of the Mineralization, Magnetic Susceptibility and Geochemical Date of the Telimbela Area

The previous rock geochemical survey on the Zones I and II reported that distinct anomalous zones of Cu and Mo were acquired over both Zones, particularly the Cu anomalous zones gave high values (16,720-6,300 ppm of "first-order anomalies" and 6,299-580 ppm of "second-order anomalies").

2–1–6 San Miguel Area

(1) Location

This area is situated about 15 km east of Balzapamba and 45 km, accessible in about 1.5 hours, from its settlements.

(2) Geology

The basement in this area is the Macuchi Formation composed of andesite lava, its pyroclastic rocks (An) and quartz-bearing andesite lava (Qan). Pliocene to Pleistocene Lourdes Volcanic Rocks (Da, Cgl) comprising dacite and its pyroclastic rocks are distributed over this basement (Plate II-2-5, Figs. II-2-9, 10). Further, Quaternary Guaranda Volcanic Rocks (Ptf) consisting mainly of volcanic ashes and pumice are distributed, extensively covering these underlying rocks. Locally Las Guandias granodiorite (Gr) is exposed in a small range of area. In the central part of this area, a fault zone runs in NNW-SSE direction. This fault had displaced the eastern block downward and dislocates up to the Lourdes Volcanic Rocks but falls short of cutting the Guaranda Volcanic Rocks.

(3) Mineralization

Mineralization in this area occurs in the above fault. Mineralized zones are distributed as echelon in the fault zone of about 100 m in width. Hydrothermal activity had taken place in these mineralized zones in three stages as described below. The total extension of alteration zones is about 1.5 km. 1st stage: hydrothermal activity accompanied by sulfide minerals; 2nd stage: hydrothermal activity accompanied by acid alteration involving hematite; and 3rd stage: hydrothermal activity accompanied by acid alteration involving no metallic elements. Hydrothermal activities in the 1st and 2nd stages extended alteration up to the Lourdes Volcanic Rocks, and the 3rd stage altered up to the Guaranda Volcanic Rocks.

A mineralized zone with sulfide minerals is well observed in Pahaca quarry. Geology of this place consists of dacitic tuffs of the Lourdes Volcanic Rocks and includes argillious patch from pumice. The mineralized zone is networked quartz veins containing a very small quantity of chalcopyrite and a small quantity of pyrite in the fault. Alteration of host rock mainly consists

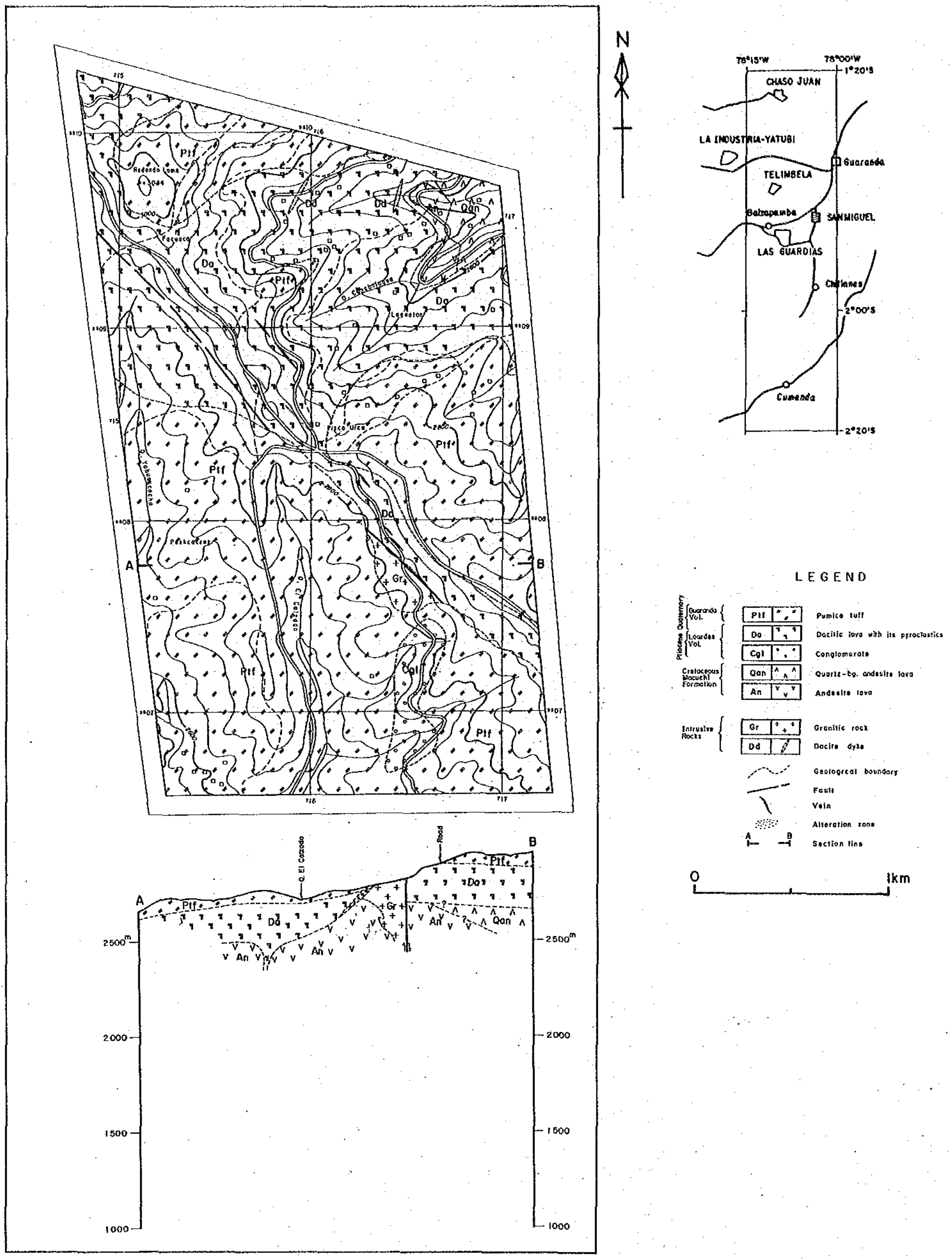


Fig. II－2－9　Geological Map and Mineral Showings of the San Miguel Area

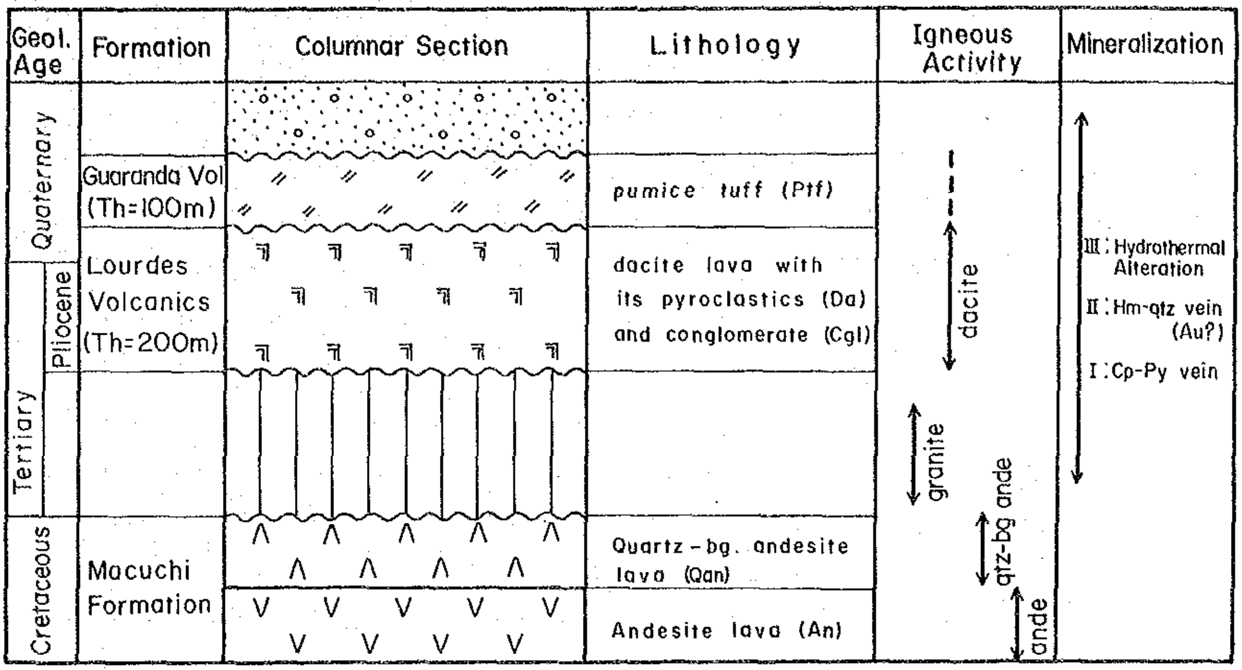


Fig. II－2－10　Generalized Stratigraphic Columnar Section in the San Miguel Area of silicification, accompanied by sericitization and chloritization. This mineralized zone can be traced in NNW-SSE direction for about 250 m. The fault on the south side of the quarry has a width of about 10 m in which networked veins occur. Of these networked veins, a part of about 2 m is strongly silicified and is abundant with sulfide minerals. At this point, the strike of the mineralized zone is N50°W, and its dipping, 80°N. Analytical results on chips obtained from this area showed a poor ore grade of 0.01% Cu. White colored soluble acid materials considered formed as secondary exuded products are observed on the surface of the outcrops. In identification of altered minerals by X-ray diffractive analysis, sericite, chlorite and kaolinite were observed. This kaolinite is considered related to the 2nd stage or 3rd stage hydrothermal activity. Other mineralized zones containing sulfide minerals include a pyrite disseminated zone and pyrite-(quartz) veinlet in an agrilized zone which is exposed on the side of the newly built road in the south of Pisco Urcu. The former is about 10 m in width and continues for about 200 m in NNW-SSE direction. The latter is observed for about 50 m on the side of the road. The strike and dipping of the veinlet is N70°W ~ EW and 40° N 80°N, respectively.

Products of the 2nd and 3rd stage hydrothermal activities can be observed on the side wall of the newly built road in the south of Pisco Urcu and on the road at the summit. Products of the 2nd stage comprise hematite-(silica sinter) that exist in a irregular networked vein in white-argillized host rock. Products of the 3rd stage resulted from the last stage of hot spring activity and are accompanied by white argillization. X-ray diffractive analysis of 2nd and 3rd stage altered minerals showed kaolinite. These alteration zones are distributed in echelon in the fault mentioned above and extend in NNW-SSE direction.

(4) Results of Magnetic Susceptibility Measurement and Geochemical Survey

Since this area is in extremely advanced stage of weathering, magnetic susceptibility in all the outcrops has drodpped under its strong effect. However, demagnetization is observed in hydrothermal alteration zones. In the above mentioned mineralized zone, a demagnetization zone extends in NW-SE direction (Fig. II-2-11).

In geochemical survey, samples were collected to investigate the spread of elements, centering about channel feeders of hydrothermal solution in the 2nd stage hydrothermal activity. Reults of this investigation show that Zn, Co and Ni tend to be more concentrated as sampling points approach the channel feeder while Cu presents an opposite trend. The 2nd stage hydrothermal activity was in a period of acid hydrothermal solution accompanied by magnetite and hematite. From this fact, the concentration of Zn, Ni and Co may probably reflect leaching from a great depth of elements which were the origin of the Macuchi Formation. As for Cu, it may be

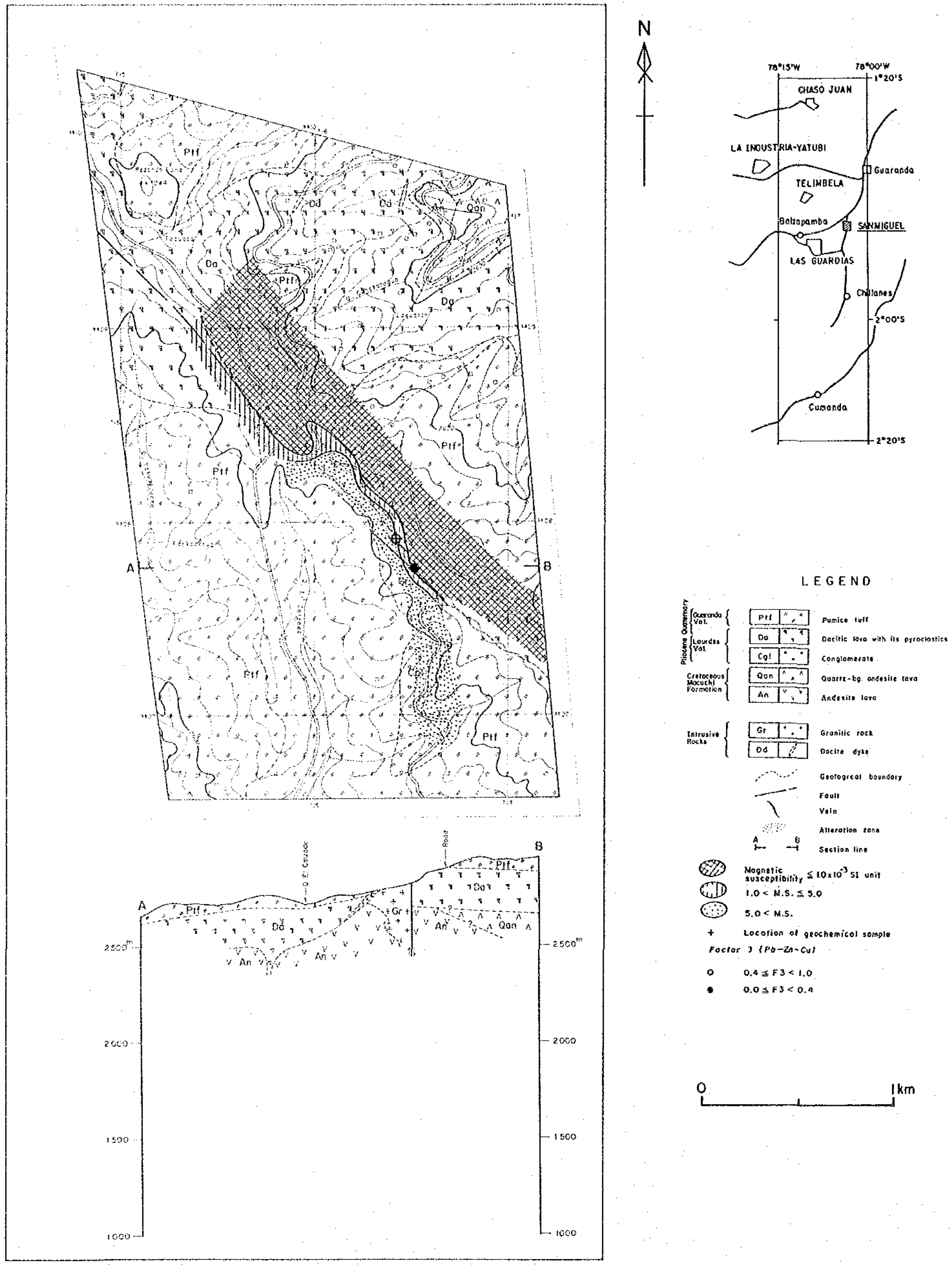


Fig. II – 2 – 11 Synthetic Interpretation Map of the Mineralization, Magnetic Susceptibility and Geochemical Date of the San Miguel Area

possible that this element had been deposited in this place in the 1st stage but leached away by hydrothermal activity in this period.

2–1–7 Las Guardias Area

(1) Location

The Las Guardias area lies on the southern proximity of the Balzapamba area, to which it takes about a half hour by car. The western to southern end of the area is bounded by the Babahoyo-Guaranda highway.

(2) Geology

The geology of the Las Guardias area is entirely dominated by andesitic volcanic rocks of the Macuchi Formation and a batholithic mass of granitic rocks (Plate II-2-6, Fig. II-1-2, Fig. II-2-12).

The andesitic volcanic rocks are distributed mainly in the western part of the area, and a relatively narrow part in the northern margin of the area. The rocks can be subdivided stratigraphically into three mappable units; (1) dark grey~black andesite-origin hornfels (An-1), (2) andesitic tuff (Tf) which is interbedded in hornfels unit, and (3) dark grey quartz-bearing andesite flows (Qan-1) being upper unit. The former two units and the last units can be correleted with the Member A and the Member B in the Balzapamba area, respectively.

The granitic rocks occupy the remaining extent, from the northern to southern part of the area, and they consist mostly of coarse-grained, leucocratic biotite-hornblende granodiorite-quartz diorite (Gd), associated with contrastively minor amount of melanocratic diorite (Di). The granodiorite-quartz diorite facies is considered to occur as a batholithic mass continued to the Balzapamba area but is abundant in hornblende in comparision with that in the Balzapamba area. The melanocratic diorites occur as a stock along or near Angas valley in the north, and as small NW-SE trending dykes with 40 ~ 80 m wide in the central to south. A typical sample of biotite-hornblende quartz diorite facies gave the K/Ar dating result of 30.1±1.1 Ma.

Microscopic characteristics of typical sample are as follows:

Biolite-hornblende quartz diorite (B1071)

Locality : Babahoyo-guaranda highway, 1.5 km east of Las Guardias village

Texture : Equigranular, holoerystalline

Constituent minerals : Plagioclase > quartz, hornblende, biotite >> K-feldspar, apatite

Alteration minerals : Chlorite, epidote > actinolite > albite, sericite

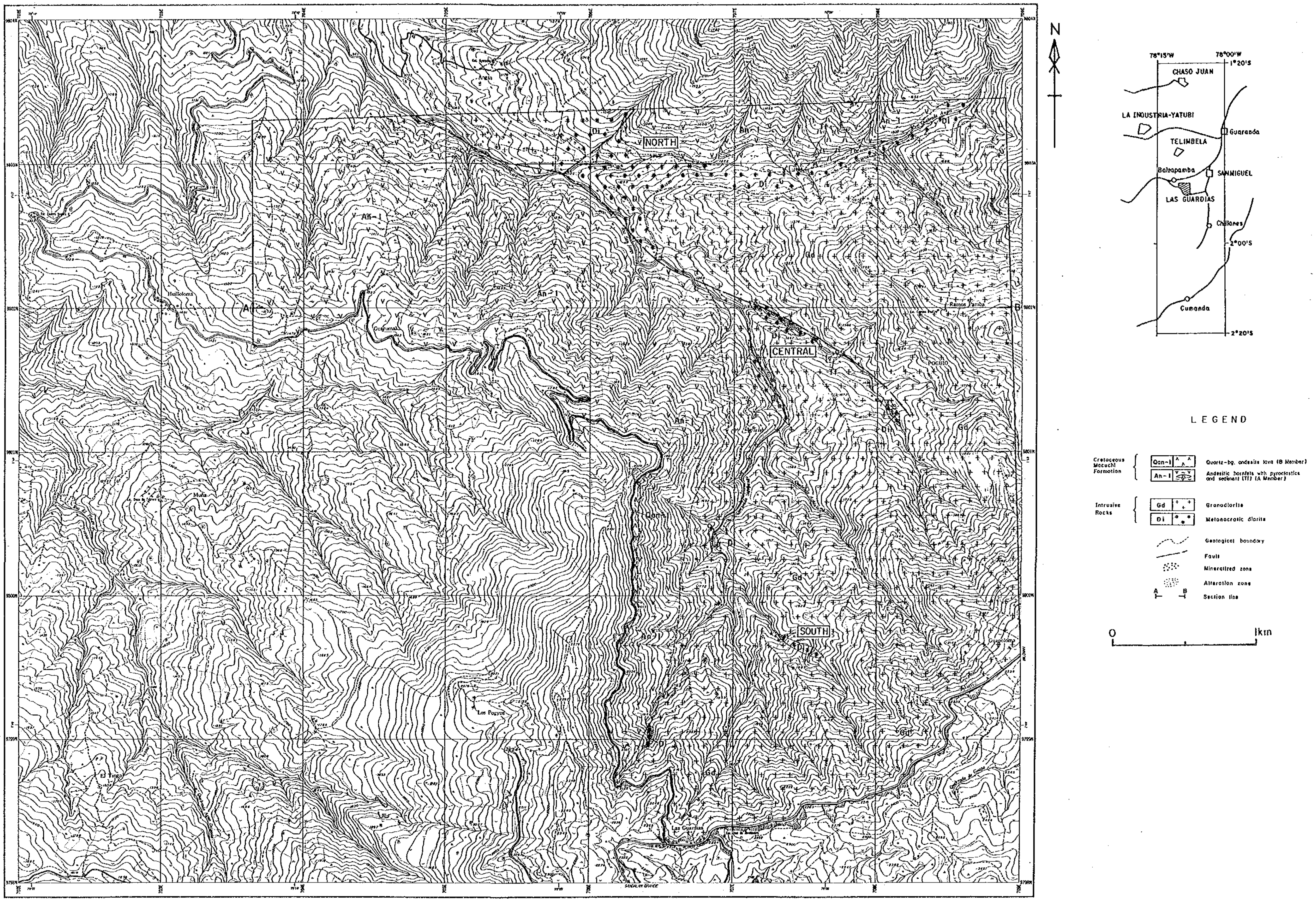


Fig. II-2-12 Geological Map and Mineral Showings of the Las Guardias Area

A major NW-SE trending fault extending for more than 4 km strike long traverses along San Jorge river and its tributary Motilones valley. This NW-SE trending structure also dominates intrusion of melanocratic diorite dykes and general trend of minerlization. Other than this, a minor NE-SW fault is observed in the northern end of the area.

(3) Mineralization

In the northern, central and southern parts of this area, mineralization of porphyry-copper type is noted in granitic rocks and the Macuchi Formation. This mineralization features following points:

1) Mineralized zones consist of chalcopyrite-pyrite-molybdenite disseminated zones and net-worked veins. Disseminated zones are mostly found in granitic rocks while networked veins largely occur in the Macuchi Formation. This is the same as the situation in the El Torneado mineralized zone and Osohuayco mineralized zone, Balzapamba.
2) Alteration of host rock is characterized by silicification and secondary biotitization. In X-ray diffractive analysis, sericite was identified although K-feldspar was not. Thus, the alteration in this area closely resembles alteration around vein in network-vein mineralized zones of the El Torneado mineralized zones,, Balzapmaba.
3) Mineralized zones distributed in the northern, central and southern parts are all in NW-SE direction. This NW-SE system agrees with fault structure in this area, and may be considered to be a conjugate set with the major fault structure of NE-SW system in the Bolivar area, as an interesting feature.

Description of individual mineralized zones is as follows:

The north mineralized zone comprises two dissemination and network showings of chalcopyrite, pyrite and minor amount of molybdenite formed in the melanocratic diorite stock and the Macuchi Formation. The size of each showing is about 50 m along strike. The chemical analyses of the typical sample gave the contents of 0.6g/t Ag and 0.02% cu.

The central mineralized zone is observed along the lowermost reach of Motilones valley. It has an extent of 350 m NW-SE x 50 m NE-SW, and occurs as dissemination and network veinlets of chalcopyrite and pyrite in melanocratic diorite, batholith of granodiorite-quartz diorite and a small hornfels block of the Macuchi Formation which is enclosed in quartz diorite. The assay of the representative sample is 0.09% Cu. Alteration minerals of quartz, sericite and chlorite are predominant in this mineralized zone.