1-4-3 Drilling survey

1-4-3-1 Purpose of drilling survey

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

1-4-3-2 Details of drilling survey

(1) Area for drilling work

The El Torneado mineralized zone where drilling were conducted is situated about 1 km northeast of Santa Lucia basecamp which is nearly the center of the Balzapamba area. The drilling sites were located on a steep slope of about 1,600 m above sea level.
MJE-1 hole was located based on results of geological and geophysical surveys. The other holes were decided, taking into consideration results of the drill holes completed. The location of each drill holes are shown in Fig.II-1-6.

(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, 1989 for Phase I survey and September 6 to October 12,1989 for Phase II survey.

Drilling machines used were Craelius Model D900 and Longyear L-38. Work for site preparations and equipment dismantling and relocation was performed on a day time shift only. Drilling work was as a rule carried out for 24 hours a day. for drilling method, overvurden was stripped and wire line process was applied to improve core recovery and other work efficiency.

1-4-3-3 Results of drilling survey (Figs.II-1-7 and II-1-8)

(1) MJE-1

Location: Latitude 9808.14 N, Longitude 708.00 E, 1,652 m ASL.

Inclination: -90°

Depth: 305.40 m

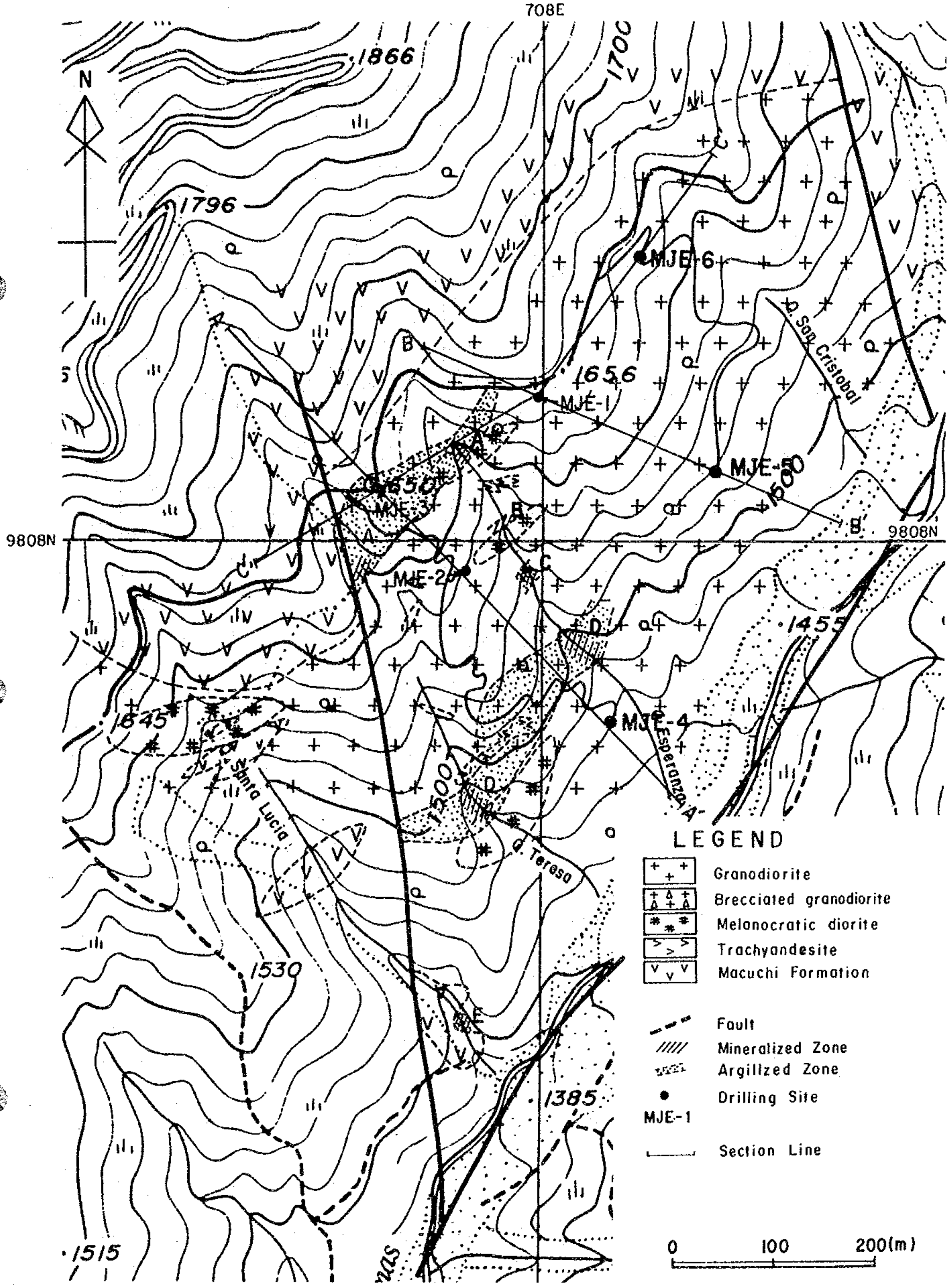


Fig. II-1-6 Location map of drill holes

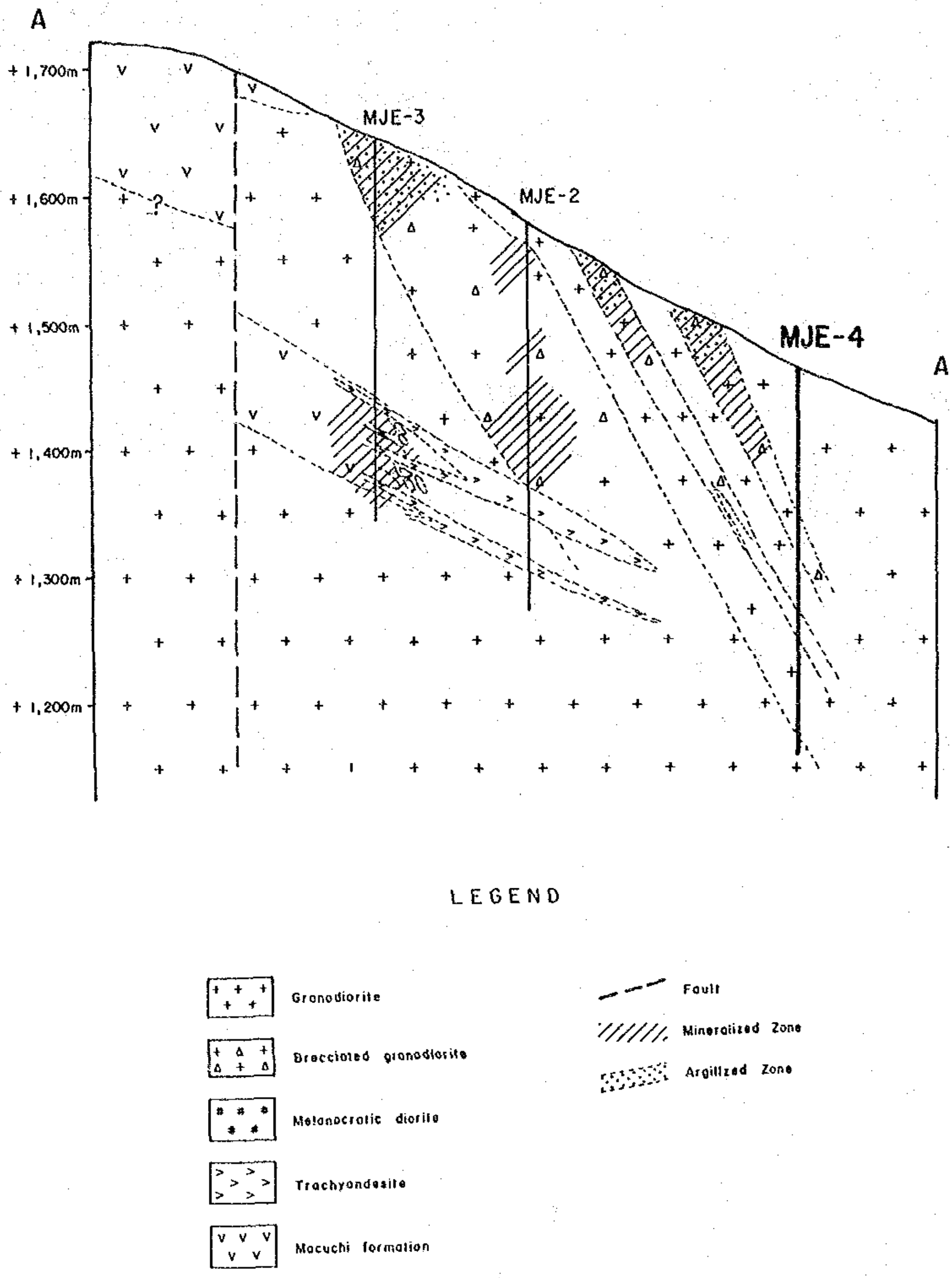
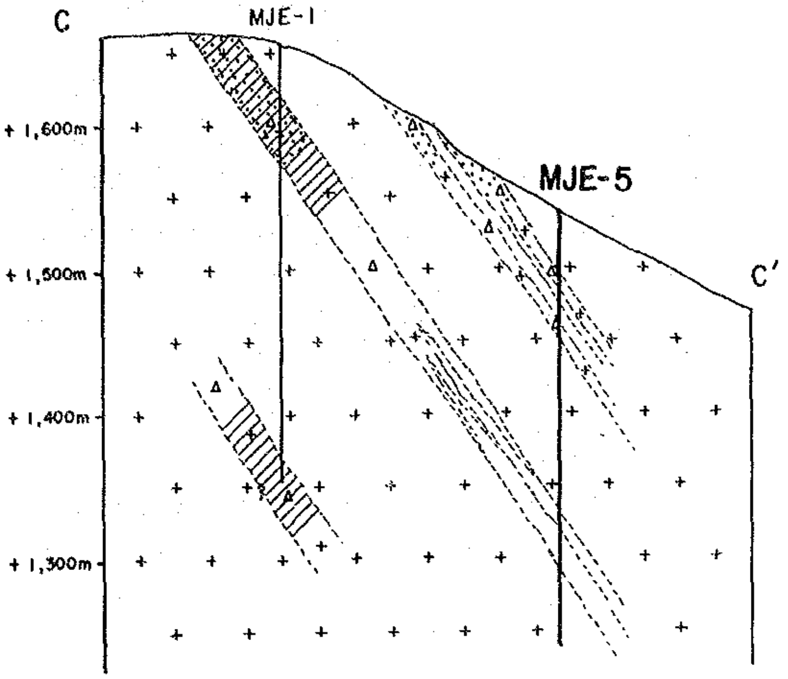


Fig. II-1-7 Geological section of drill holes MJE-2, 3, and 4



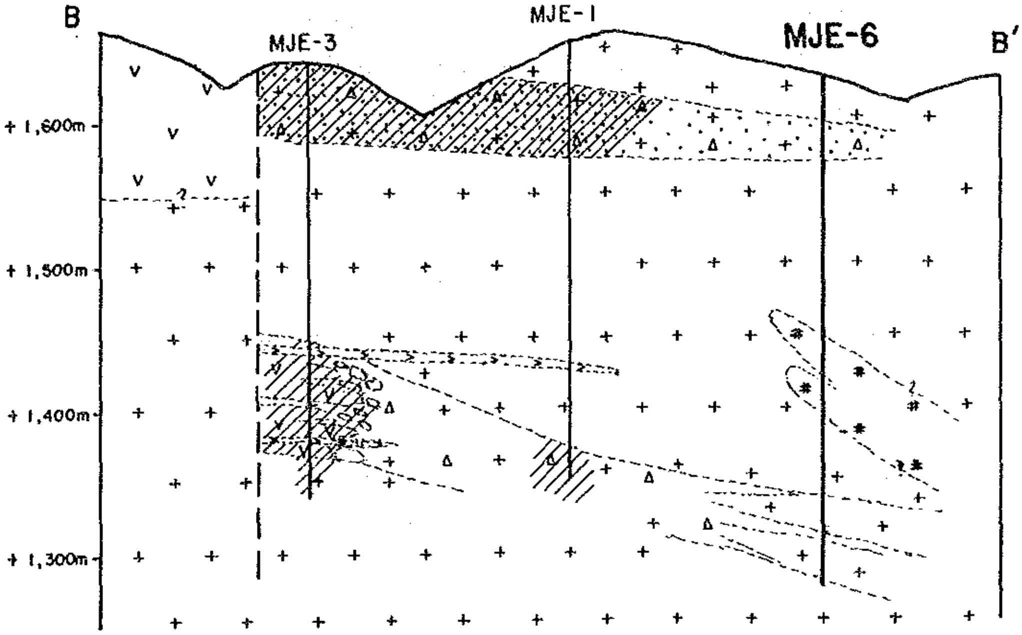


Fig. II-1-8 Geological sections of drill holes MJE-1 and 5, and holes MJE-1, 3, and 6

0 to 30.00 m

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

30.00 to 34.80 m

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 occur mainly in the portion of mafic minerals. Pyrite is present locally, disseminated in host rock, pyrite veins (mostly in veins of about 0.5 cm wide), and chlorite-(sericite)-quartz veins.

34.80 to 36.10 m

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

36.10 to 110 m

Rock facies consists of granodiorite presenting appearande of brecciation. Networked veins contaioning sulfide minerals occur in the interstices of the breccia. The width of individual networked veins is about 1 to 4 cm. 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 92.60 m shows that chalcopyrite cuts pyrrhotite as a form of addition, fine-grained sphalerite is recognized.

In the 36.10 to 54.50 m zone, relatively large chalcopyrite abounds. There were 13 chalcopyrite pieces more than 5 mm 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 to 77.60 m 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 to 282.20 m

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 261.80 m, sulfide minerals and chlorite veins gradually increase. Both chalcopyrite and pyrite are present in chlorite-(epidote)-quartz veins, or in host fock as a dissemination. Calcite veins locally exist.

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

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

282.20 to 305.40 m

Rock facies consists of brecciated granodiorite, and the interstices of breccias are filled with irregular netwirked 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 298.90 m, 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 0.01 % Mo and 0.06 % W (ore grade for one representative sample) for 298.90 to 305.40 m section.

(2) MJE-2

Location: Latitude 9807.97 N, Longitude 708.93 E, 1,575 m ASL.

Inclination: -90°

Depth: 305.40 m

0 to 16.00 m

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

16.00 to 38.00 m

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 suldide 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 to 26.00 m 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 27.50 m downward, sericitization becomes extremely weak.

38.00 to 209.80 m

Rock facies consists of coarse granodiorite which is intersected with networked veins, presenting bercciated structure as a whole. Trachyandesite veins are found in the 38.50 to 40.10 m, 120.60 to 121.70 m and 125.80 to 126.90 m 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 to 97.00 m, 108.20 to 109.40 m, 114.00 to 115.40 m, 134.50 to 143.00 m 153.70 to 156.00 m, 165.00 to 188.00 m, and 197.80 to 203.50 m sections. Mineralized zones in these sections are chalcopyrite-(molybdenite)- pyrite-epidote-secondary biotite-quartz netwirked veins. Alteration around vein consists of silicification and chloritization with partial sericite alteration. Microscopic observation of samples collected from a depth of 177.55 m shows presence of veined chalcopyrite in cracks of pyrite. Fine-grained sphalerite is also noted. Analytical results of ores from this range are as follows:
88.50 to 97.00 m: 0.5 g/t Ag, 0.13 % Cu, 0.05 % Mo; 134.50 to 143.00: 0.05 % Cu, 0.02 % Mo, 0.05 % W; 165.00 to 188.00: 0.07 % Cu, 0.02 % Zn, 0.06 % W; 197.80 to 203.50 m: 0.21 % Cu, 0.01 % Zn, 0.04 % W.

232.60 to 266.20 m

Coase grained granodiorite. Fine grained chalcopyrite and pyrite are disseminated throughout this rock. Chalcopyrite-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 to 273.40 m

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

273.40 to 305.40 m

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

(3) **MJE-3**

Location: Latitude 9808.05 N, Longitude 707.84 E, 1,647 m ASL.

Inclination: -90°

Depth: 303.30 m

0 to 29.50 m

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

29.50 to 55.40 m

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 to 5 mm long and pyrite about 1 cm across are present with small quantities of fine grained chalcopyrite. Host rock has a dissemination of fine granined chalcopyrite and pyrite.

Alteration of host rock is mainly sericitization. Alteration at the surroundings of veins shows silicificatio and chloritization. Analytical results of ores show as follows: 29.50 to 45.80 m: 0.3 g/t Ag, 0.06 % Cu, 0.09 % Mo (average of three samples); 49.90 to 54.00 m: 0.06 % Cu, 0.13 % Mo (grade of one representative sample).

55.40 to 195.30 m

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 to 65.20 m section where chalcopyrite occurs relatively in large quantities show 0.05 % Cu and 0.06 % Mo (average of two samples).

195.30 to 263.00 m

Rock facies consists mainly of andesite and its tuffs of thermally metamorphosed the Macuchi Formation with partial intrusion of coarse grained granodiotite and trachyandesite. In these rocks, episote-secondary biotite-quartz veins containing suldide minerals exist in networked patterns. The width of veins ranges from a few cm to about 120 cm. Suldide minerals in veins occur in relatively large lenses or amoebiform. Pyrite concentrates of coarse grained crystals of 0,5 cm are partially present in sone places. Chalcopyrite is in fine grains but partially occurs in as large size as 1 cm. 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. Analyticla results of ore samples obtained in the area of this zone where chalcopyrite occurs in relatively larger quantities are as follows:

235.50 to 236.50 m: 0.10 % Cu, 246.00 to 248.30 m. 0.14 % Cu, 251.50 to 252.00 m: 0.36 % Cu.

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

263.00 to 273.00 m

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

273.00 to 303.30 m

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).

(5) MJE-5

Location: Latitude 9808.83 N, Longitude 708.17 E, 1,537 m ASL.

Inclination: -90°

Depth: 305.20 m

0 to 10.90 m

Masa of coarse-grained granodiorite

10.90 to 26.40 m

Lithology is biotite-hornblende coarse-grained granodiorite (hereinafter called "coarse-grained granodiorite"), and abounds in secondary biotite. Fine-grained chalcopyrite is slightly disseminated. In this entire area, limonite-(pyrite) this veins exist in cracks, etc. of host rock. The vein width is 1 to 5 mm. Analytical results of ore samples obtained from the 15.50 to 16.00 m section show 0.02 % Cu and 0.02 % W.

26.40 to 30.00 m

Lithology is melanocratic medium-grained granodiorite, and abounds in secondary biotite. Pyrite is slightly disseminated. Veinlets such as pyrite-sericite-quartz veins and (chalcopyrite)-pyrite-chlorite veins are observed in comparatively large quantities. The vein width is 1 to 7 mm.

30.00 to 70.00 m

Lithology is coarse-grained granodiorite, and abounds in secondary biotite. Pyrite is slightly disseminated. Pyrite-sericite-quartz veinlets (5 mm to 3 cm in vein width) and chalcopyrite-pyrite-(chlorite)-(quartz) thin veins (1 mm in vein width) in cracks of host rock locally exist. Toward 70 m in depth, the dissemination and number of thin veins increase. Analytical results of ore samples obtained from this area show 0.01 % Cu and 0.03 % W (average of two samples). Also in the 35.40 to 36.20 m, 38 to 39.10 m, 42.90 to 43.20 m, 54.90 to 55.00 m, 62.20 to 63.70 m and 65.60 to 65.70 m sections, the fracture zone is filled with extra fine-grained (muddy) pyrite-secondary biotite-(chlorite)-quartz veinlets. Results of X-ray diffractive analysis show that chabazite and stilbite, which are considered to be formation at the end of the hydrothermal activation stage, are observed in the veins in the 38.00 to 39.10 m section.

70.00 to 85.00 m

Lithology is coarse-grained granodiorite, and abounds in secondary biotite, Chalcopyrite and pyrite are disseminated scattered and like a film. Chalcopyrite-pyrite-chlorite thin veins (about 1 mm in vein width) mostly exist along the cracks in host rock of this hole. Analytical results of ore samples obtained from this area show 0.03 % Cu and 0.03 % W.

The interstices of brecciated host rock are filled with secondary biotite-quartz networked veins in the 76.60 to 83.50 m section.

85.00 to 155.00 m

Lithology is coarse-grained granodiorite, and abounds in secondary biotite. Pyrite is disseminated. The 90 to 120 m section is dotted with comparatively large lens (about 5 cm long) of pyrite. Chalcopyrite-pyrite-(chlorite) thin veins (about 1 mm in vein width) locally exist. The dissemination of sulfide minerals and quantity of secondary biotite start to gradually decrease in the vicinity of 130 m in depth. Analytical results of ore samples obtained from this area show 0.01 % Cu and 0.04 % W (average of three samples).

Also secondary biotite-quartz veins 1 cm in vein width exist along the fracture zone in a depth of 89.90 m.

155.00 to 305.20 m

Lithology is coarse-grained granodiorite, and is affected by weak chloritization. The secondary biotite of host rock found in the upper portion is hardly observed. Fine-grained pyrite is slightly disseminated. Chalcopyrite-pyrite is slightly disseminated. Chalcopyrite-pyrite-chlorite thin veins (about 1 mm in vein width) locally occur. Fine-grained molybdenite is locally observed in the thin veins. Analytical results of ore samples obtained from this area show 0.01 % Cu (average of nine samples).

In this area, both the quantity of sulfide minerals and number of veins are much fewer than those in the upper portion. Also veinlets of barren quartz veins (1 to 2 cm in vein width) are observed.

Also in the 210.90 to 221.30 m sections, secondary biotite-quartz networked veinlets occur. In these veins, druses have developed, in which chalcedony quartz is observed in a limestone form. Results of X-ray diffractive analysis show that stilbite also exists in the druses.

(6) MJE-6

Location: Latitude 9808.29 N, longitude 708.10 E, altitude +1,625 m

Inclination: -90*

Depth: 353.00 m

0 to 8.00 m

Masa of coarse-grained granodiorite

8.00 to 28.20 m

Lithology is biotite-hornblende coarse-grained granodiorite (hereinafter called "coarse-grained granodiorite"). Pyrite is slightly disseminated scattered entirely and mainly in the portion of mafic minerals. This area is characterized by the fact that large quantities of limonite-(pyrite)-(chlorite)-(quartz) thin veins are present in cracks of rock in the 8 to 22 m section. Two kinds of limonite are observed: One is limonite which produced from sulfide minerals by oxidation. And the other is limonite obtained when the iron element which has been eluted into ground water accumulated.

The host rock is entirely affected by weak chloritization, and sericitized zone is locally present. Chalcopyrite-pyrite-chlorite-secondary biotite-quartz veinlets with a length of core of 40 cm exist in a depth of 23.90 m. Analytical results of ore samples obtained from this area show 0.01 % Cu.

29.20 to 57.80 m

Lithology is coarse-grained granodiorite, and pyrite is entirely disseminated. Veinlets such as chalcopyrite-pyrite-chlorite-(secondary biotite)-quartz veins and pyrite-chlorite-(secondary biotite)-quartz veins exist in comparatively large quantities. The vein width is 0.5 to 5 cm. Chalcopyrite in the veins is fine-grained, and mostly less than 1 mm wide. Comparatively large pyrite are observed in large quantities though there are some more than 5 cm in length of lens. Analytical results of ore samples obtained from this area show 0.02 % Cu.

The host rock is entirely affected by weak chloritization. This area is characterized by the fact that sericitization has most developed in this hole. Chalcedony quartz veinlet zone where druses have developed exists in the 52.00 to 53.00 m section. In this zone, epidote and sericite are also observed.

57.80 to 179.80 m

Lithology is coarse-grained granodiorite. Fine-grained pyrite is slightly disseminated. The entire area is affected by weak chloritization. Veinlets such as pyrite-sericite-quartz veins and chalcopyrite-quartz veins locally exist and local chalcopyrite-pyrite-chlorite-secondary biotite quartz veinlets exist. The vein width is 1 to 5 cm. The number of these veins is high between around 160 m and 179.80 m in depth. Also chalcopyrite-pyrite-chlorite-(quartz) thin veins locally exist like a film in small cracks of host rock. The width is 1 to 3 mm, and mostly about 1 mm. Analytical results of ore samples obtained from this area show 0.01 % Cu (average).

Variations in the quantity of occurrence of chalcopyrite are observed depending on the depth. That is, there are very few in the approximately 55 to 115 m section, and much are observed in the film-shaped thin veins in small cracks of host rock in areas deeper than 115 m, and the quantity increases somewhat. However, only pyrite is disseminated in host rock, and not chalcopyrite.

In the 59.80 to 60.90 m section, chalcedony quartz veinlet zone, where druses have developed. Stilbite has crystallized in druses. Also in the 68.40 to 76.00 m section, secondary biotite-quartz veins exist in the fracture zone. In voids of these veins, chalcedony quartz and epidote are locally observed.

Noticeable sericitization observed in the above 29.20 to 57.80 m section is only observed as alteration around veins of pyrite-sericite-quartz veins, and exists only intermittently. Secondary biotite is also omnipresent in veins.

179.80 to 200.50 m

Lithology is melanocratic biotite-hornblende medium-grained to coarse-grained granodiorite, and abounds in secondary biotite. Fine-grained pyrite is slightly disseminated. Chalcopyrite-pyrite-chlorite-(quartz) thin veins are locally present in small cracks of host rock. The vein width is about 1 mm. Sericitization is locally observed in and around pyrite-sericite-quartz veins. The width of the alteration zone is about 50 cm. Analytical results of ore samples obtained from this area show 0.02 % Cu (average of two samples).

200.50 to 209.30 m

Lithology is coarse-grained granodiorite. Pyrite is slightly disseminated. Pyrite-chlorite-secondary biotite-(sericite)-quartz veins are locally present. The vein width is 4 to 5 cm. Analytical results of ore samples obtained from this area show 0.02 % Cu.

209.30 to 232.20 m

Lithology is melanocratic biotite-hornblende medium-grained granodiorite, and is affected by weak chloritization. Pyrite is slightly disseminated. Chalcopyrite-pyrite-chlorite veins with a vein width of about 1 mm are locally observed in small cracks of host rock. This tends to increase toward the peripheral portion (near 232.20 m in depth) of this rock. In a depth of 231.20 m, molybdenite is locally observed in chalcopyrite-pyrite-(epidote)-quartz veins with vein width of 7 cm. Analytical results of ore samples obtained from this area show 0.01 % Cu and 0.05 % W.

232.20 to 270.00 m

Lithology is coarse-grained granodiorite. Pyrite is slightly disseminated, and is affected by weak chloritization. Chalcopyrite-pyrite-chlorite-(secondary biotite)-quartz veins are locally present. The vein width is 1 mm to 2 cm. Dissemination of sulfide minerals starts to increase in vicinities of 270 m in depth.

Analytical results of ore samples obtained from this area show 0.02 % Cu and 0.07 % W (average of two samples).

270.00 to 340.00 m

Chalcopyrite and pyrite are disseminated scattered and like a film. Chalcopyrite-pyrite-chlorite-(quartz) thin veins (about 1 mm in width) are locally present in veinlets (1 to 10 cm and mostly 1 to 2 cm in vein width) such as chalcopyrite-pyrite-chlorite-secondary biotite-quartz veins and pyrite-sericite-quartz veins, and in small cracks of host rock. Analytical results of ore samples with length of core of 10 cm obtained at a depth of 273.10 cm are 0.1 g/t Au, 3.8 g/t Ag, 0.02 % Cu, 0.26 % Pb, 1.59 % Zn, and 0.20 % W. The number of the above veins and dissemination of sulfide minerals are higher in this area than in areas shallower and deeper than this depth. They are high especially in vicinities of 310 to 320 m in depth, where dissemination of chalcopyrite is observed in comparatively large quantities even in host rock. Analytical results of ore samples obtained from this area show 0.02 % Cu and 0.06 % W (average of five samples).

The host rock is affected by weak chloritization, and epidote is observed comparatively more in this area than in others.

In addition, in the 289.10 to 290.10 m, 312.90 to 312.91 m, 315.30 to 315.35 m, 319.80 to 320.80 m sections, extra fine-grained (muddy) to fine-grained pyrite-(chalcopyrite)-(chlorite)-secondary biotite-quartz veinlets are present along the fracture surface of fracture zones. The vein width is not fixed since it expands and shrinks, but is mostly 0.2 to 1 cm.

340.00 to 353.00 m

Lithology is coarse-grained granodiorite. Fine-grained pyrite is disseminated in small quantities. Veinlets (1 to 3 cm in vein width) such as (chalcopyrite)-pyrite-chlorite-secondary biotite-epidote-quartz and pyrite-quartz-sericite are locally observed. As a whole the quantity of sulfide minerals is exceedingly lower than that in the upper portion.

Also in the 349.00 to 349.40 m, and 350.30 to 351.20 m sections, extra fine-grained pyrite-secondary biotite-quartz veinlets are present in the fracture zones. In these porous veinlets, druses have developed, and limestone-shaped or raindrop-shaped chalcedony quartz is observed in these druses. This host rock has been leached and has locally changed into loosen vesicular rock.

1-4-4 consideration ofsurvey results of El Torneado zone, Balzapamba area

Survey in this area was performed for two years, and detailed geological survey, CSAMT geophysical survey, drilling hole IP method electric prospecting, and drilling survey were conducted. As a result, the following facts were found in the El Torneado mineralization area.

The El Torneado mineralized zone consists of two mineralized zones: "disseminated" mineralized zone and "networked" vein mineralized zone which are different each other in status and properties. The former extends over a range of 400 m x 400 m, and the latter extends in NNE-SSW direction and is distributed in a scale of 40 to 70 m wide and 70 to 350 m in extension in the distribution area of the former. The former is cut by the latter, and the former has been mineralized earlier than the latter.

The "disseminated" mineralized zone is mineralized in the same status and properties as those of other porphyry copper type mineralized zone in the Bolivar area. From the central portion of the mineralized zone toward outside, the tendency of a fixed change is observed in the paragenesis, status, alteration, etc. of sulfide minerals.

That is, in the central portion of the mineralized zone, chalcopyrite and pyrite are disseminated not only in veinlets, but also in host rock. The sulfide minerals are entirely disseminated also in quartz and plagioclase sections with mafic mineral section. Alteration of host rocks comprises noticeable secondary biotitization and chloritization. Epidote tends to increase where chalcopyrite abounds. Outside the mineralized zone, the quantity of sulfide minerals generally reduces, and the chalcopyrite/pyrite ratio gradually reduces. The chalcopyrite is not observed as dissemination in host rocks, but is omnipresent only in veinlets. Further outside, sulfide minerals in veinlets are only chalcopyrite. Dissemination of sulfide minerals in host rocks is omnipresent in the portion of mafic minerals. For alteration of host rocks, moreover, secondary biotite is not observed, but only weak chloritization is observed. Further outside, an unaltered zone enters. This tendency is observed toward the lower portion of the mineralized zone in the outside edge of the mineralized zone.

The "networked" vein mineralized zone is distributed in NNE-SSW direction in the distribution area of the "disseminated" mineralized zone. This type of mineralization is not observed in other porphyry copper type mineralized zones in the Bolivar area, but exists only in the El Torneado area. Also in this mineralized zone, the tendency of a fixed change is observed from the central portion of the mineralized zone toward outside.

That is, in the central portion of the mineralized zone, the breccia structure of host rock has noticeably developed, and the interstices of breccias are filled in a network form with chalcopyrite-pyrite-(molybdenite)-(pyrrhotite)-secondary biotite-chlorite-quartz veins. At the end portion, breccias scarcely developed, and sulfide minerals in networked veins reduced into veinlets. Vertically the lower portion of this mineralized zone transited to shearing fracture zone, and the networked veins changed into fine-grained pyrite-secondary biotite-(chlorite)-quartz veins existing along the fracture surface.

For alteration of host rocks, chloritization, silicification and secondary biotitization are observed along veins. In the central portion of the mineralized zone this alteration is strong, and is comparatively wide. As, however, it reaches the end and lower portion, it becomes weaker, and its width becomes narrower to only the bordering area of veins. Sericitization spreading over the entire mineralized zone, which is observed in vicinities of ground surface, extends horizontally, but is not observed in the lower portion.

On the basis of the following facts: (1) horizontal and vertical changes in the "disseminated" mineralized zone as mentioned above, (2) MJE-4 and MJE-5 holes have penetrated the lower limit of the "networked" vein mineralized zone, (3) the phenomenon, in which the "disseminated" mineralized zone is also coming closer to the lower limit, and the like, it is considered that the principal portion of the El Torneado mineralized zone.

1-5 Osohuayco zone of Balzapamba area

1-5-1 Geological survey

1-5-1-1 Geology

The Geology of Osohuayco zone of Balzapamba area consists of Macuchi Formation and Intrusive rocks (Figs.II-1-9 and II-1-10).

(1) Stratigraphy

1) Macuchi Formation

Macuchi Formation is mainly distributed in the northeastern part (Osohuayco North) and southern part (Osohuayco South) of the surveyed area. Macuchi Formation is intruded by granodiorite in the central part.

More than 800 m in the northeastern part and over 750 m in the southern part.

Macuchi Formation consists of member A and B. Member A is composed of andesitic lavas (AAn) and their pyroclastics (ATf). Member B is composed of quartz grain bearing andesitic lavas (BAn) and their pyroclastics (BTf).

Pyroclastic portion (Tf) is dominate generally in the survey area, and lava portion are recognized as intercalated layers in the pyroclastics. Pyroclastics include following rock types: volcanic breccia, tuff breccia, lapili tuff, coarse tuff, crystalline tuff, and alternation of fine tuff and siliceous fine tuff. These rock facies indicates change of volcanic activities.

Member B distributes in a small area only near the eastern edge of the surveyed area.

(2) Intrusive rocks

Intrusive rocks are in the order of activities: granodiorite botholith (Gd), Melanocratic diorite stocks or dikes (Di), Tracky andesite dike (Tr) and Aplite dike (Ap).

1) Granodiorite (Gd)

Granodiorite (Gd) distributes in the western part (West of Las Palmas branch river) of the surveyed area and the central part (Q. Osohuayco river), showing a shape of distribution, letter "L".

Granodiorite (Gd) shows massive,light gray to greenish gray in color, and medium to coarse grain equi-granular. Brecciated parts of this rock body are observed in El Torneado

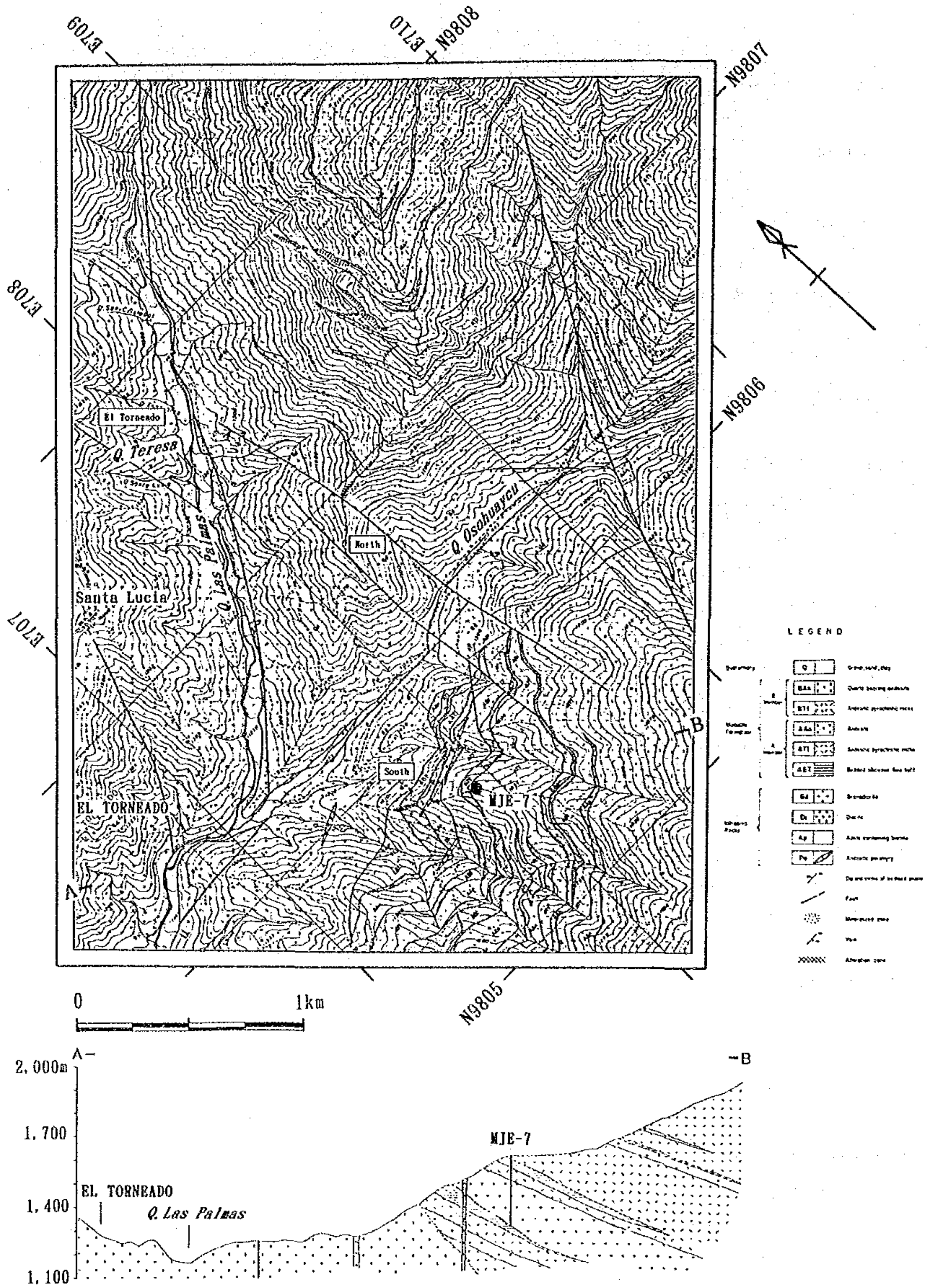


Fig. II-1-9 Geological map of the Osohuayco, Balzapamba area

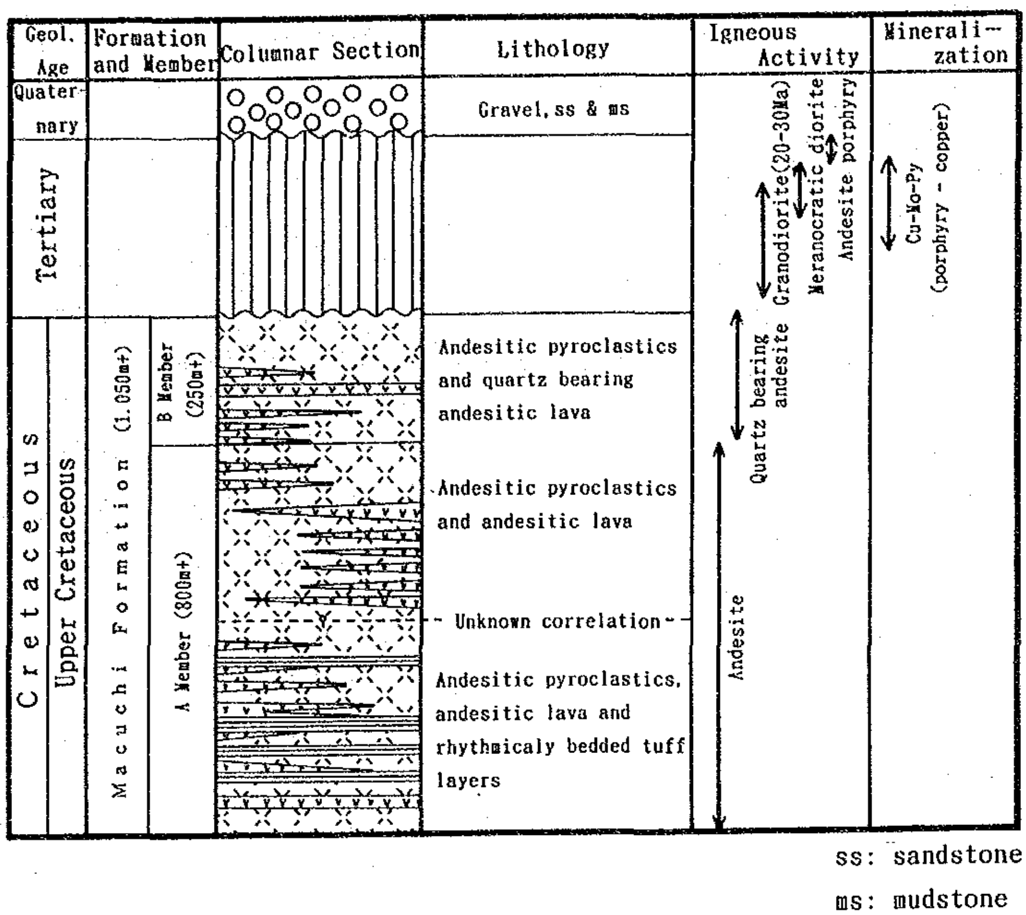


Fig. II-1-10 Generalized stratigraphic section of the Osohuayco, Balzapamba area zone and in an area about 1.5 km south of it where surrounded by Q. Las Palmas river and Q. Osohuayco river.

In and along fractures of brecciated parts, mineralization of chalcopyrite and pyrite are recognized.

2) Melanocratic diorite (Di)

Melanocratic diorite (Di) intruded into Macuchi Formation (AAn and ATf) in the south-western part of the surveyed area. Four sheets of this dikes are observed in Osohuayco South. Direction and inclination suspected were as follows: the direction was ENE-WSW, the width was 10 to 30 m and the length 50 m for shorter and 500 m for longest one.

Melanocratic granodiorite shows massive, gray to light gray in color and medium to coarse grain as size of rock forming minerals.

At the contact, child margin is formed in which hornblende, biotite and plageoclase are observed.

3) Aplite (Ap)

Aplite (Ap) intruded into granodiorite (Gd) as three dikes in the up stream of Q. Terresa branch river. Direction of intrution is N50°W 70°NE and N40°E 90°. Width is 20 tO 50 m.

Aplite (Ap) shows massive, light gray to white in color and fine grain holocrystalline. Micro grains of biotite are observed as mafic minerals.

4) Porphyritic andesite (Pa)

Porphyritic andesite (Pa) distributes as a dike at the up stream of Q. Terresa branch river in the northwestern part of the surveyed area, just east ofwhich granodiorite (Gd) batholith is brecciated, altered and mineralyzed.

Direction and inclination of dike is approximately N20°E 90° though the dike shows bending slightly. width is 50 to 100 cm.

Porphyritic andesite shows massive, gray in color and fine grained porphyritic texture. Phenocrists are hornblende, biotite and quartz. The rock body is also mineralyzed with chalcopyrite and pyrite. chalcopyrite are concentrated where hornblendes are altered to green minerals.

1-5-1-2 Geological structure

(1) Lineaments

Lineaments were analyzed with aerophotograph (1 to 60,000) in the survey area. The result of the analysis is shown on topographic map at a scale of 1 to 20,000.

Prominent system of lineaments is of NE-SW direction. Principal lineaments are two: one is along Q. Las Palmas river and the other along Q. Osohuayco river. The former is NNE-SSW direction and has a branch, NNW-SSE direction. The latter directs E-W, the same direction as Q. Osohuayco river. The E-W lineament is dislocated by N-S lineament and NNE-SSW lineaments.

Where distribution density of lineaments is comparatively high situates in an area of 3 km X 1 km including El Torneado mineralized zone and Osohuayco North mineralized zone. Within this area, two lineament systems (NNE-SSW and E-W) intersect each other.

(2) Faults

Following lineaments were interpreted as faults in surveyed area:

a) NNE-SSW lineament of Q. Las Palmas river, which is prominent among lineament systems.

b) NNW-SSE lineament, a branch of NNE-SSW lineament mentioned above.

c) E-W lineament of Q. Osohuayco river.

d) N-S and NNE-SSW lineaments, which dislocates E-W lineament mentioned above.

The reason of interpretation is as follows:

- Silicified and white argillized zone was actually observed on the ridge extending E-W direction in up stream of Q. Osohuayco river, adding this breccia zone which may have been formed associating with faulting was also at about 500 m north of silicified and argillized zone described above, confirmed on the floor of river.

- White argillized zone (partly accompanying silicification) was observed at the contact of Macuchi Formation and granodiorite batholith (Gd) on the ridge (1,720 m to 1,740 m ASL) between Q. Las Palmas river and Q. Osohuayco river.

Following is the result of X-ray powdery diffractive analysis on the sample collected from white argillized zone which may be results of faulting.

White argillized rock (partly silicified) (C3070)

Identified minerals: Quartz plageoclase hornblende, sericite.

1-5-1-3 Mineralization and alteration

(1) Type of mineralization

The mineralization confirmed in the surveyed area are of two types: one is observed in granodiorite, and the other observed in Macuchi Formation.

Phase II geophysical survey delineated two major IP anomalies. One is distributed in the Osohuayco North where dissemination and network veinlets of chalcopyrite-pyrite are observed in and along branch rivers and confimed to be porphyry copper type (hereinafter refers Osohuayco North mineralized zone).

The other is distributed in the Osohuayco South, northern portion of Osohuayco South anomaly is porphyry copper type mineralization embarrassed in granodiorite, while southern portion is dissemination and networky veinlets of chalcopyrite (hereinafter refers Osohuayco South mineralized zone north side) and pyrite embarrassed in Macuchi Formation (hereinafter refers Osohuayco South mineralized zone south side).

(2) Occurrence of mineralized zone

Osohuayco mineralized zone

The extension of the Osohuayco north mineralized zone is about 900m X 400 m.

In the eastern outcrops, granodiorite is partly brecciated where observed are dissemination and networky veinlets of chalcopyrite and pyrite. While in the western outcrops no brecciation is recognized and sulfide minerals exist in networky veinlets zone.

Alteration are all, macroscopically, silicification and chloritization. Silicification includes two different types: replacement of rock forming minerals and segregation of micro grained secondary quartz. Secondary quartz shows calcedonic in western putcrops and crystolline quartz in eastern putcops.

Assay result of chip samples collected from eastern outcrops was 1.18 % Cu. Though only a few outcrops are available to the east of Osohuayco North mineralized zone, mineralization accompning chalcopyrite are recognized locally in Macuchi Formaion along the ridge and branches of Q. Osohuayco river.

Osohuayco South mineralized zone

(North side)

This mineralized zone occur as dissemination and networky veinlets of chalcopyrite and pyrite in granodiorite in an area of 200 m X 300 m. Disseminated ore assayed to be 0.08 % Cu.

(South side)

This mineralized zone occurs in alternation units of fine tuff and siliceous fine tuff of Macuchi Formation. Skarn minerals are observed, partly and characteristically, in calcareous part of alternation units which show distinctive laminas of fine tuff and siliceous fine tuff.

Chalcopyrite and pyrite are associating with skarn minerals in forms of dotted and ameba of dissemination or veins (1 to 10 cm in width) of chalcopyrite-pyrite-calcocite-grossular-quartz. Mineralized outcrops of this mineralized zone distribute in three branch rivers running to northwest. Two principal mineralized horizons are recognized, and lower one is predominant in mineralization.

Thickness of lower one varies from 2 to 10 m. Chip ore samples collected in this horizon assayed to be 2.60 % Cu. No sulfide minerals have been observed in the outcrops on and along the ridge which situates between two mineralized outcrops.

(3) Structural control of mineralization

All of the mineralized zone recognized in the surveyed area are arranged macroscopically in a N-S direction. Actually, line up El Torneado mineralized zone, Osohuayco North mineralized zone and Osohuayco South mineralized zone from north to south.

Furthermore, N-S fault is confirmed and mapped at the western edge of El Torneado mineralized zone. Adding this, two N-S faults are also suspected to be around Osohuayco North mineralized zone. Mineralized horizone in Osohuayco South, however, shows apparently N20° to 30°E in direction and 20° to 45°SE in inclination.

1-5-1-4 Magnetic susceptibility measurement

To determine quantitatively demagnetization due to mineralization, magnetic susceptibility was measured, using a potable magnetometer. This measurement was made through the area. The magnetometer was Kappameter Model KT-5 of Czechoslovakia with measurement susceptibility of 1×10^{-3} SIU.

At the measurement, efforts were made to completely scrape weathered portions off and surface unevenness. each measurements are the average of three values disregarding the highest and lowest ones.

Measured values in this surveyed area showed generally the magetic susceptibility that each rock possess originally. On the contrary demagnetization due to mineralization was not clear.

1-5-2 Geophysical survey

1-5-2-1 Purpose of survey

The purpose of this survey is to clarify the lateral and vertical extension of the mineralization detected by the Phase II Survey in the northeastern zone of Telimbela area. To meet the above, an investigation of the electrical structure of the area was carried out by clarifying the distribution of IP anomalies in the survey area by means of a conventional IP method.

1-5-2-2 Survey method

(1) IP method

An IP (Induced Polarization) method is a geophysical technique that measures the polarization effects caused by the electrochemical nature of the minerals and rocks. This method has been mainly utilized for detecting sulphide deposits.

There exist four measuring methods to observe an IP phenomenon, i.e.,

1) Frequency-domain

When using the frequency-domain method, the magnitude of the IP phenomenon is expressed by the parameter called Frequency Effect (FE) which is proportional to the resistivity difference at two frequencies.

2) Time-domain

In this method, the magnitude of the IP effect is expressed by the Chargeability which is determined by observing the transient voltage curve after the electric current is turned off.

3) Phase-domain

The magnitude of the IP phenomenon in the phase-domain method is expressed in terms of the difference of the phase angle between the transmitted and received signals.

4) Spectral IP

The magnitude of the IP phenomenon is here expressed as the normalized amplitude and phase in each frequency referred to the lowest frequency among a wide variation of frequencies.

(2) Measurement method

The measurements were done by using the frequency-domain method at the frequencies of 3.0Hz and 0.3Hz and adopting a dipole-dipole electrode configuration with a separation factor n from 1 to 5.

Based upon the geological structure, six survey lines of 1600m each in length were set along a NW-SE direction with a 300m line spacing. The numbering of the points were set one by one from 0 to 32 with a 50m interval from the northwest end of each line and the measurements were done every 100m spacing with a 100m potential electrode.

1-5-2-3 Discussion

The main mineralization in this area seems to have a good correspondence with the high resistivity and high FE anomalies caused by the strong silicification associated with mineralization.

Assuming the above mentioned resistive/high FE body as the source of the IP anomaly, and taking into account the results of the model simulation carried out on the lines 01, 03 and 04, the location of anomalous sources under the other three lines have been qualitatively selected. These results are indicated in Fig.II-1-11, where three zones of anomalous sources trending NE-SW are indicated and named from northeast as IP anomaly sources 1, 2 and 3.

Taking into consideration the results of the geological results, the geophysical survey carried out in this zone drew the following results:

1) The geological survey revealed that mineralization is confirmed within the lower two of the three tuff formations. IP anomaly sources 2 and 3 correspond well with the above formations.

On lines 02 and 03, no indication of the IP anomaly source 3 were detected, however the trend indicated by the two anomalous sources show the same pattern than the tuff formation.

The two anomaly sources 2 and 3 are interpreted as south-dipping dike-shape body which coincides with the geological survey results.

The IP anomaly source 2 on Line 04 is interpreted as having a resistivity of 4,500 Ohm-m and FE of 10.0%, whereas IP anomaly source 3 suggests a resistivity of 2,500 Ohm-m and FE of 8.0%.

2) IP anomaly source 1 resembles somewhat the pattern of the above mentioned sources, except that this anomaly was detected in an area where granite is distributed. This source corresponds actually to mineralization found between the lines 03 and 04, in the creek between the lines 04 and 05, and in the north of Osohuayco creek.

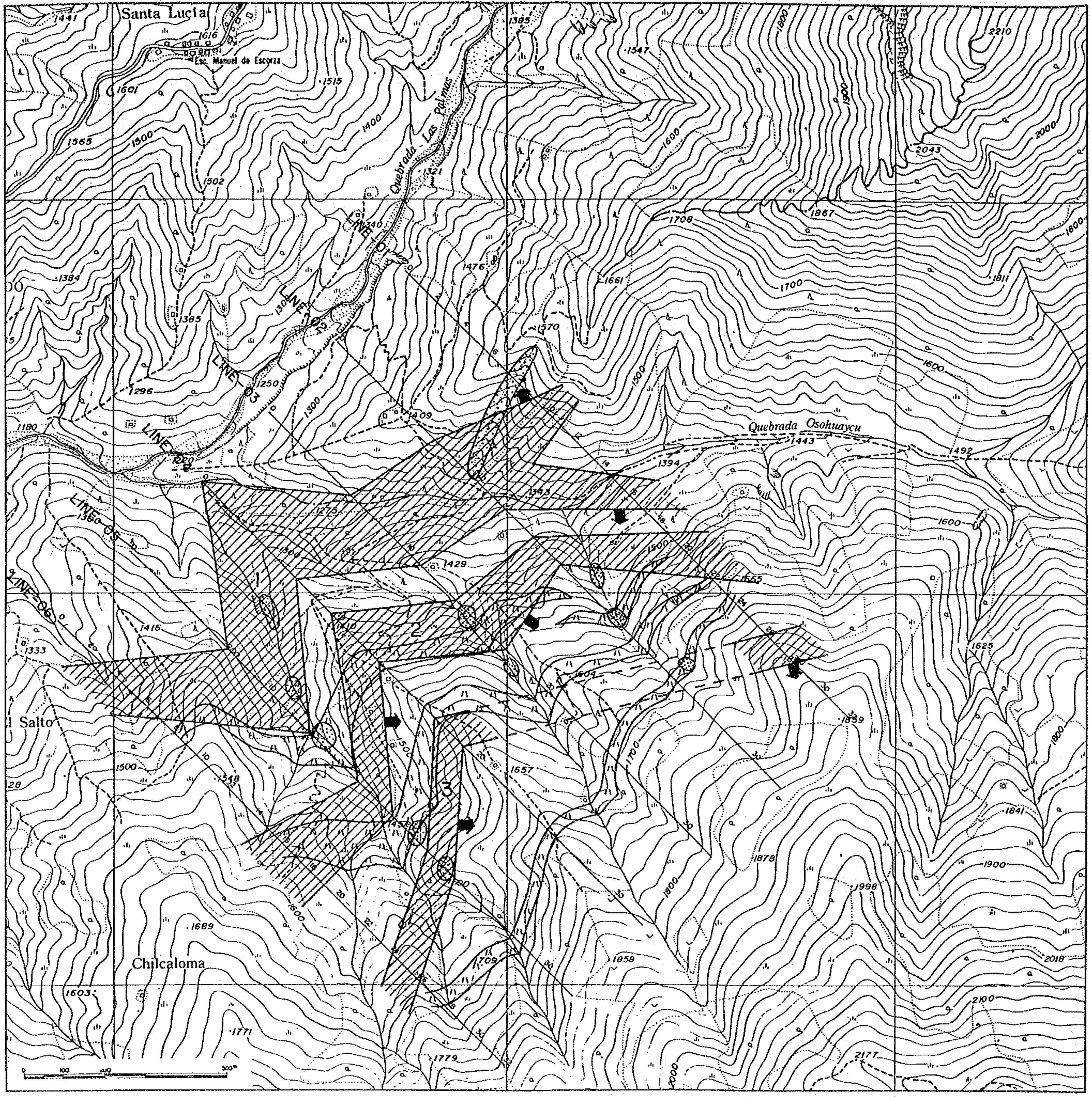
This anomaly detected seems to be reflecting several anomalous sources because of the following reasons:

a) Dipping angle of mineralization in the north and south of Osohuayco creek are different

b) The values of resistivity, FE, width and dip do not coincide among the different lines

c) Two split anomalies were detected on Line 01

d) A fault is assumed in Osohuayco creek where mineralization is expected



LEGEND

IP Anomaly Source (High Resistivity, High FE)

Mineralized Zone

Macuchi Tuff

Fig. II-1-11 Interpretation map on IP anomalous zones of the Osohuayco, Balzapamba area

3) In the center of Line 01, a wide and shallow conductive and high FE zone are interpreted, corresponding to strong argillization associated with mineralization.

To simulate the actual existence of line silicified veins, a single structure was assumed as a silicified zone existing at depth veins. This deep structure was modeled with 700 Ohm-m in resistivity and 8.0% of FE.

4) Comparing the results of the geological map with the result of FE map for n=1 clears that Macuchi formation shows a low FE while granitic rocks especially in the contact zone with Macuchi formation show high FE.

On the other hand, apparent resistivity results are considered to correlate with alteration processes rather than physical difference between geological formations: for instance, high resistivity reflects silicification; and low resistivity, argillization.

The original target in this area was to find mineralization in tuff formation, however an FE anomaly (IP anomalies I and II) of about 5.0% were detected under the tuff formation, while the most prominent IP anomaly of more than 10.0% FE was detected in granodiorite body in the northeastern part of the area.

Other IP anomalies were also detected inside the granitic rock distribution area, where they were unexpected to exist. The existence of mineralization in granitic rocks can be greatly underestimated due to poor outcropping in the area which is mainly covered by pasture. Few outcrops exist along the creek.

Regarding the IP anomaly detected under tuff formation, the measured FE resulted lower than that of northeastern anomaly, however the anomalous source determined by simulation appears to be about the same as the anomaly in granite. Consequently, the anomalous source under tuff formation was not so reflected at the surface due to the existence of a surface conductive zone, nevertheless the same scale of mineralization as in the granitic distribution area should be expected here.

In this sense, the IP method geophysical exploration used in this survey, contributed very much, especially for mineralizated zone in the less outcropped area and for the mineralized zone concealed by the Macuchi Formation. The method CSAMT carried out for the Phase I survey of this project revealed a distinctive resistivity contrast in a narrow area. The same resistivity contrast was detected also in the northern part of El Torneado area. Findings in both areas indicate prosperous mineralization. As an experience with the above results, it is recommended as a exploration methodology, to use the CSAMT method in order to detect whether or not a similar resistivity contrast exists in the prospecting area. Thereafter, in the detected anomalous area, IP method should be followed up to confirm a scale and location of mineralization precisely.

1-5-3 Drilling survey

1-5-3-1 Purpose of drilling survey

The purpose of the drilling survey to clarify the mineralyzing condition in the depth of two mineralized horizons (Osohuayco South mineralized zone south side) delineated on IP anomaly detected through Phase II geophysical survey, in the Macuchi Fromation in southern part of the surveyed area.

1-5-3-2 Results of drilling survey (Fig.II-1-12)

Followings are the results of examination on the drill hole core of MJE-7:

0.0 to 30.0 m

Siliceous, grayish white fine tuff. Fractures are developed. No sulfide minerals was recognized.

30.0 to 40.0 m

Siliceous, grayish white, banded fine tuff. No sulfide minerals was recognized.

40.0 to 79.3 m

Siliceous, grayish white fine tuff. Fractures are developed. Intercalation of medium-fine grained biotite granodiorite (0.8 to 3.3 m in core length).

Sulfide minerals in forms of films of patches. Principal ore mineral is fine grained pyrie.

79.3 to 91.1 m

Siliceous, grayish white and pale green banded fine tuff. Fine grained pyrite, epidote, and chlorite are recognized in and/or along fractures of the host rock.

91.1 to 104.7 m

Siliceous and calcareous,grayish white fine tuff. the result of microscopic obsevation for sample collected at the depth of 98.00 m, observed are skarn minerals: a large amount of garnet and a small amount of zoisite. Furthermore, calcite was observed in fractures of host rock, opaque minerals, however, was not confirmed.

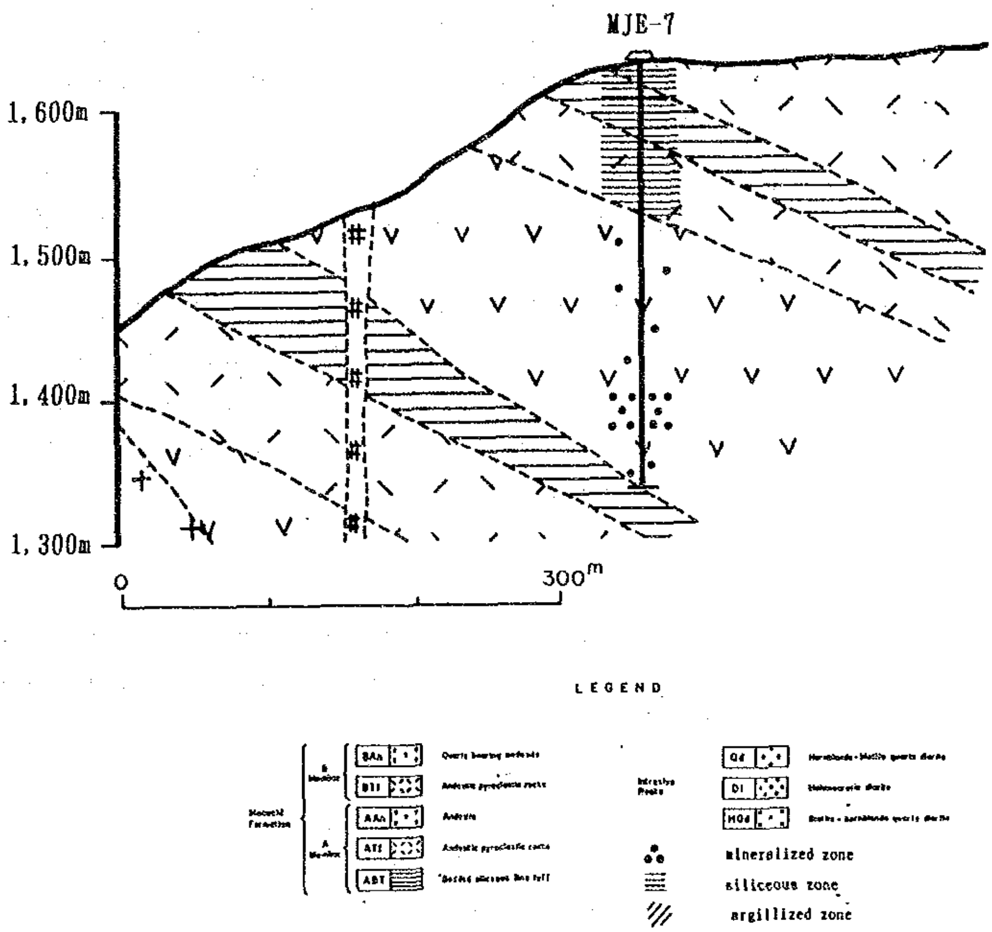


Fig. II-1-12 Geological section of drill hole MJE-7

104.7 to 305.0 m

Dark bluish green andesite (partly hornfels)
Below 120 m, epidote is common and secondary biotite apperas occasionally.
Below 190 m, secondary biotite occupies nearly 50 % of the rock forming mineral in volùm.

The microscopic observation on the sample collected at the depth of 267.3 m revealed that secondary biotite is 0.2 to 0.3 mm in size and distributes uniformly in the field of scope. This is considered to be the results of contact metasomatism (hornfels) caused by intrusion of granodiorite into Macuchi Formation.

In fractures of andesite (including hornfels) film and/or veinlets of pyrite-chalcopyrite-chlorite-quartz are recognized, especially below 190 m dissemination and patch of pyrite and chalcopyrite were dominate.

Polished section of 245.5 m and 267.4 m were studied carefully, chalcopyrite, bornite, pyrite and magnetite were identified. where chalcopyrite shows patchy in form (at the depth of 245.3 m), bornite occurs as primary mineral and associates as a assembly of chalcopyrite-bornite-(pyrite)-quartz. Magnetite occurs in rock forming minerals in form of micro grain such as 0.01 to 0.02 mm in diameter.

These samples were assayed to be 0.03 % Cu and 0.01 % Zn.
Where hornfels is predominant micro chalcopyrite dots distribute in secondary biotite (at the depth of 267.4 m). Rounded chalcopyrite was included into pyrite. Pyrite includes magnetie too. Where chalcopyrie associates with magnetite, chalcopyrite includes magnetite.

The assay result are as follows:
From 261.4 to 264.3 m: 0.9 g/t Ag, 0.14 to 0.16 % Cu, 0.01 % Zn;
From 267.9 to 270.9 m: 0.01 to 0.02 % Cu, and 0.01 % Zn.
Principal mineralized zone is from 231.4 m to 264.3 m in depth. A average grade in this interval is Au: Tr, Ag: up to 1.2 g/t, Cu: o.ol to o.18 (average 0.05 %), Pb: 0.00 %, Zn: 0.01 %, Mo: 0.00 %
Molibdenite was not recognized neither in nakid eye nor under microscopic observation.

1-5-3-3 Discussion

MJE-7 hole intersected calcareous thin bed which intercalated into fine tuff units of Macuchi Formation at the very depths of geological estimation. Calcareous thin bed was partly suffered skarnization but no sulfide minerals were associated with skarn minerals.

The mineralized zone confirmed by the MJE-7 hole exists in hornfels or andesite of macuchi Formation in forms of dissemination and films of chalcopyrite and pyrite. This mineralized zone may be considered to be a part of porphyry copper type, and through fracture system mineralized parts be connected between mineralized zone in granodiorite and those in Macuchi Formation.

The depth of themineralized zone intersected corresponds to the depth of IP anomaly (high resistivity and high FE). IP anomaly detected dissemination of chalcopyrite-pyrite as corresponds to high FE in hornfels-andesite as corresponds to high resistibity.

The grade of mineralized zone, however, was too low for further survey.

1-5-4 Consideration of survey results in Osohuayco zone, Balzapamba area

Follows are the characteristics of mineralization in this surveyed area obtained as a result of geological and geochemical survey, and magnetic susceptibility measurement, geophysical survey (CSAMT method, and IP method) and Drilling survey:

Porphyry copper type mineralization in the surveyed area has two different host rocks. One is granodiorite: examples of mineralized zones are Osohuayco North mineralized zone, and Osohuayco South mineralized zone north side. The other is Macuchi Formation: examples are Osohuayco south mineralized zone south side. These mineralized zones are line up in North-south direction, adding this El Torneado mineralized zone situates on te same straight line about 1.7 km north of Osohuayco north mineralized zone.

During field survey, however, it had not been able to sub-divide granodiorite batholith or distinguish apropriate stocks for mineraization. Therefore igneous rocks which have close relationship with mineralization have not yet been identified.

On the other hand, MJE-7 hole was carried out to clarify the geological condition in the depth at the Osohuayco South mineralized zone south side, and the hole encountered dissemination zone of chalcopyrite and pyrite between 230m and 280 m in depth within the andesite or hornfels of Macuchi Formation.

This mineralized zone, encountered by the Drill hole, was different from what previously assumed but similar to or a part of the mineralization which is recognized at Osohuayco South mineralized zone north side as a porphyry copper type in granodiorite.

These mineralized zones situate along and/or in the vicinity of N-S geological structure, and intersection of N-S principal lineament and E-W local lineament.

To conclude, mineralization associating with skarn minerals in the Macuchi Formation (Osohuayco South mineralized zone south side) may be limitted and local, neither extensive holizontally nor vertically. This mineralized zone may have less potential.

For the future survey, Osohuayco North mineralized zone may still have potential because analytical data are required more to evaluate.

Chapter 2 Chaso Juan area

The Chaso Juan area is situated 40 km north of the Balzapamba area. The access by road can be done from Balzapamba via Babahoyo (159 km), and takes about 3 hours by car. In this area, geological and geophysical surveys were conducted.

2-1 Geological Survey

2-1-1 Geology

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

(1) Macuchi Formation (An)

Macuchi Formation An is mainly distributed in small a area at the northeastern corner, and further expands outside of and to the east and west of the area. In the north and west, it is exposed as xenolith in the granodiorite. This rock consists mainly of dark gray tight and massive pyroxene andesite lava and coessential tuff breccia. Coessential fine-grained tuff, which is considered to be contained therein, and boulders of dark gray siliceous sediment are also observed.

The Macuchi Formation An is mostly metamorphosed to hornfels, and original minerals and texture of source rock cannot be identified, but present hard and tight rock facies. They are locally similar to those of the Member A of the Balzapamba area. Fine-grained biotite, hornblende, pyroxene and quartz are observed.

(2) Granitic rocks

Granitic rocks are almost distributed in this entire survey area, and consist of hornblende-biotite granodiorite botholith (Gd), melanocratic diorite dike (Di) and quartz diorite dike (Qd).

1) Hornblende-biotite granodiorite (Gd)

Hornblende-biotite granodiorite (Gd) is almost distributed over the entire survey area. Lithology is holocrystalline and equi-granular (medium-grain to coarse-grain). The medium-grained dominates in the northeast and central parts (Central mineralized zone) of the survey area and toward the southeastern part, and the coarse-grained in other areas.

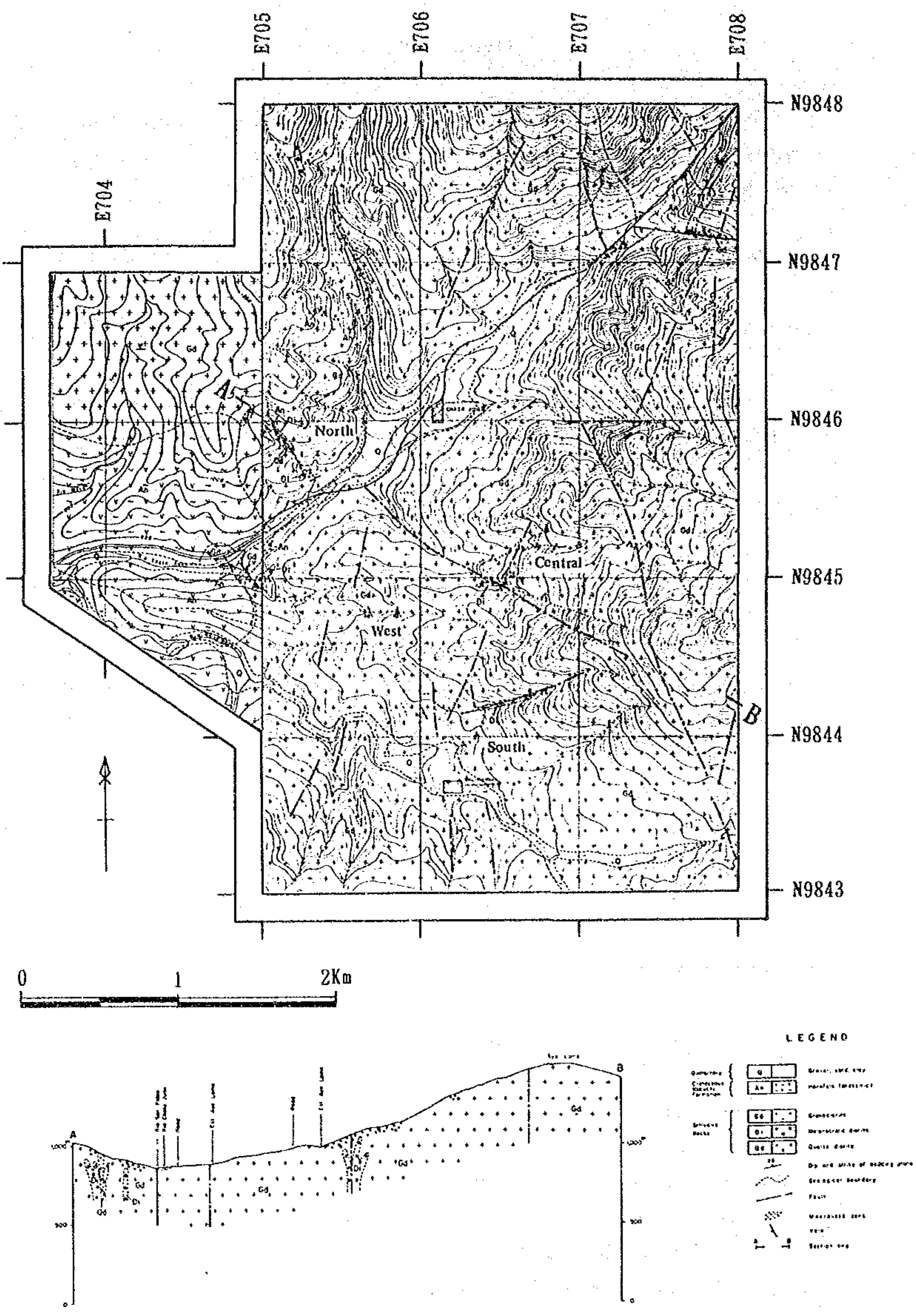
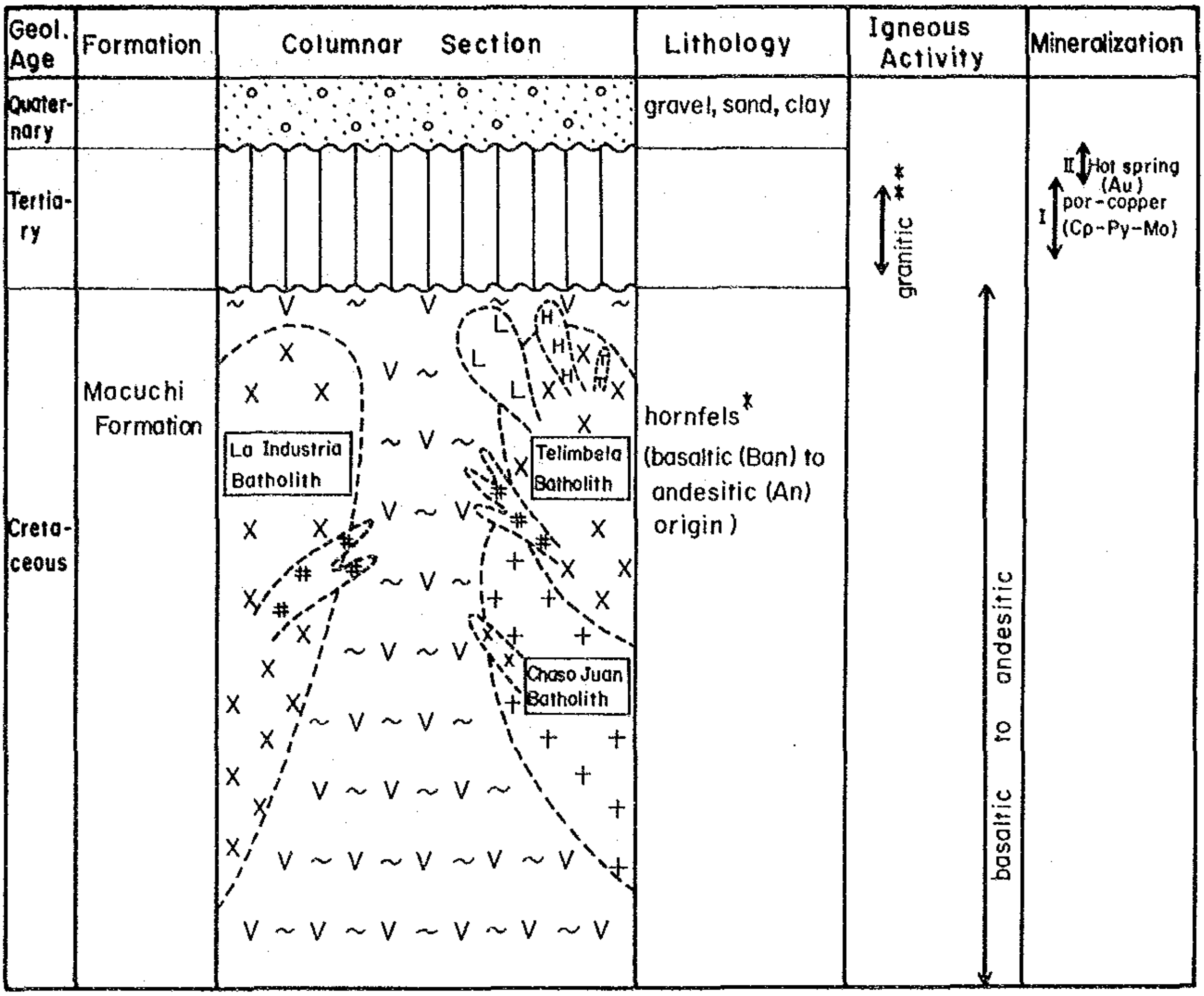


Fig. II-2-1 Geological map of the Chaso Juan area



Granodiorite (Gd)

Quartz diorite (Qd)

Melanocratic diorite (Di)

Quartz porphyry (Qp)

Hornblende quartz diorite (HQd)

Porphyritic quartz diorite (PQd)

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

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

**	Chaso Juan	: 20.9 ± 0.7 Ma (Gd), 17.5 ± 0.6 Ma (Di)
	La Industria	: 25.5 ± 0.9 Ma (Qd)
	Telimbela	: 19.4 ± 0.6 Ma (Qd), 14.5 ± 3.0 Ma (HQd), 15.7 ± 1.0 Ma (Qp)

Fig. II-2-2 Generalized stratigraphic section of the Caso Juan area

2) Melanocratic diorite dike (Di)

In melanocratic diorite dike (Di), were observed at least 7 rock bodies. Large quantities of these rock bodies are distributed around the mineralized zone. The direction of intrusive rocks are in the N-S trend or NE-SW to ENE-WSW trends. The with of dikes ranges from 20 to 50 m showing contacts irregur.

The distribution of dikes as follows:

a) Northwest of survey area:	2 rock bodies
b) West of survey area:	2 rock bodies
c) Western end of survey area:	1 rock body
d) Central part of survey area:	1 rock body
e) South of survey area:	1 rock body

For a rock body of e), microscopic observation, age determination and analysis of entire rock were conducted.

3) Quartz diorite dike (Qd)

Quartz diorite dike (Qd) has intruded into the northern mineralized zone and west of the survey area in NW-SE direction, and is a rock body 60 m long and 20 m wide.
This rock body has penetrated the melanocratic diorite dike (Di).

2-1-2 Geological structure

Structurally the area is emphasized by the NW-SE and E-W trends as the direction of individual mineralized zones, but the distribution of the mineralized zone shows N-S trend. The direction of dikes is in N-S, NW-SE and ENE-WSW.

Lineaments develop in the NNE-SSW, N-S, NE-SW, NW-SE and E-W direction. Among them, the central mineralized zone converges on the intersection of NNE-SSW trend and NW-SE trend, and the southern mineralized zone is situated at a position where NNE-SSW, NE-SW and N-S trends cross each other.

2-1-3 Mineralization and alteration

In the north, west, central and south of the chaso Juan area, porphyry-copper type mineralization is observed in granodiorite batholith. The features of mineralization can be cited as follows:

1) The mineralized zone consists of chalcopyrite-pyrite-(molybdenite) dissemination and veinlet zone.

2) Chalcopyrite/pyrite ratio of the mineralized zone is higher than that of any other mineralized zones in the Bolivar area, though with a small quantity of pyrite
3) Chalcopyrite is large grained.
4) Alteration of host rock varies among each mineralized zone and is characterized mainly by silicification and biotitization. Some are characterized by chloritization.
5) Direction of individual veinlets is in NW, NE and E-W trends.

The occurrence of major mineralized zones is as follows:

(1) North mineralized zone

The North mineralized zone is situated in tributary of San Pablo valley. Mineralized zones are 10 to 50 m wide over 400 m long and scattered in granodiorite and melanocratic diorite at three places. In these mineralized zones, observed are chalcopyrite-pyrite-(molybdenite) veinlets and dissemination.

The analytical results of the ore samples show 1.3 g/t in Ag, and 0.10 % in Cu. Noticeable alteration is observed in secondary biotite.

(2) West mineralized zone

The West mineralized zone is situated 10 km southwest of Chaso Juan. The mineralized zone is chalcopyrite and pyrite dissemination and veinlet zone in coarse-grained granodiorite which is affected by strong silicification. The width of the outcrop is 25 m, and the mineralized zone shows N20°W in strike, and 40°S in dip. Disseminated sulfide minerals mainly occur in the portion of mafic minerals.

The analytical results of the ore samples show 0.1 g/t in Au, 1.7 g/t in Ag and 0.24 % in Cu. For alteration, silicification is conspicuous, and secondary biotite is common. Large quantities of limonite veins of 2 to 3 cm wide are observed for about 200 m on the downstream side of this outcrop. The mineralized zone shows N20° to 40°W in strike, and 40° to 55°S in dip.

(3) Central mineralized zone

The Central mineralized zone (the east mineralized zone of the Phase I survey) is situated in the middle reaches of Aya Loma valley and its branches , extending over 600 m x 400 m, and mineral showings are scattered at eleven places. The mineralized zone consists of chalcopyrite and pyrite dissemination and veinlet in zone of melanocratic granodiorite and granodiorite. Molybdenite is locally observed in veinlets. Major mineralized zone is observed for 150 m along the valley. Veinlets of the mineralized zone show N80°W in strike, and 60°S in dip.

The analytical results of the ore samples show 0.1 g/t in Au, 4.2 g/t in Ag, and 1.41 % in Cu at maximun. As a result of microscopic observation of sample No.A2017, chalcopyrite-pyrite-magnetite-molybdenite is observed in quartz veinlets (3 mm wide) and in host rock.

Host rock is affected virtually by chloritization and epidotization. The former is widely observed in the mineralized zone, and the latter tends to dominate in a portion where large quantities of chalcopyrite are present in the mineralized zone. By X-ray diffractive analysis for the latter, potassium feldspar and secondary biotite are locally detected. In the eastern upper stream side, white alteration zone accompanied with pyrite extends over 50 m in N70°E direction along the river.

(4) South mineralized zone

The South mineralized zone is situated in the northern part of Mulidiahuan. This mineralized zone extends over an are of 800 m x 300 m, and the east of the mineralized zone shows different occurence from the west. In the east of the mineralized zone, chalcopyrite-pyrite dissemination and veinlet zone occur in coarse-grained granodiorite. A mineralized zone is observed for about 300 m along the valley in the southwest direction.

The analytical results of the ore samples show 0.1 g/t in Au, 7.6 g/t in Ag and 1.46 % in Cu at maximum. The host rock is affected by silicification and weak chloritization. White alteration rocks are present locally.

In the west of the mineralized zone, two rows of chalcopyrite-pyrite veinlet zones in small cracks of coarse-granodiorite are distributed with intervals of about 100 m. The veinlet (about 1 to 10 cm of vein width) shows N20° to 30°W in strike, and 45° to 65°S in dip.

The analytical results of the ore samples show 1.5 g/t in Au, 160.9 g/t in Ag and 9.03 % in Cu at maximum. The host rock is affected by weak silicification.

In addition, chalcopyrite-pyrite dissemination and veinlet zones are observed at four places, in the northeast of the survey area, but each of them is small in scale.

2-1-4 Magnetic susceptibility measurement

To determine quantitatively demagnetization due to mineralization, magnetic susceptibility was measured, using a portable magnetometer. This measurement was made through the area. The magnetometer was Kappameter Model KT-5 of Czechoslovakia with measurement susceptibility of 1×10^{-3} SIU.

At the measurement, efforts were made to completely scrape weathered portions off from outcrops and to plane surface smooth to prevent measuring errors due to weathering and surface unevenness. Each measurements are the average of three values disregarding the highest and lowest ones.

Measurement values sharply fluctuated from 0.04 to 137×10^{-3} SIU depending on the outcrop. Fresh granodiorite showed 20 to 40×10^{-3} SIU, melanocratic diorite, 40 to 137×10^{-3} SIU, andesite lava in the Macuchi Formation, 50 to 70×10^{-3} SIU, quartz-bearing andesite lava, tuffs, and sedimentary rocks (Las Guardias area) in this formation, all less than 10×10^{-3} SIU. Main mineralization in this area was porphyry copper type. Taking into consideration the results of the previous year and with values below 20×10^{-3} SIU as anomalously low, each anomalous values for low magnetic susceptibility were set as follows: 0.1 to 5.0×10^{-3} SIU as extremely low; 5.1 to 10.0×10^{-3} SIU as low considerably; 10.1 to 20.0×10^{-3} SIU as low, and more than 20.1×10^{-3} SIU as background. Based on these four anomalous values, an analytical chart for anomalous zones was prepared (Fig.II-2-3).

Anomalous zones for magnetic susceptibility are found at four places. These anomalous zones consist of a zone extending in N-S direction from the Central mineralized zone to the South mineralized zone, zones detected in the Northern and West mineralized zones, and zones detected in mineral showings in the northwestern and northeastern zones. All of these anomalous zones are associated with mineralization. The scale of the foremost former anomalous zone is as intense as that of the anomalous zone detected in the El Torneado mineralized zone of Balzapamba area. The other anomalous zones are small in scale. As described above, magnetic susceptibility measurement was highly effective in understanding the scale of mineralization.

2-1-5 Geochemical survey

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 the fact is also confirmed that the Cu contents tend to decrease clearly outward from the mineralized zones.

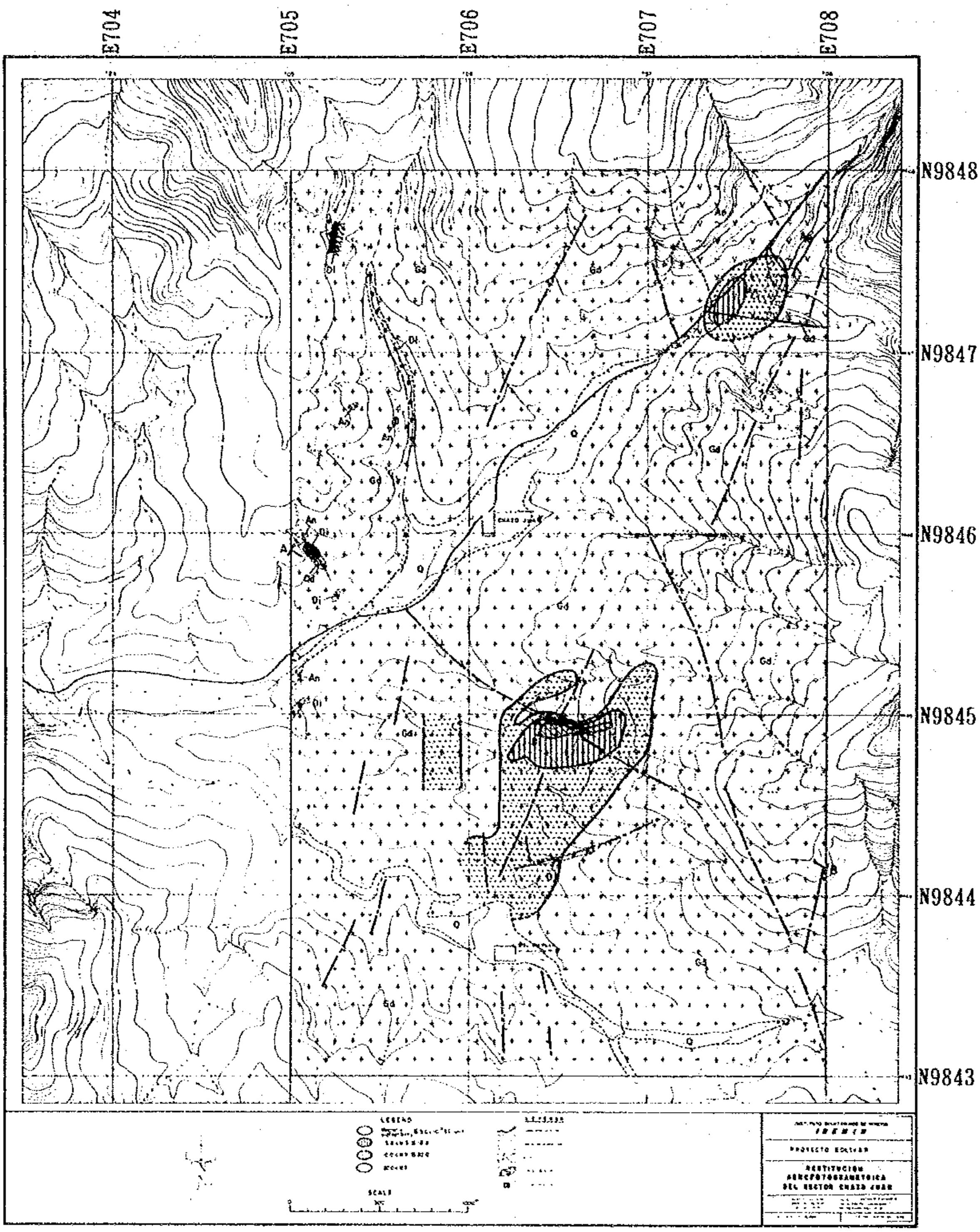


Fig. II-2-3 Interpretation map of magnetic susceptibilitity of the Caso Juan area

2-2 Geophysical survey

2-2-1 Purpose of survey

The detailed geological survey was carried out on several mineral showings confirmed by the Phase I survey, and a promising mineralized zone was selected for further exploration work by means of IP method geophysical survey.

The purpose of the survey is to investigate the possible existence of the ore deposits there by a conventional IP method.

2-2-2 Survey method

(1) Measurement method

The measurements were done by the frequency domain method using 3.0Hz and 0.3Hz in a dipole-dipole electrode configuration with a separation factor n from 1 to 5.

The geological results of the first phase survey and this year survey concluded that the Wast and South mineralized zones were promising. Therefore, this survey was carried out in order to clarify the existent correlation between the East and the South mineralized zones as well as to find the distribution of mineralization at the depth of the above mentioned mineralized zones.

Based on the investigated geological structure, six survey lines with an extension 1,600m each were set along a S60° E direction and keeping a 300m line spacing.

The numbering of the measuring stations was set from 0 to 32 from the northwest end of every line to southeast with a 50m interval. The measurements were done between stations spaced 100m with a 100m potential electrode.

2-2-3 Discussion

The IP anomalies are delineated based upon the results of simulation on Line C2 and C4, and with the same procedure the the geophysical structure of the other lines was interpreted quantitatively. Results combined are shown in Fig.II-2-4.

Summary of the results are as follows:

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

low FE. This lineament suggests, therefore, a existence of fault.

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

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

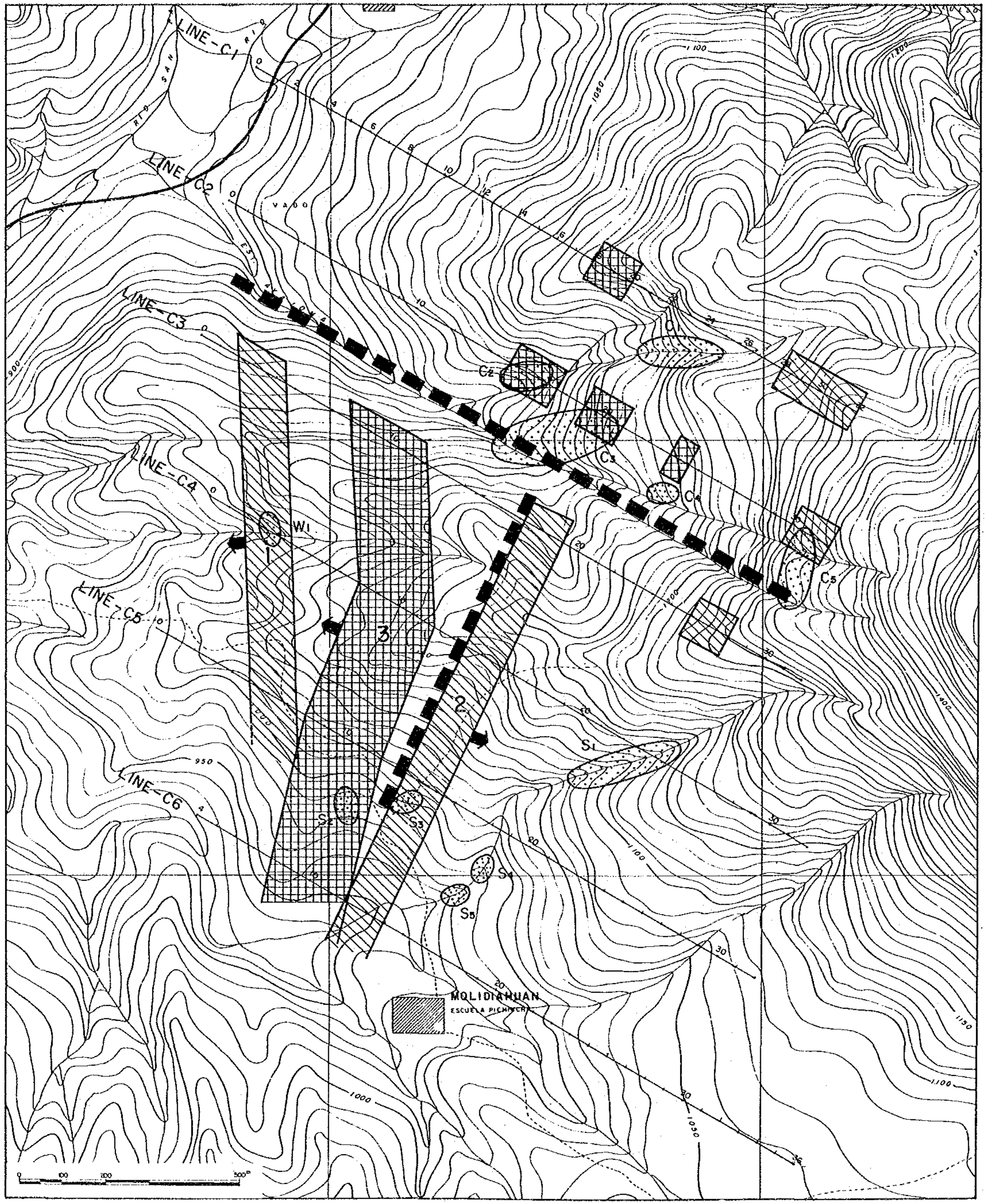
4) The anomaly IP source 2 continues from Line C3 to Line C6 along with a lineament in a NNE-SSW direction between the central and the southern mineralized zone. This source, which is assigred a 1,300 Ohm-m and 7.0% FE, is thought to be indicative of alteration associated with mineralization.

5) A blind IP anomaly source 3 with about 200m thickness is assumed to continue from Line C3 to Line C6 and extend and between the IP anomaly source 1 and 2.

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

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

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



LEGEND

Lineament

IP Anomaly Source (High Resistivity, High FE)

IP Anomaly Source (Medium Resistvity, High FE)

Mineralized Zone

Fig. II-2-4 Interpretation map of IP anomalous zones of the Chaso Juan area

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

1) Meneralization type differs location to location;

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

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

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

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

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

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

Necessary topographical correction was carried out first, to eliminate influence on apparent resistivity: to make the value lower at the bottom of valley; and to make it up at the top of the hill.

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

2-3 Consideration of survey results in Chaso Juan area

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

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

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

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

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

Chapter 3 Telimbela area

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

3-1 Geological survey

3-1-1 Geology

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

(1) Macuchi Formation (Ban)

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

(2) Granitic rocks

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

1) Leucocratic hornblende-biotite quartz diorite (Qd)

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

2) Melanocratic diorite dike (Di)

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

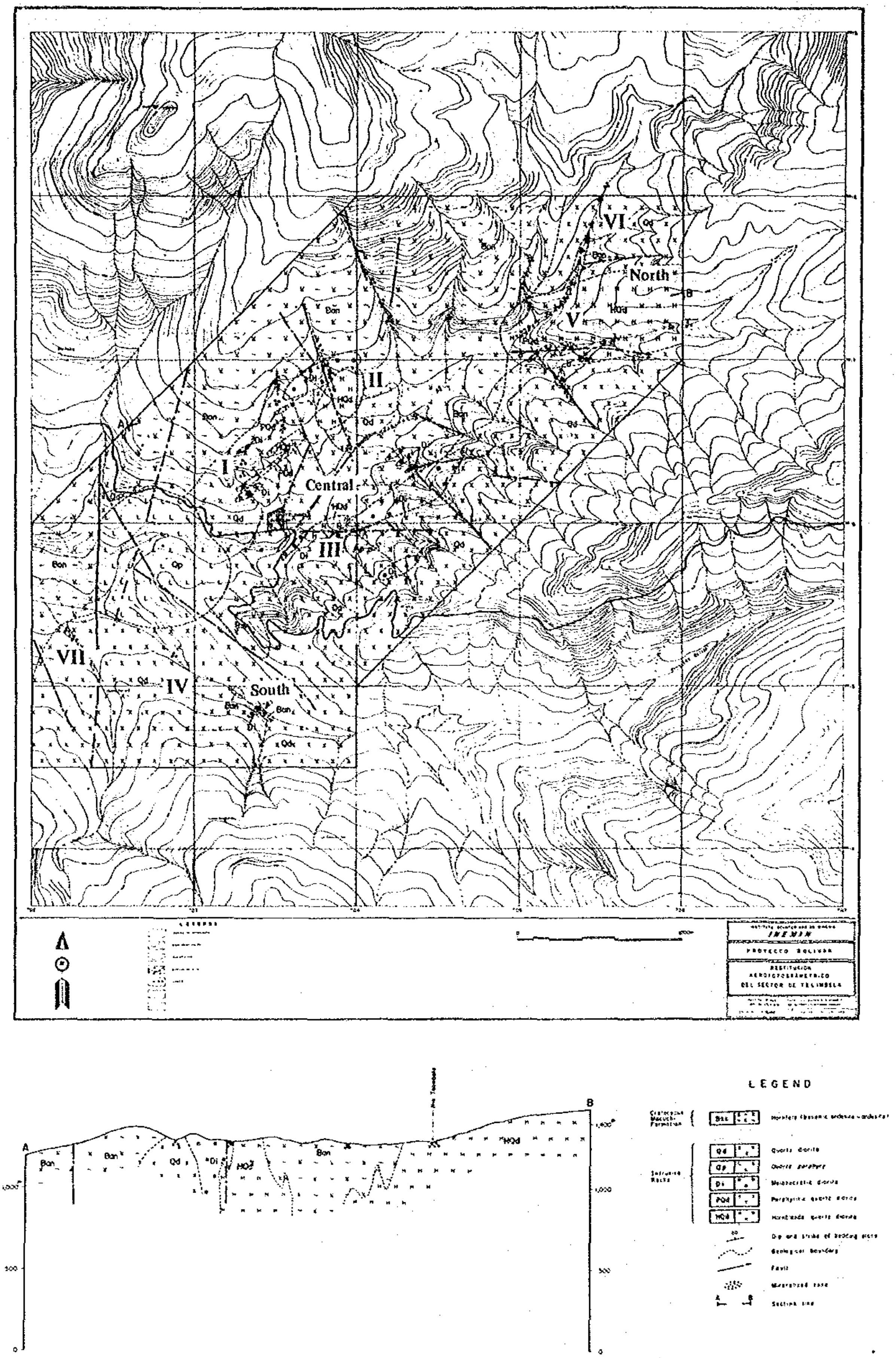


Fig. II-3-1 Geological map of the Tiimbela area

3) Porphyritic quartz diorite dike (PQd)

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

Biotite is affected locally by sericitization.

4) Hornblende quartz diorite (HQd)

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

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

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

5) Quartz porphyry (Qp)

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

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

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

6) Aplite dike (Ap)

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

Biotite is locally affected by chloritization.

(3) Geological structure

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

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

3-1-2 Mineralization and alteration

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

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

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

(1) Central mineralized zone

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

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

Zone II occurs in granitic rocks as well as the Macuchi Formation, and consists of chalcopyrite-pyrite-(molybdenite) dissemination and veinlet zones, which are distributed over an area of 200 m x 400 m. The assay of ore samples is 0.2 g/t in Au at maximum, 1.6 g/t in Ag, and 0.16 % in Cu. The sketch of the mineralized Zone I is shown in Fig.II-4-2.

(2) South mineralized zone

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

Zone III is pyrite disseminated and veinlet zones, and distributed over an area of

400 m x 900 m.

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

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

(3) North mineralized zone

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

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

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

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

Assemblage of alteration minerals was quartz-sericite-chlorite.

3-1-3 Magnetic susceptibility measurement

The data of the magnetic susceptibility measurement were analyzed in the same manner as in the Chaso Juan area. The obtained map is shown together with the locations of the mineral showings in Fig.II-3-2.

For anomalous zones of the magnetic susceptibility, the following three places were detected: one in NE-SW direction including the Central and South mineralized zones; next in the east side of Zone III; and the other in the North mineralized zone. Among them, the scale of the foremost former anomalous zone is more than twice that of the anomalous zone detected in the El Torneado mineralized zone in the Balzapamba area. In Zone II, the mag-

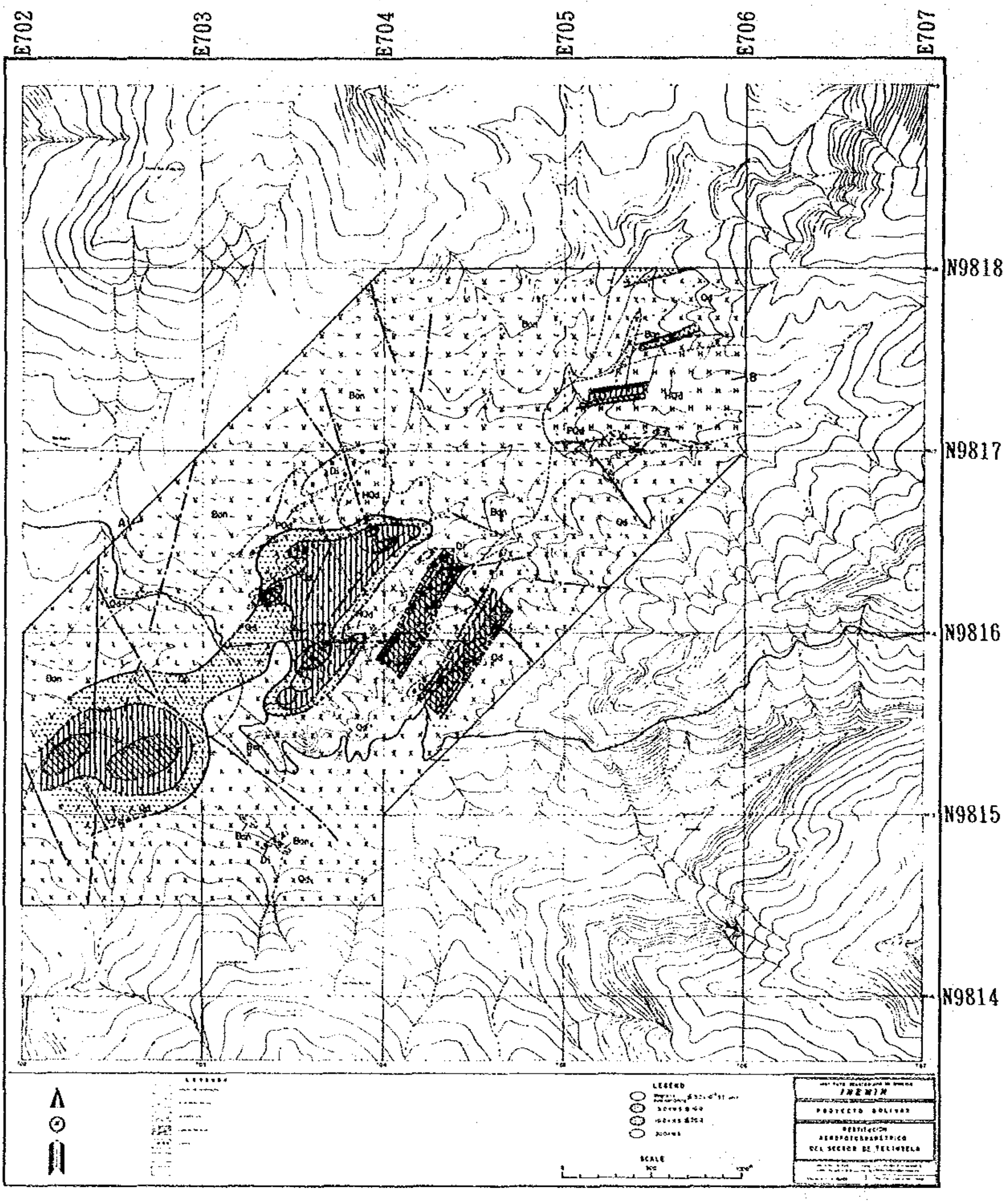


Fig. II-3-2 Interpretation map of magnetic susceptibilitity of the Telimbela area netic susceptibility of the volcanic rocks of the Macuchi Formation decreases from 83 x 10^{-3} to 36 x 10^{-3} SIU toward the main mineralized zone. The demagnetization caused by mineralization is observed.

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

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

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

3-1-4 Discussion

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

Taking a broad view, the mineralized zone in the Telimbela area is distributed over the peripheral part of granitic batholith, trending toward the NE-SW. A number of dikes intrude into mineralized zones, which are hornblende quartz diorite (HQd), quartzporphyry (Qp), melanocratic granodiorite (Di) and porphyritic quartz diorite (PQd) dikes, etc. The dikes are also extending in the NE-SW direction. In the north of this area, a major tectonic line which continues from Guayaquil to the east of Quito in the NE-SW direction. The alignment direction of the intrusive rocks and mineralized zones in this area coincides with the major tectonic line. This implies that the igneous activity and its subsequent hydrothermal activities are associated with the major tectonic line. Quartz porphyry (Qp) is dated as 15.8 ± 1.0 Ma, consequently hornblende quartz diorite(HQd) as 14.5 ± 3.0 Ma, and the isotopic values of the intrusive rocks show the youngest age in the Bolivar area.

This fact means that the igneous activity of granitic rocks in this area has continued to the last in the Bolivar area. The scale of mineralized zone in this area is larger than any other areas surveyed in the Bolivar area, and the Macuchi Formation is affected by strong mineralization. Also pyrite dissemination and veinlets are widely observed in granitic rocks.

3-2 Northeast zone, Telimbela area

The Northeast zone of telimbela area is located 10 km north of the Balzapamba area. The access by road is available from Balzapamba via babahoyo. It takes 3 hours approximately by car. The detailed geological survey has been conducted in the area.

3-2-1 Geological survey

3-2-1-1 Geology

The Northeast zone of the Telimbela area is underlain by the Macuchi formation and granitic rocks which were emplaced in the Macuchi formation (Figs.II-3-3 and II-3-4).

(1) Stratigraphy

1) Macuchi Formation

Macuchi Formation is mainly distributed in the western part of the surveyed area, in the central part (about 500 m west of Ashuaca), small blocks of which are also observed in the vicinity of Ashuaca as xenoblocks in the batholith of hornblende-biotite quartzdiorite (Qd) and stocks of hornblende-quartzdiorite (HQd).

More than 700 m in the western part of the surveyed area.

The Macuchi Formation Consists of andesite lava (AAn) and the lower part of the thick piles of these igneous rocks is composed of lavas 220 m thick, which intercalates 2 or 3 sheets of pyroclastics. In the Upper part of it, pyroclastic sediments develop and pile up more than 460 m thick.

Principal constituents of the Macuchi Formation are coarse tuff, crystalline tuff and fine tuff.

(2) Granitic rocks

Granitic rocks are almost distributed in the entire area surveyed, and consist of hornblende-biotite quartzdiorite batholith (Qd), melanocratic quartzdiorite (Di), hornblende quartzdiorite stocks (HQd), coarse quartzdiorite dikes (CQd), and porphyritic andesite dikes (Pa).

1) Hornblende-biotite quartzdiorite

Hornblende-biotite quartzdiorite (Qd) is distributed in the southeastern part and northeastern part of the surveyed area.

Rock facies is light gray to gray in color, and massive, medium grain and equigranular. Color index of the rock is between 15 % and 20 %. Rock forming minerals are rec-

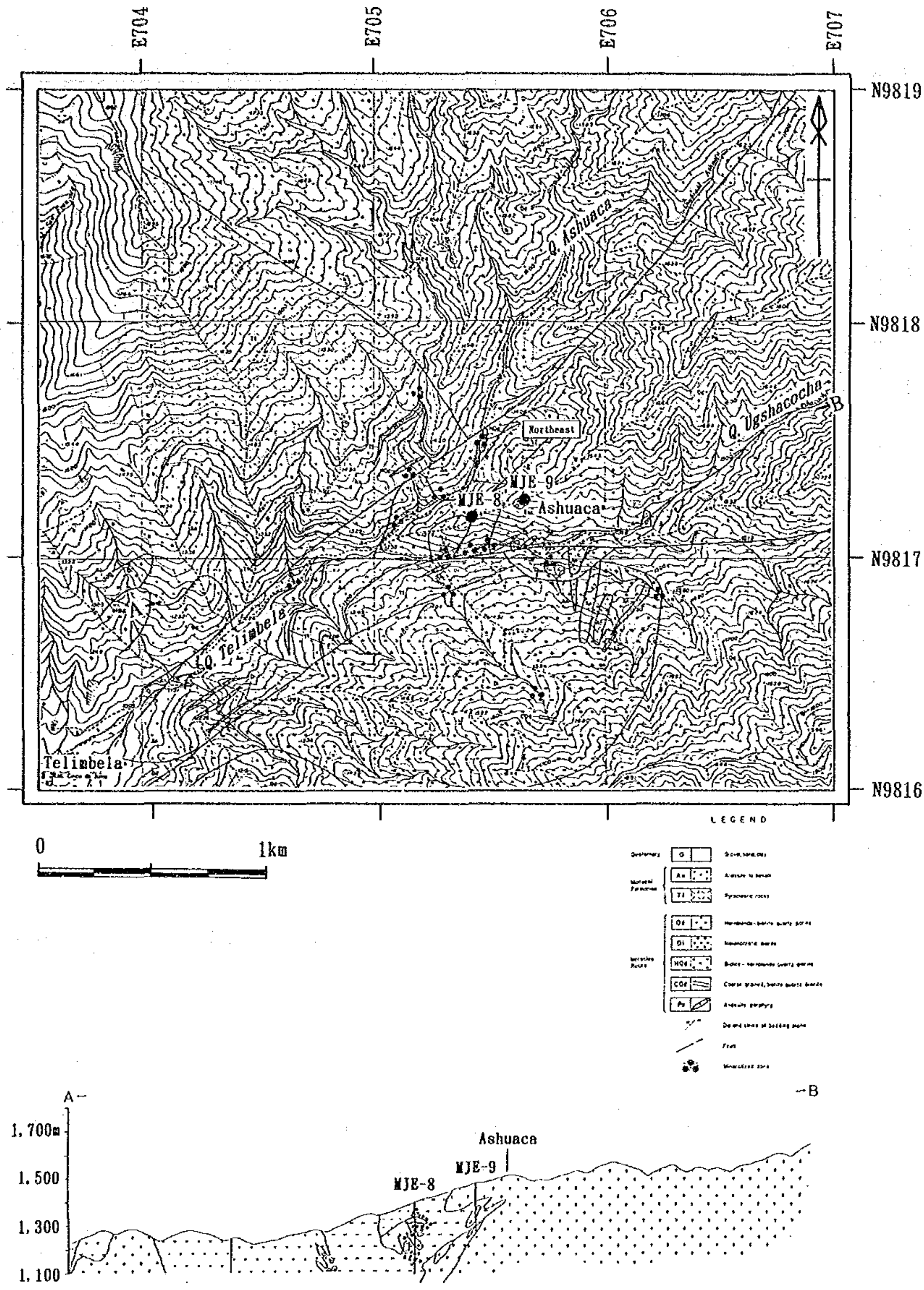


Fig. II-3-3 Geological map of the Northeast, Tlimbela area

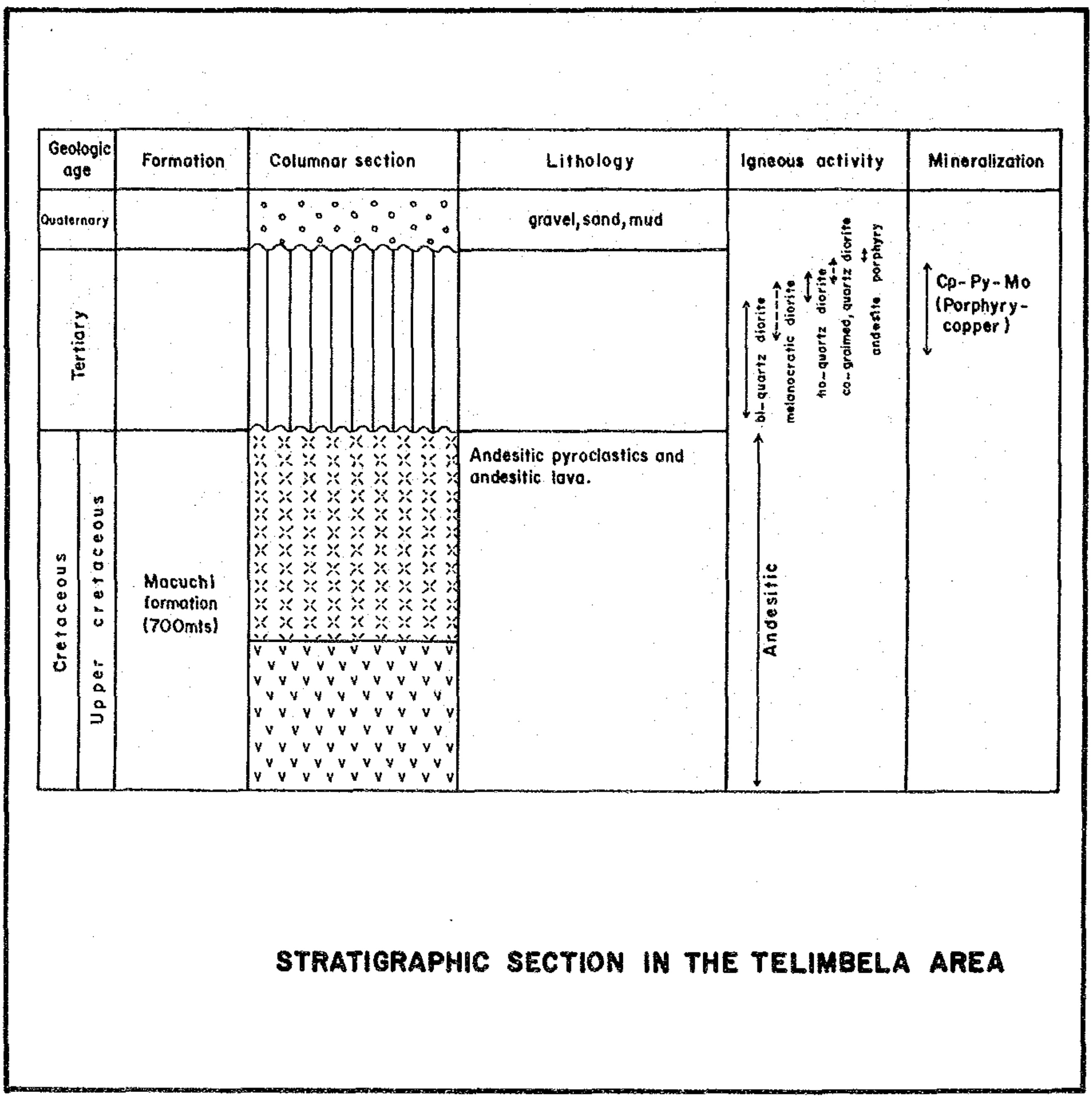


Fig. II-3-4 Generalized stratigraphic section of the Northeast, Telimbela area ognized in naked eyes plageoclase and quartz as feltic minerals and hornblende and biotite as mafic minerals. Mafic minerals have been occasionally altered to chlorite etc. Chalcopyrite dots are disseminated in secondary green-minerals in the area of intense alteration.

The rock (Qd) is estimated to have intruded into the Macuchi Formation in late-Createaceous through early Paleogene of Tertiary, included blocks and breccias of the Macuchi Formation near the contact of the both rock bodies and contact-metamorphosed it.

2) Melanocratic quartzdiorite (Di)

Melanocratic quartzdiorite (Di) crops out in the southern part of the surveyed area, extending about 2,500 m long and 100 m wide.

The rock (Di) also crops out at about 2,200 m north of Ashuaca as a small intrusive body of 150 m wide and 500 m long in the NE-SW direction.

Five more small-bodies are recognized in the survey area.

The rock (Di) shows dark gray to dark green in color, massive, and medium to fine grain size of rock forming minerals. Color index of the rock is 30 % to 40 %.

Following rock forming minerals are recognized in naked eyes:
Plageoclase quartz as feltic minerals and hornblende biotite as mafic minerals. As the result of microscopic observation, ratio of hornblende and biotite varies, and these mafic minerals have been altered to chlorite and epidote from one place to another.

3) Hornblende quartzdiorite (HQd)

Hornblende quartzdiorite (HQd) distributes in the west and south of Ashuaca, the central part of the surveyed area, as two small stocks and a dike. This stocks intruded into Macuchi Formation (An and Tf), Hornblende-biotite quartzdiorite (Qd) and Melanocratic quartzdiorite (Di).

Hornblende quartzdiorite (HQd) shows massive, gray to greenish gray in color and medium grain. Color index of the rock is between 20 % and 30 %. The rock body contains a number of blocks, breccias and fragments of Macuchi Formation (An and Tf), hornblende-biotite quartzdiorite (Qd) and Melanocratic quartzdiorite (Di).

Chalcopyrite, pyrite and molibdenite are recognized in forms of dissemination, films, patches or veinlets in the stocks. Following minerals are also recognized as rock forming minerals, in makid eyes: Plageoclase qurtz and hornblende biotite. Mafic minerals are partly altered to chlorite or other green minerals.

4) Coarse quartzdiorite (CQd)

Coarse quartzdiorite (CQd) occurs as a dike intruded into a small intrusive body of melanocratic quartzdiorite.

The rock (CQd) shows light gray to light brownish gray in color, massive and coarse grain. Color index of the rock (CQd) is 2 % to 3 % only. Chalcopyrite dissemination are recognized intensely in the rock body. As constituent minerals detected in naked eyes are plageoclase quartz and biotite. Biotite is substituted partly by some green alteration minerals such as chlorite, etc.

5) Porphyritic andesite (Pa)

Porphyritic andesite crops out at 1,750 m in altitude along the ridge of Ashuaca, trending toward NE-SW direction.

The rock (Pa) shows gray in color, porphyritic and compact. Plageoclase and hornblende are obvious as phenocrysts. Neither mineralization nor alteration are observed.

(3) Lineaments

Lineaments in the surveyed area were analyzed with aerial photograph of 1 to 60,000. The result are shown on a topographic map of 1 to 20,000 (Figure A-5).

The most prominent lineament detected on the aerial photograph is NW-SW one which passes Telimbela village and directs toward northeast direction, next prominent one is E-W, a branch lineament of the former, which runs just south of Ashuaca. Other significant lineaments are mentioned as follows: NNW-SSE, NE-SW and ENE-WSW directions.

(4) Faults

Major lineaments analyzed are to be correspond to geological faults. For instance, one: NE-SW fault which passes telimbela village and directs toward northeast direction and two: E-W fault which is a branch of the former and runs along the river Q. Ugshacocha, just south of Ashuaca. Two white argillized and silicified zones are both situated actually on the Fault lines which mentioned above.

Adding this surveyed area lies on or near a tectonic zone trending NE-SW direction where crossing the Frente de Banos fault which stretches from Guayaquil to Quito. Therefore, NW-SW lineament, a lineament of the same direction as the Frente de Banos fault, may be a product relating to the same tectonic movement.

3-2-1-2 Mineralization and alteration

Outcrops, which are mineralized of pyrite and chalcopyrite, are recognized along Q. Ugshacocha, Q. Ashuaca and their branches. They are mainly and approximately distributed in an area of 1.5 km x 1.0 km near Ashuaca. This mineralized zone is called "Northeast mineralized zone" which is correspond to mineralized zones V and VI in the Phase II report. Intense mineralized area within the Northeast mineralized zone is concentrated in a limited area of 400 m x 600 m in the west of Ashuaca School, therefore called the "Ashuaca mineralized zone".

Northeast mineralized zone

(1) Type of mineralization

Type of mineralization recognized in the survey area is porphyry copper type.

(2) Occurrence

In the area mineralized are all type of rocks including not only granitic ones but also the Macuchi Formation. Furthermore, molybdenite is recognized where intense chalcopyrite and pyrite mineralization and where high ratio of chalcopyrite/pyrite. Five more mineralized outcrops are observed, which are also good mineral showings.

Sulfides occur differently between inner and outer part of the mineralized zone. The former, the mineralization are of chalcopyrite and pyrite in forms of spotted, film and/or veinlets, and the mineral assemblages of chalco-pyrite-pyrite-quartz veins are common. In the latter, contrary, they are in a form of dissemination along cracks only. Content of ore minerals decreases here.

Assay result of ore samples from the Northeast mineralized zone were 0.71 to 1.38 % Cu in the central part and less than 0.1 % in the outer part, where pyrite dominates in forms of dissemination and/or veinlets. Pyrite is more abundant in southern part than in other parts.

Pit survey is also adopted in an area of Ashuaca, because surface is covered by thick weathered soil. Dissemination and veinlets of limonite are observed commonly in every pit, one of which contained a grain of malachite. Cu content of samples collected from pits was distinctively higher than that of background. The highest one was 0.51 % Cu. Therefore Cu content in the samples from pits indicates that pit exists in an area mineralized intensely of chalcopyrite and that the samples properly acquired chalcopyrite and/or its oxidized minerals which were contained in the country rocks.

Alteration associated with mineralization are strong silicification and chloritization.

(3) Structure control

Northeast mineralized zone distributes in the vicinity of NE-SW fault along Q. Telimbela-Q. Ashuaca and of E-W fault along Q. Ugshacocha. Furthermore "Ashuaca mineralized zone", a intense mineralized zone, occupies in the vicinity of intersection of those two faults mentioned above.

Most of lineaments, which develop in the survey area, are considered to be related to the activities of the tectonic line, the Frente de Banos fault, because it traverses nearby the survey area and trends toward NE-SW direction.

This assumption is supported by the facts that numbers of stocks and dikes are concentrated in the surveyed area, and their number is more than that of any other project areas in bolivar region, and that their distribution is also and/or elongation of intrusion controlled in the NE-SW direction.

3-2-2 Geophysical survey

3-2-2-1 Purpose of survey

The purpose of this survey is to clarify the lateral and vertical extension of the mineralization detected by the Phase II Survey in the northeastern zone of Telimbela area. To meet the above, an investigation of the electrical structure of the area was carried out by clarifying the distribution of IP anomalies in the survey area by means of a conventional IP method.

3-2-2-2 Survey method

(1) IP method

An IP (Induced Polarization) method is a geophysical technique that measures the polarization effects caused by the electrochemical nature of the minerals and rocks. This method has been mainly utilized for detecting sulphide deposits.

There exist four measuring methods to observe an IP phenomenon, i.e.,

1) Frequency-domain

When using the frequency-domain method, the magnitude of the IP phenomenon is expressed by the parameter called Frequency Effect (FE) which is proportional to the resistivity difference at two frequencies.

2) Time-domain

In this method, the magnitude of the IP effect is expressed by the Chargeability which is determined by observing the transient voltage curve after the electric current is turned off.

3) Phase-domain

The magnitude of the IP phenomenon in the phase-domain method is expressed in terms of the difference of the phase angle between the transmitted and received signals.

4) Spectral IP

The magnitude of the IP phenomenon is here expressed as the normalized amplitude and phase in each frequency referred to the lowest frequency among a wide variation of frequencies.

(2) Measurement method

The measurements were done by using the frequency-domain method at the frequencies of 3.0Hz and 0.3Hz and adopting a dipole-dipole electrode configuration with a separation factor n from 1 to 5.

Based upon the geological structure, six survey lines of 1600m each in length were set along a NW-SE direction with a 300m line spacing. The numbering of the points were set one by one from 0 to 32 with a 50m interval from the northwest end of each line and the measurements were done every 100m spacing with a 100m potential electrode.

3-2-2-3 Discussion

Apparent resistivity values in this zone range from 38 to 3,370 ohm-m with an average of 349 ohm-m, which are extremely low compared with those detected in Chaso Juan area, and Osohuayco zone of Balzapamba area surveyed by the same method during the Phase II.

Geology of this zone, as in the case of the two above mentioned areas in the Phase II, consists of Macuchi formation with andesite and tuff group, and granitic intrusives. However, in these two areas, silicification which is a cause of high resistivity was the dominant process, while in this year survey, argillization (chloritization and montmorillonitization), which cause low resistivity, seems to be the dominant process. Moreover, in the two areas of the Phase II, because of the dominant silicification is accompanied with mineralization, the mineralized zone reflects high resistivity and high FE. However, in this area, according to physical property tests, the close relation found between mineralization and argillization permitted to understand that the grouping of low resistivity and high FE becomes an important factor for the understanding of mineralization process in this report.

In this section, the simulation analysis carried out on parts of lines T-4, T-5 and T-6 had the purpose of giving an estimate of the high FE anomalies located in area of the unknown mineralizations (western part of survey area). These results are shown in Figs. A-9-1, A-9-2 and A-9-3.

As described in section 2-2-4 (3), the abnormal values caused by EM coupling, artificial structures and or low S/N ratio, are seen at the depth deeper than n=2.

These values present difficulties to be simulated by this analysis, however if simulated, the assumed model indicates unrealistic values of FE. In the simulation analysis, it is clearly seen that by reducing 3-4% of FE from the abnormal values of more than 8% indicated below, good realistic model can be obtained.

Line T-3: n=4 of station No.12, n=5 of station No.13

Line T-4: n=3 of station No.15, n=5 of station No.17

Line T-5: n=4 of station No.18

As shown in Fig.A-9-2, a value of less than 1.0% of FE, is considered to be the effect of artificial structure, which if ignored, a pants-legs shaped anomaly can be assumed. This anomaly reflects a low resistivity and high FE layer at the stations No.8 to No.10 on the surface.

Interpreted results by taking into consideration the quantitative analysis, is shown in Fig.II-3-5. Results of present geophysical survey can be summarized according to the results of geological survey, as follows:

1) High FE anomalies V and VI are interpreted as the results of a buried mineralized body in hornblende-quartz diorite distributed in the center of this district and including its surrounded chalcopyrite and pyrite disseminated area. A resembling low resistivity pattern corresponding to chalcopyrite and pyrite disseminated zone are seen along the southern and western creeks of Ashuaca.

2) High FE anomaly VI is interpreted as tongue shaped low resistivity and high FE zone A (100-600 ohm-m and 8.0-20.0% FE), which is from station No.22 on Line T-1 to station No.19

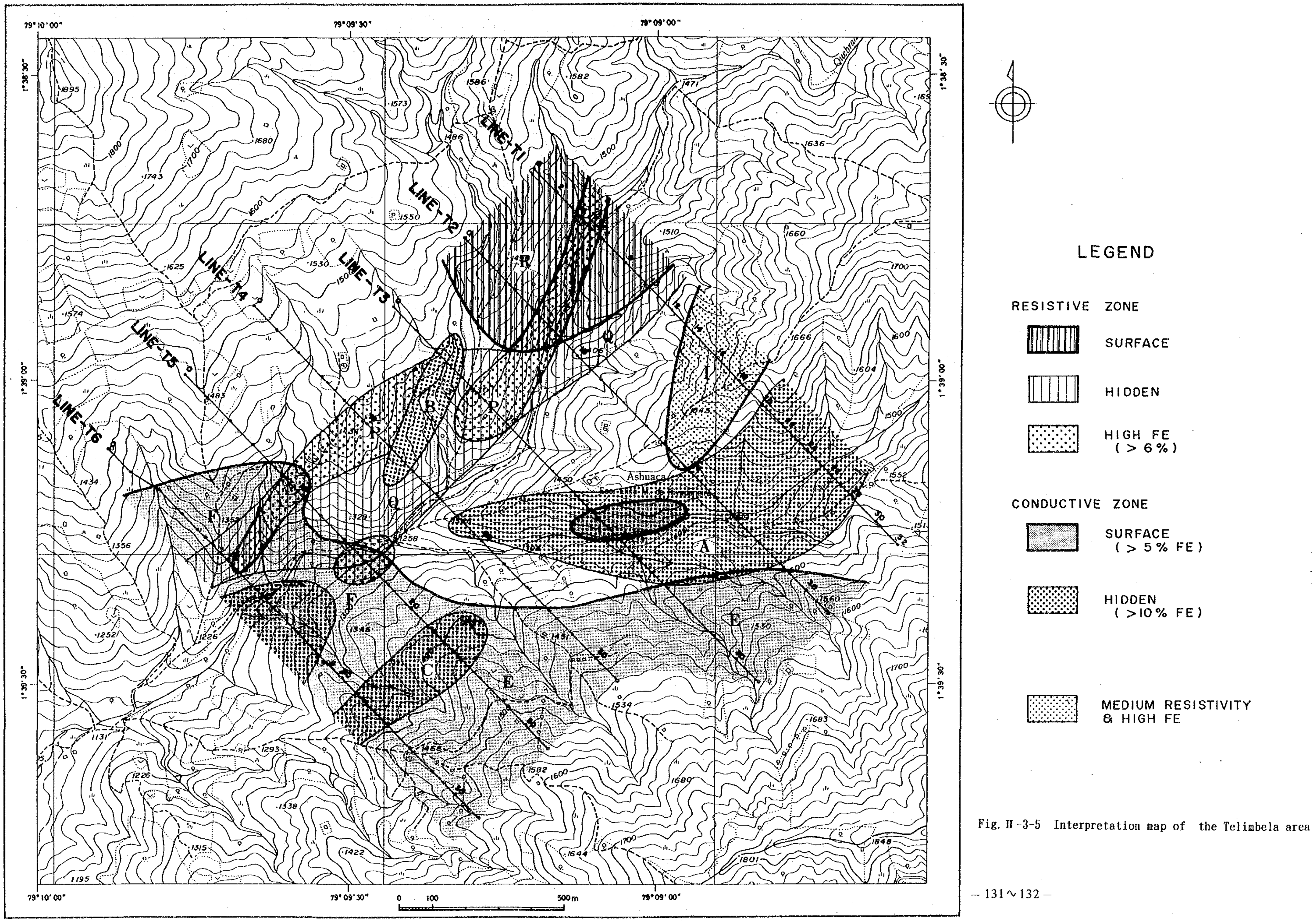


Fig. II-3-5 Interpretation map of the Telimbela area

on Line T-4 in the south of Ashuca ridge. This zone crop out on the surface, and deepens westwards and northeastwards.

3) Northern resistive body R is in the zone of quartz diorite. And hidden resistive zone Q is suggested to reflect silicification, detected along a NE-SW fault, from station No.10 on Line T-1 to station No.10 on Line T-6. Inside of these resistive zone, high FE part P with more than 5%, is found from station No.5 on Line T-1 to station No.11 on Line T-6. Moreover, hidden low resistivity and high FE zone B (200 ohm-m and 13.0-15.0% FE) is suggested from station No.7 on Line T-3 to station No.13 on Line T-4, crossing the high FE P. These high FE zone corresponded to the high FE anomaly V in the depths.

4) In the surface of Asuaca ridge, low FE layer assumed with 30-80 m in thickness and 2.0% of FE, is indicated leaching out of mineralization in weathered layer. Moreover, confirmed mineralization along Q.Ashuaca is inhered small mineralized zone consisting of thin veins on fracture zone.

5) In the south district, melanocratic quartz diorite is interpreted with 200-250 ohm-m and 4.0-6.0% FE. That mineralization and argillization is suggested as stronger than the other intrusive rocks. And High FE layer is assumed in southeastern end of Lines T-2 to T-6. Moreover, hidden low resistivity and high FE zone (200 ohm-m and 20.0% FE) is assumed at the part of contact with Macuchi formation, between station No.23 on Line T-5 and station No.22 on Line T-6. This zone correspond to high FE anomaly IV, is not conformed mineralization.

6) In the surface of southwestern district (station No.8 to No.10 on Line T-5 and station No.4 to No.20 on Line T-6), low resistivity and high FE layer F corresponded to high FE anomaly III is interpreted with 20-60m in thickness, 80-300 ohm-m and 7.0-12.5% FE. This layer is suggested dissemination with sulfide in Macuchi formation. And under the layer F in station No.12 to No.17 on Line T-6, another low resistivity and high FE zone D assumed with 60 ohm-m and 9,0% FE, extend to depths of southeast and have a possibility to continue southeastwards.

7) High FE anomaly I between station No.12 and No.19 on Line T-1, is typical shallow anomaly with pants-legs shape. This anomaly is considered to reflect montmorilloniti-zation with pyritization near surface, because montmorillonite is detected by geological survey at PT-02 and PT-04 in the northeast of Ashuaca.

3-2-3 Drilling survey

3-2-3-1 Purpose of drilling survey

The purpose of the drilling survey is to clarify the mineralyzing condition in the deeper part of the mineralized outcrops which were confirmed through detailed geological survey.

3-2-3-2 Results of drilling survey

In the course of selecting the drilling site, following information were considered comprehensively: the results of detailed geological investigation and IP method electrical survey, both of which were carried out prior to drilling survey.

MJE-8 hole was drilled nearly at the center of the "Ashuaca mineralized zone" which was confirmed to consist of a number of mineralized outcrops accompanying chalcopyrite and pyrite. A principal group of outcrops consists of disseminated and networked zones of mineralization which develop in an area of about 50 m wide and 350 m long, extending in E-W direction.

Mineral paragenesis of the mineralized zone is a assemblage of chalcopyrite-pyrite-(molybdenite)-secondary biotite-chlorite-quartz. And these minerals occur in the interstices of brecciated parts of quartzdiorite as well as in xenoliths of andesite. Breccias of the host rock (HQd) are chloritized and silicified generally.

Surface around MJE-8 and MJE-9 is weathered intensely and covered with thick soil layer. Therefore, no geological and mineralogical information is available whether the rock is mineralized partly or completely.

Pit survey was adopted on the ridge area to acquire any information on the mineralization by observing surfaces of country rocks and/or collecting ore or soil (layer-"C") samples for chemical analysis. Investigation inside of pits revealed that limonite-quartz veinlets be common at the ridge top and rich in copper.

The mineralization, which is confirmed to be intense enough at the river floor of Q. Ugshacocha and Q. Ashuaca, is still desirable level of metal contents at the ridge top where drilling sites are located, the difference of altitude between them, river floor and ridge top for MJE-8 and 9, are 120 m and 150 m respectively.

IP anomaly in the vicinity of drill hole sites (MJE-8 and 9) were as follows: High Frequency Effect of 8 % and High Resistivity of 400 ohm-m.

Brief explanation of both drill holes are as follows (see Fig.II-3-6):

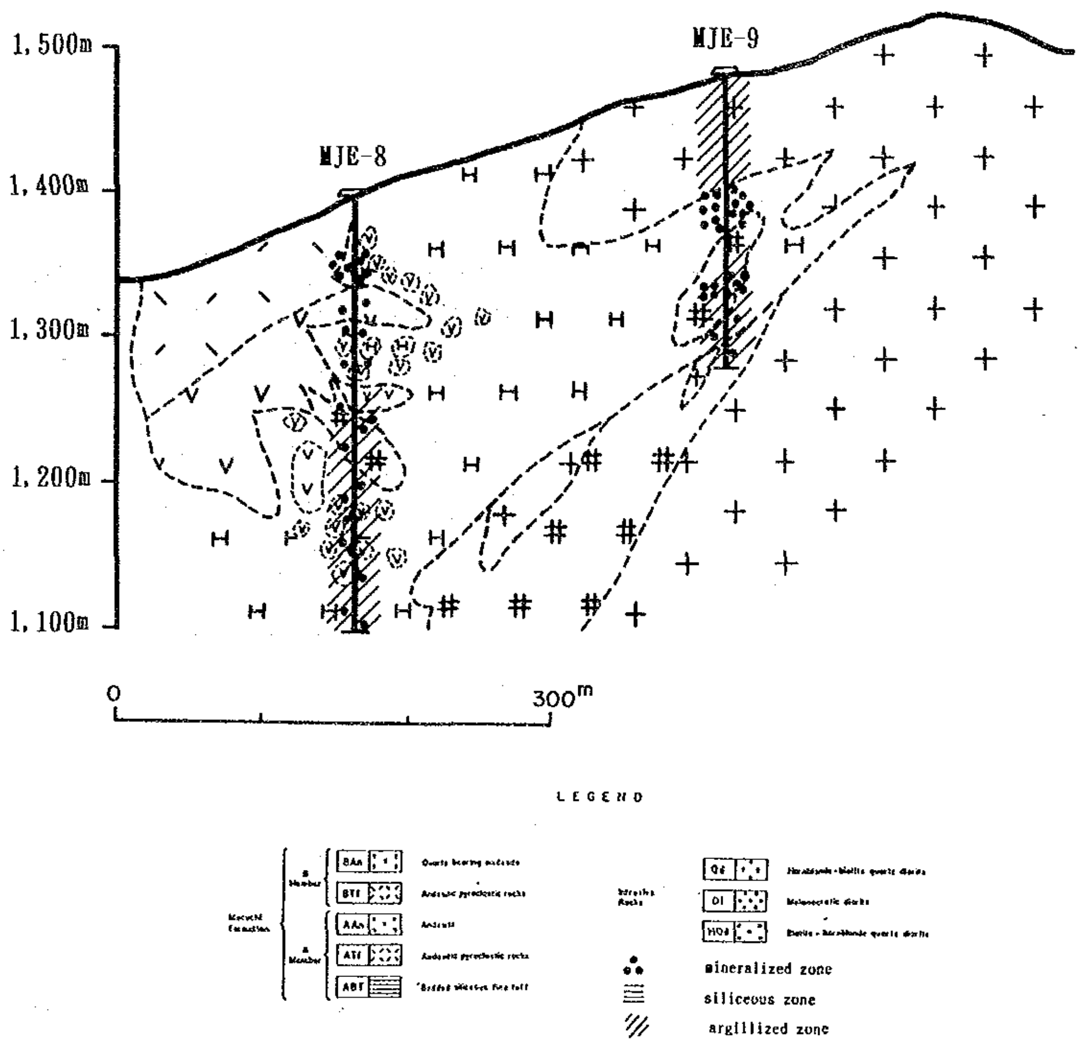


Fig. II-3-6 Geological section of drill holes MJE-8 and 9

(1) MJE-8

Location: (See Fig.II-3-3)

Latitude distance 9817.17 N

Longitude distance 707.40 S

Elevation ASL +1,400 m

Inclination: -90° (vertical)

Depth: 301.00 m

0 to 24.0 m

Masa of hornblende quartzdiorite

24.0 to 79.0 m

Pale green massive compact hornblende quartzdiorite (HQd). Contains breccias of andesite-hornfels as xenoliths, and brecciated intrusive rock (HQd) itself. Throughout the interval recognized are dissemination, films and/or patches of chalcopyrite and pyrite.

Hornblende-quartzdiorite (HQd) is recognized to be biotized intensely under the microscopic observation at the depth of 55.0 m. Rock forming minerals are also deformed by shear. Plageoclase altered partly to chlorite and epidote.

Polished section revealed that chalcopyrite was precipitated isolated mineral grains as large as 1 to 1.5 mm in diameter filling interstices of rock forming minerals and containing rounded micro grains (0.1 to 0.2 mm in diameter) of pyrite.

79.9 to 86.5 m

Hornfels-andesite. Mineralized in the form of dissemination and films of chalcopyrite and pyrite.

86.5 to 144.0 m

Pale green hornblende quartzdiorite (HQd) contains breccias of hornfels-andesite as xenoliths, and brecciated intrusive rock (HQd) itself. Throughout the interval, recognized are dissemination, films (and/or patches) of chalcopyrite and pyrite. The microscopic characteristics are that the host rocks are suffered intensely by propylitization, that deformation of rock forming minerals by shear, athat albitization and epidotization of plageoclase, and that complete chloritization and epidotization of biotite.

144.0 to 154.4 m

Dark gray andesite (An). Intense chloritization. Mineralized in the form of dissemination of chalcopyrite and pyrite.

154.4 to 161.6 m

Pale green hornblende quartzdiorite (HQd). Contains breccias of hornfels-andesite. Mineralyzed slightly in forms of dissemination and films of chalcopyrite and pyrite.

161.6 to 193.3 m

Dark gray to black medium grain, massive compact melanocratic quartzdiorite (Di). Intercalates four sheets of hornblende quartzdiorite, core lengths of which varies from 1.1 to 5.3 m. Mineralized in forms of dissemination (and films partly) of chalcopyrite and pyrite.

193.3 to 220.0 m

Pale green honblende quarzdiorite (HQd). Contains a number of breccias of hornfels-andesite. Mineralyzed slightly in forms of dissemination (and films partly) of chalcopyrite and pyrite.

220.0 to 229.2 m

Dark green andesite (An). Intense chloritization with mineralization in the form of films of chalcopyrite and pyrite. Quartz thin veins are also developed.

229.2 to 242.8 m

Pale green hornblende quartzdiorite (HQd). Partly chloritized and argillized. Mineralization in forms of dissemination and films of chalcopyrite and pyrite.

242.8 to 247.4 m

Dark bluish green andesite (An). Mineralized slightly in the form of dissemination of pyrite and chalcopyrite.

247.4 to 251.4 m

Green hornblende quartzdiorite (HQd), intense chloritization. Mineralized in the form of dissemination of chalcopyrite and pyrite.

251.4 to 265.0 m

Dark bluish green andesite (An). Brecciated completely and intruded by hornblende quartzdiorite along fractures. Mineralized slightly in the form of dissemination of pyrite and chalcopyrite.

265.0 to 301.0 m (Bottom)

Greenish blue hornblende quartzdiorite (HQd). Contains locally a number of breccias of andesite. Mineralized in the form of chalcopyrite and pyrite.

(2) MJE-9

Location: (See Fig.II-3-3)

Latitude Distance	9817.26 N
Longitude Distance	705.67 E
Elevation	1,470 m

Inclination: -90°

Depth: 205.00 m

0 to 27.8 m

Masa of biotite-hornblende quartzdiorite.

27.8 to 76.5 m

Gray, coarse, massive compact quartzdiorite (Qd). Contains a number of andesite breccias locally. Mineralized in the form of dissemination of pyrite, and only a few chalcopyrite.

76.5 to 104.0 m

Bluish green, medium grain, hornblende quartzdiorite (HQd). Mineralized in the form of dissemination of pyrite, chalcopyrite and molybdenite. Chloritization and epidotization are common throughout the inturval.

Microscopic observation in thin section of host rock (HQd) at the depth of 100 m revealed that the rock was propylitized intensely, and that rock forming minerals were deformed obviously by shear.

Plageoclase altered slightly to albite and epidote while biotite altered completely to chlorite and epidote.

Polished section of mineralized part at the depth of 93.2 m revealed dissemination of chalcopyrite of 0.1 to 0.3 mm in diameter or finer, and isolated pyrite grains of 0.3 to 0.4 mm in diameter. No magnetite was observed in the section.

104.0 to 125.3 m

Dark bluish green melanocratic quartzdiorite (Di). Intense hornfelsinization (with distinctive secondary biotite).

Mineralized in the form of dissemination of pyrite, chalcopyrite and molibdenite. Chloritization and epidotization are common.

125.3 to 169.4 m

Bluish green hornblend quartzdiorite (HQd). Contains locally breccias of dark bluish green porphyritic (and melanocratic) quartzdiorite. Mineralized in forms of dissemination and films of pyrite, chalcopyrite and an infinitesimal quantities of molibdenite.
Chlorite and epidote are also recognized commonly.

169.4 to 205.0 (bottom)
Dark greenish blue melanocratic quartzdiorite (Di). Dark green hornblende quartzdiorite intruded into this interval with a core length of 9.2 m.
Mineralized slightly in the form of dissemination of pyrite and chalcopyrite.
Chlorite and epidote are also recognized commenly.

3-2-3-3 Discussion

1) MJE-8

Considerable amount of chalcopyrite and pyrite have been observed on the cores from near surface through bottom of the hole.
Assay result of the interval between 21 m and 102 m in depth revealed as follows:
Core length 81 m, tr to 6.o g/t of Ag; 0.02 to 0.72 % of Cu, average 0.468 % of Cu.
Adding this, mineralized parts which contain copper contents more than 0.1 % are:

0.29 % of Cu from lo8 m to 110 m; 0.12 % of Cu from 124 m to 132 m; 0.32 % of Cu from 170 m to 172 m.

Intensely cu-mineralized part of the hole are recognized not only where the host rock includes a number of breccias of the Macuchi Formation but also where the host rock is brecciated itself completely.
cu-mineralization is comfirmed to exist down to the bottom of the hole.

2) MJE-9

Through the core of MJE-9, Cu-mineralization of chalcopyrite accompanying with pyrite and molibdenite, are observed as intensely as MJE-8.
Mineralized parts more than 0.1 % Cu are as follows:

Tr to 2.6 g/t of Ag; 0.10 to 0.32 % of Cu, average 0.229 % of Cu from 80 to 105 m: 0.1 to 4.7 g/t of Ag; 0.08 to 0.55 % of Cu, average 0.207 % of Cu from 124 to 161 m.
Adding those mineralized part assay result more than 0.1 % Cu are as follows: 0.19 % of Cu from 36 to 37 m; 0.12 % of Cu from 52 to 53 m; and 0.17 % of Cu from 116 to 117 m.

3-2-4 Consideration of the survey results in Northeast zone, Telimbela area

1) "Ashuaca mineralized zone" croped out in and along Q. Ugshacocha river containes chalcopyrite, pyrite and molybdenite. Hornblende quartzdiorite, which intruded into biotite quartzdiorite, has been determined its age and revealed to be 14.5 Ma. Therefore, hornblende quartzdiorite is now considered to be younger than any other intrusive rocks ever observed in this Project area.

2) Intense mineraized part of the zone are exist in and near the fructure structure. And principal ore-minerals are to be chalcopyrite and molibdenite adding to pyrite.

3) Drill hole MJE-8 and 9 revealed that considerable amount of chalcopyrite are still sbserved at and near the bottom of the holes.
Those minerals were precipitated in the open spaces of cracks of Hornblende quartzdiorite body.

4) IP anomalies are delineated at the northern and southern Ashuaca mineralized zone.
They are considered to be some indication of deeper mineralized zone which extends horizontally and vertically from mineralized outcrops observed along the Q. Ugshacocha and Q. Ashuaca.
Exact posision of which are apart slightly from these drill holes MJE-8 and 9.

5) Moderate IP anomaly was pointed out through the coarse of prossessing geophysical data, and considered to indicate pyrite dissemination in the melanocratic quartzdiorite body, which distributes widely to the southern part of Ashuaca. This pyrite disseminated zone situates, macroscopically, as a outer part (pyrite rich zone) of the mineralized area.

6) A IP anomalous zone with low conductivity and high FE "called anomaly F" is picked up. Anomalous zone consists of two anomalies, one is of shallow part and the other of deep. Former corresponds to pyrite disseminated zone observed at surface outcrops, but latter may be, possibly, of blind deposits.

7) A IP anomaly distributed to the north of Ashuaca shows shallow part anomaly, which corresponds to extensive montmorillonite zone accompanying with pyrite mineral.
Therefore potentiality of deposit is low.

8) Ashuaca area including drill hole sites (MJE-8 and 9)is expected to have potentiality of mineral ore deposits.

Chapter 4 La Industria-Yatubi area

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

4-1 Geological survey

4-1-1 Geology

The area is underlain by granitic rocks (Fig.II-4-1). Almost all granitic rocks are quartz diorite (Qd) which is considered to be batholith. Also five melanocratic diorite dykes (Di) are observed 10 to 120 m wide trending toward the NNW-SSE. The quartz diorite was dated as 25.5 ± 0.9 Ma by the K-Ar method in the Phase I survey.

4-1-2 Geological structure

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

4-1-3 Mineralization and alteration

The geological investigation has revealed the occurrence of bimodal mineralizations; porhyry copper type and hot spring type in the area. The porphyry copper type mineralization occurs as four zones with each strike of 100 to 300 m long in quartz diorite along the middle stream of San Antonio valley and its tributaries. One of which is dissemination of chalcopyrite and pyrite, and others are of predominantly pyrite in argillized silicified zone. The former assayed to be 0.05 % Cu. A X-ray diffraction analysis of the sample from the altered zone showed the alteration mineral assemblage of quartz-chlorite.

Hot spring type ;mineralization is suggested by presence of numerous 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 x 700 m in the southwestern part of the

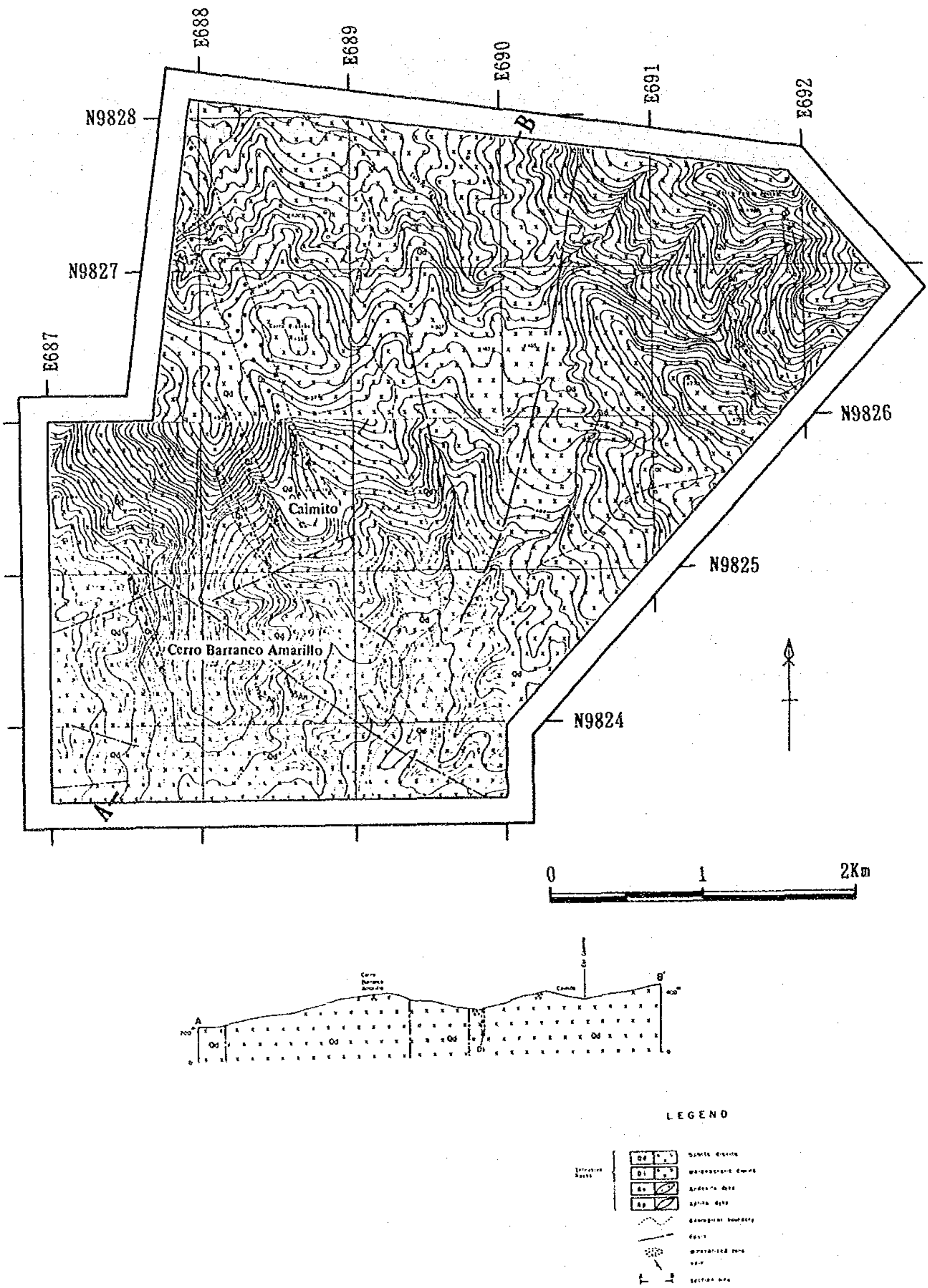


Fig. II-4-1 Geological map of the La Industria-Yatubi area

area. The analytical results of the representative samples showed the contents of 0.3 g/t Au, 16.3 g/t Ag and 0.03 % Cu. Through the Phase II survey detected are a couple of outcrops at the following two places, which are considered to to be a part of hot spring type gold ore deposit and a source of boulders (Fig.II-4-1):

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

Since the survey area is covered with surface soil by weathering, the entire extension of this mineralized zones is not disclosed yet. However, the scale of each outcrop is estimated as follows:
(1) CBA mineralized zone: Two outcrop: 100 m + * and 50 m + * are distributed for about 1 km along the ridge trending toward the N-S.
(2) Caimito South mineralized zone: Outcrops and boulders are scattered for about 100 m in the southern slope near the summit.

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

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

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

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

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

4-1-4 Magnetic susceptibility measurement

Data of the magnetic susceptibility measurement were analyzed in the same manner as in the Chaso Juan area. The obtained map is shown together with the locations of the mineral showings in Fig.II-4-2.

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

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

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

4-1-5 Geochemical survey

(1) Purpose and method of survey

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

(2) Results of analyses

1) Univariate analysis

The concentration was classified into five grades respectively, and numerical values of EDA were used for the boundary value.

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

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

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

3) Copper: Anomalous zones, more than 72.5 ppm threshold value, were widely detected in a slope along small valley including white argillized alteration zone in eastern slope of CBA (Fig.II-4-3(1)), in white clay alteration zone in the west of the Caimito South mineralized zone and in the silicificated alteration zone (porphyry copper type mineralized zone) on its southern side where limonite veinlets are locally observed. In addition, small scale anomalous zones were detected at three places in the western slope of CBA.

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

5) Zinc: Anomalous zones, more than 83.0 ppm threshold value, were detected below a steep

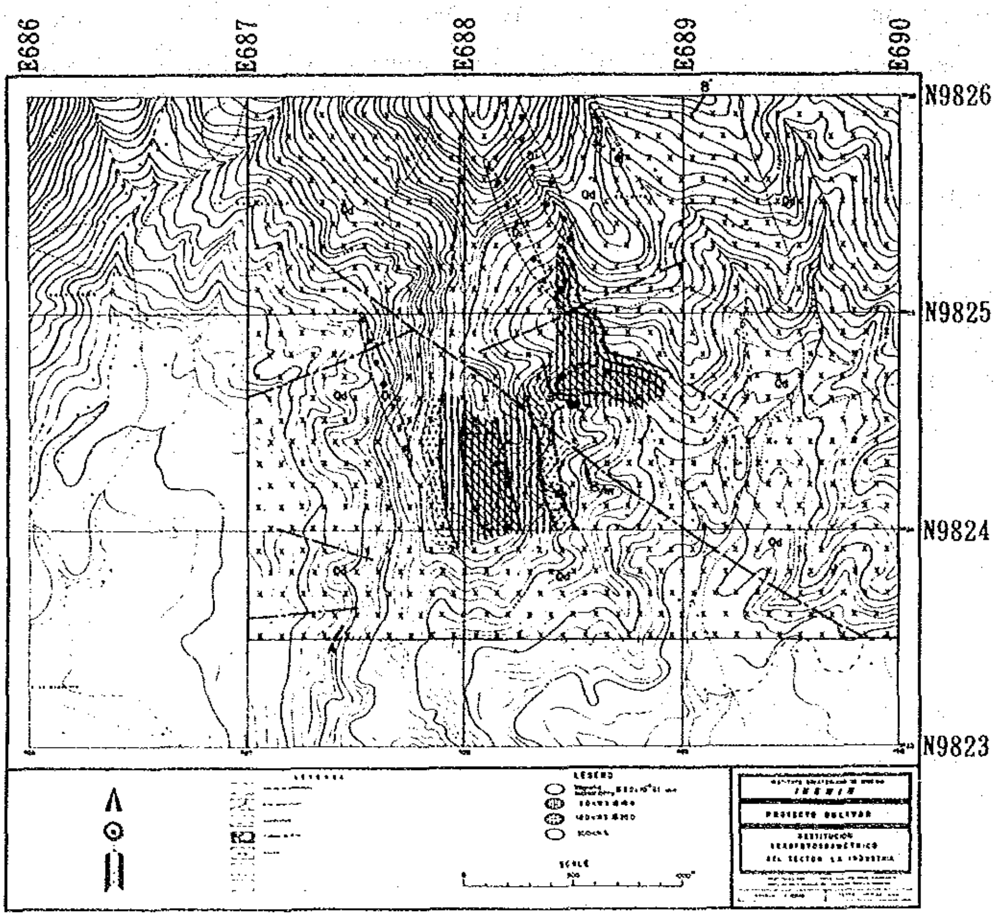


Fig. II-4-2 Interpretation map of magnetic susceptibilitity of the La Industria-Yatubi area slope in the west of CBA, middle scale anomalous zones in a part of eastern slope of CBA and about 1 km southeast of the Caimito South mineralized zone (Fig.II-4-3(3)).

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

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

8) Mercury: High anomalous zones, more than 288.0 ppb threshold value, were observed on the ridges right above the Caimito South mineralized zone and southeast of the said mineralized zone (Fig.II-4-3(5)). Low anomalous zones more than 225.0 ppb in auxiliary threshold value are distributed in middle scale around the high anomalous zones, and also are scattered at two places in the southwestern to western slopes of the CBA, and in small scale along the ridges in the northeast and north of the CBA.

2) Multivariate analysis

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

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

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

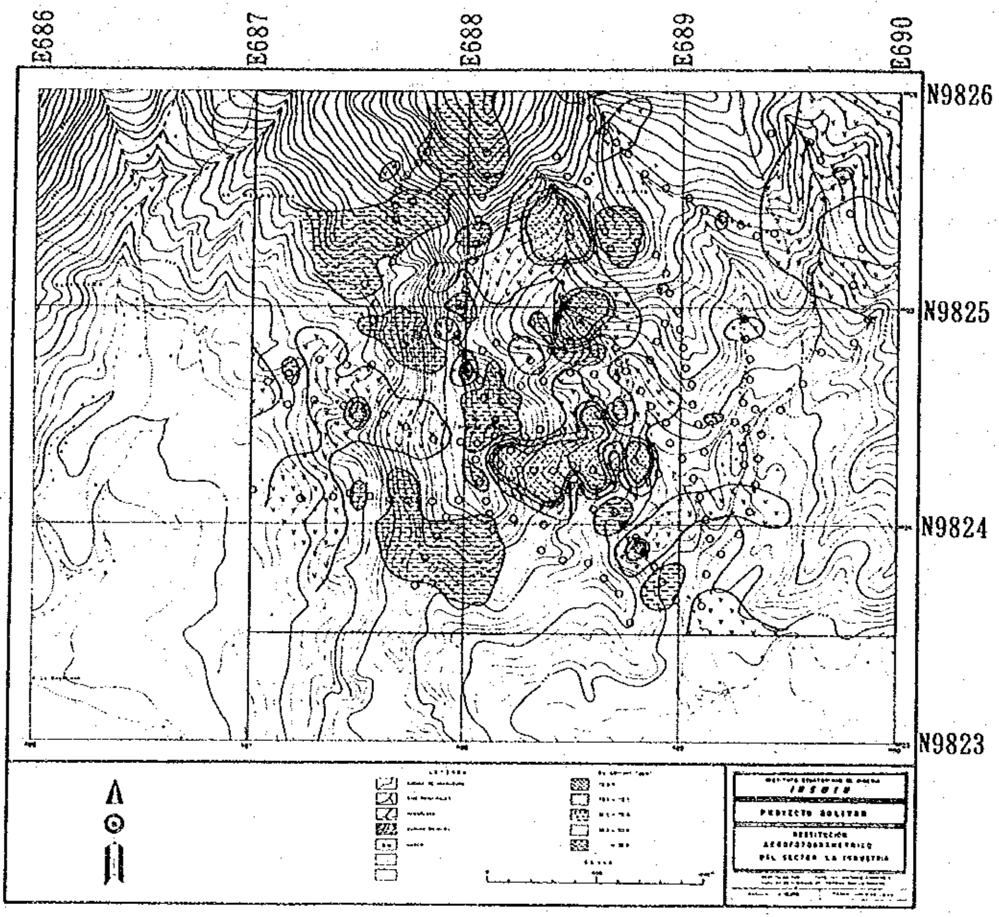


Fig. II-4-3(1) Distribution map of minor element in soil of the La Industria-Yatubi area(Cu)

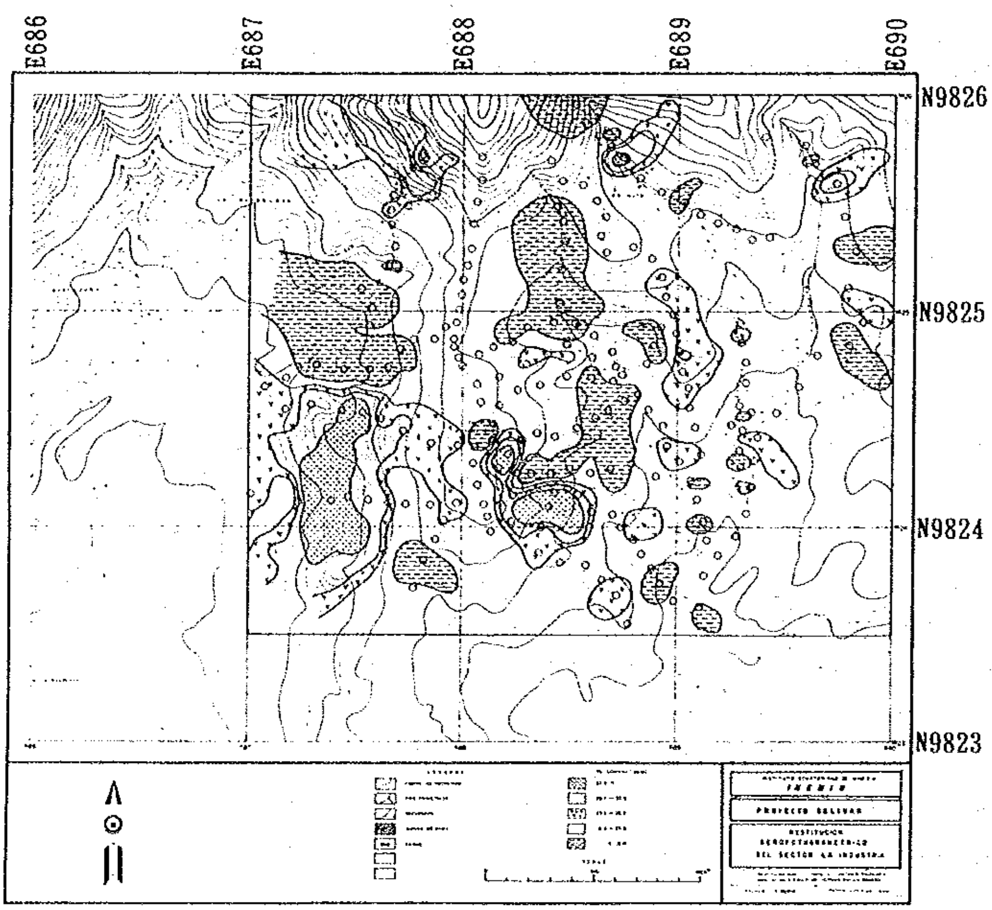


Fig. II-4-3(2) Distribution map of minor element in soil of the La Industria-Yatubi area(Pb)

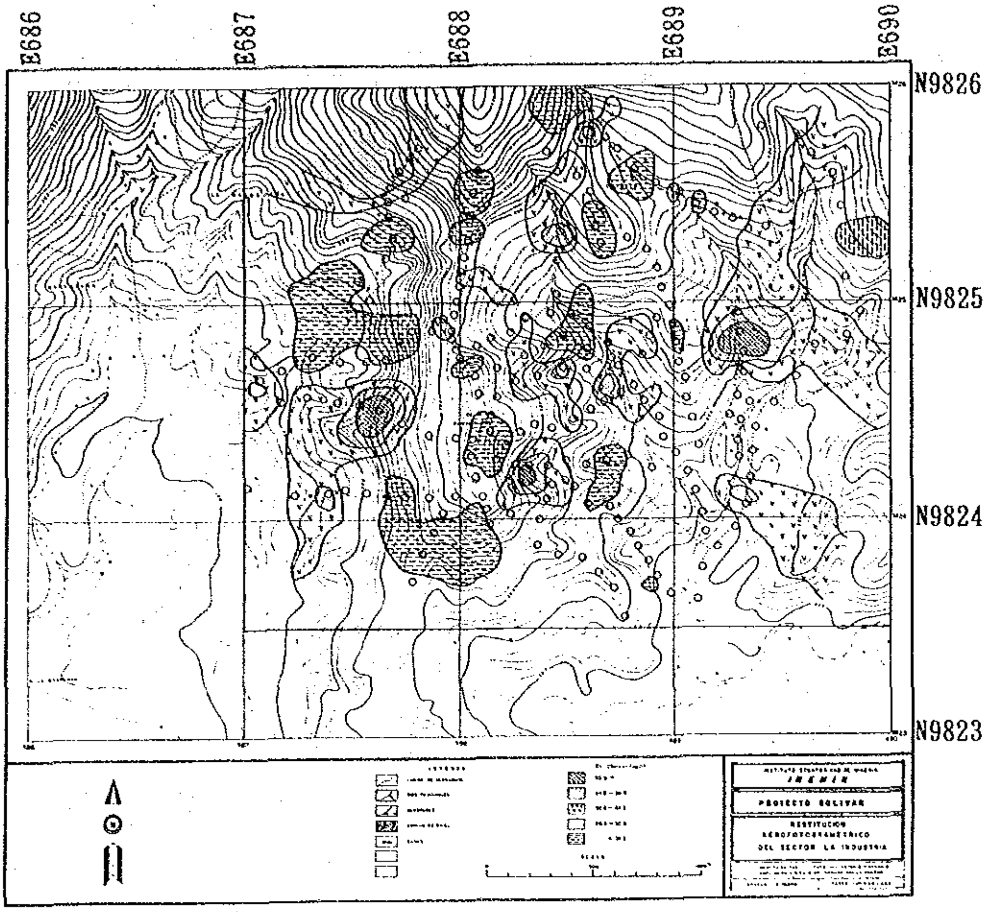


Fig. Ⅱ-4-3(3) Distribution map of minor element in soil of the La Industria-Yatubi area(Zn)

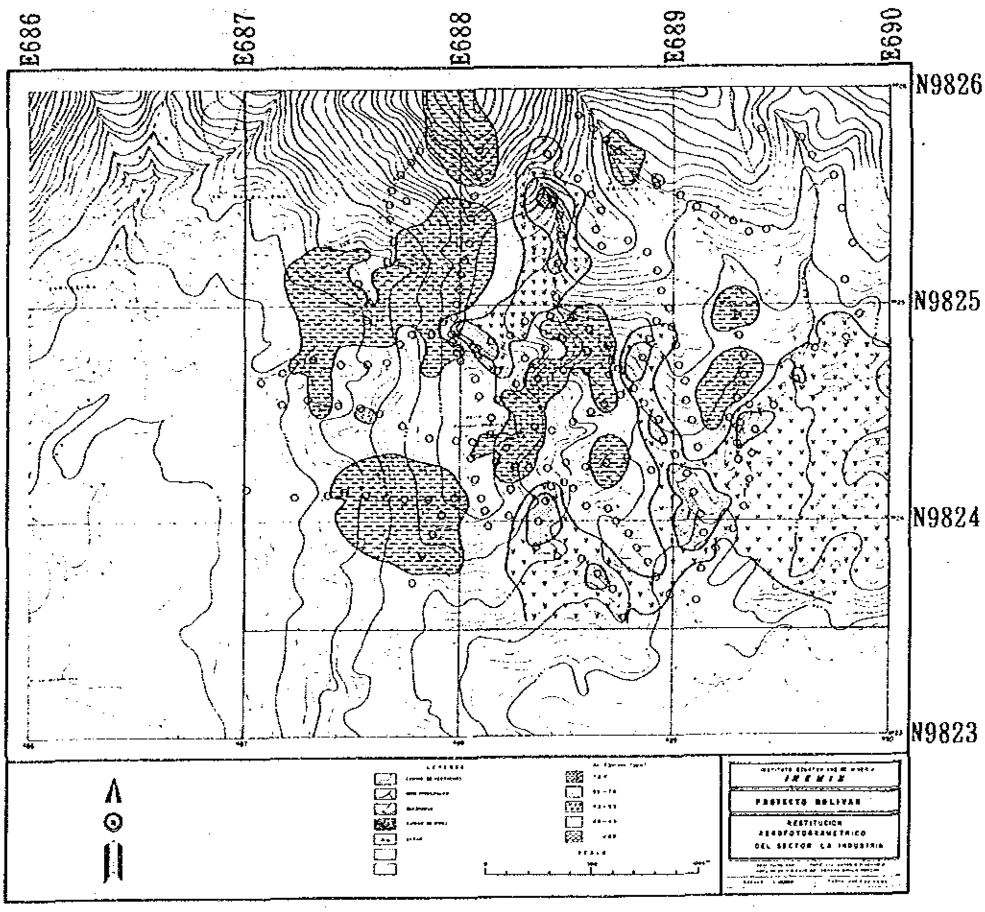


Fig. Ⅱ-4-3(4) Distribution map of minor element in soil of the La Industria-Yatubi area(As)

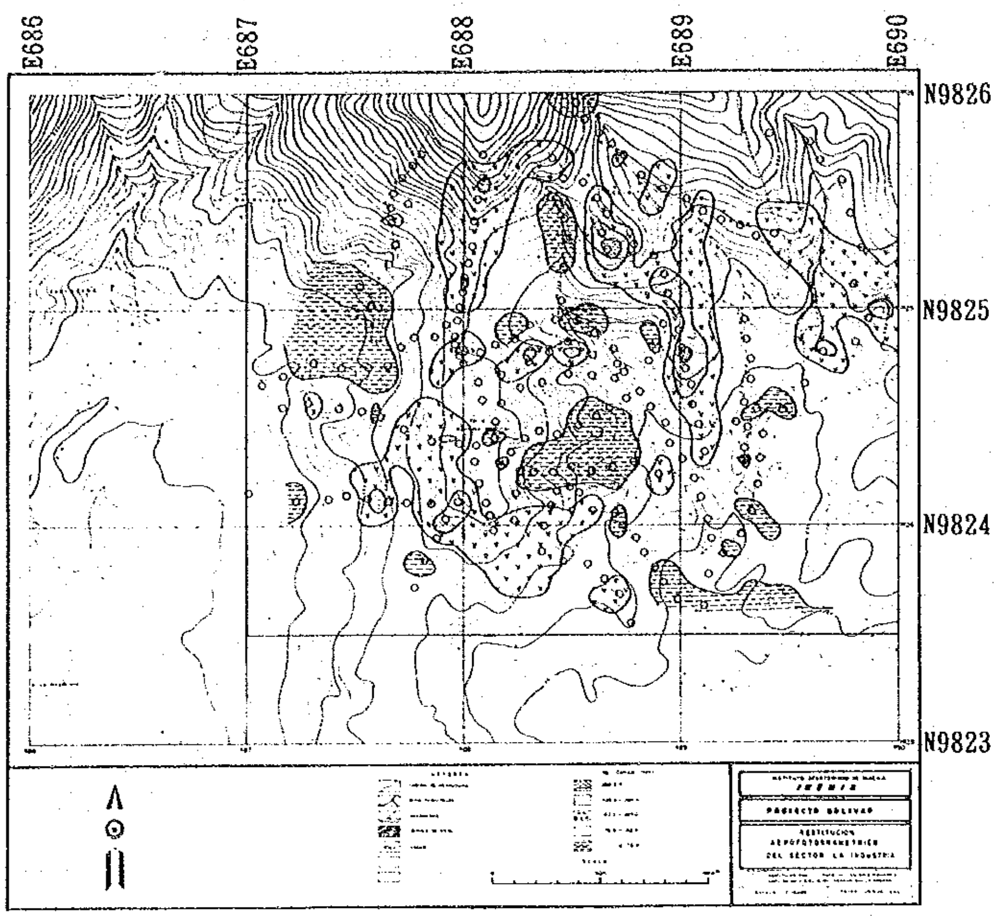


Fig. II-4-3(5) Distribution map of minor element in soil of the La Industria-Yatubi area(Hg)

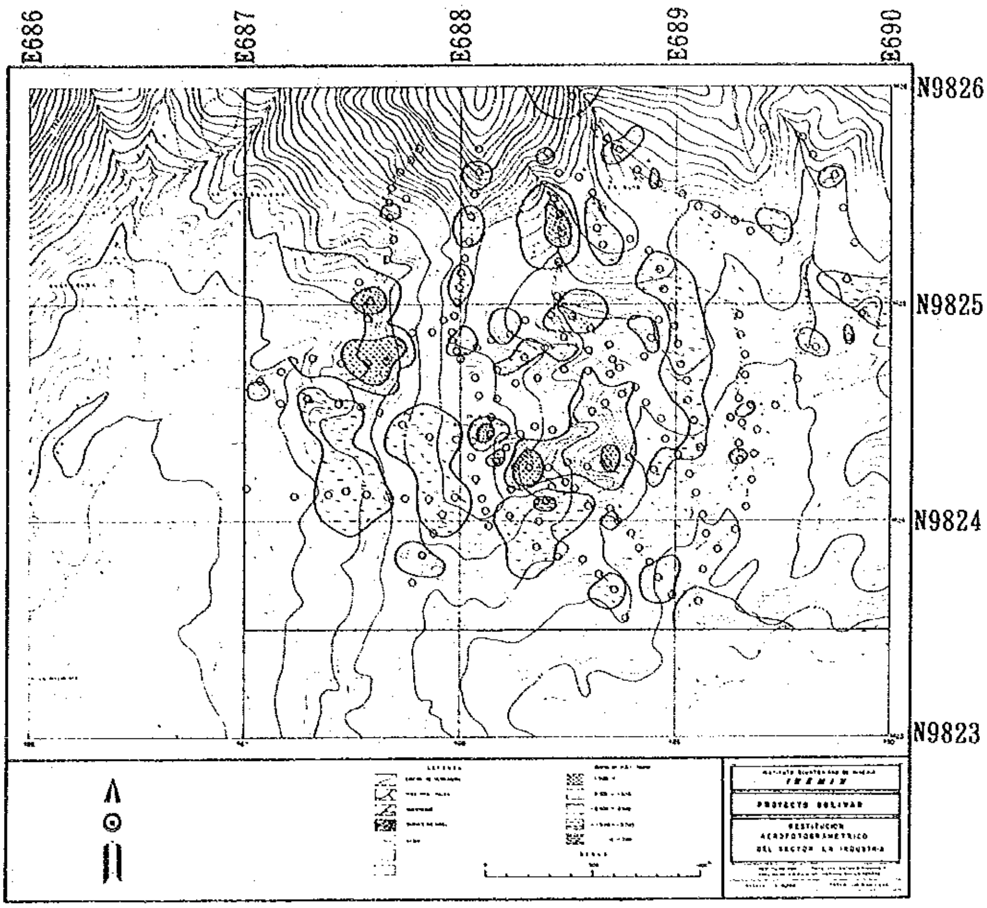


Fig. II-4-4(1) Distribution map of factor score of the La Industria-Yatubi area(Hg-Pb)

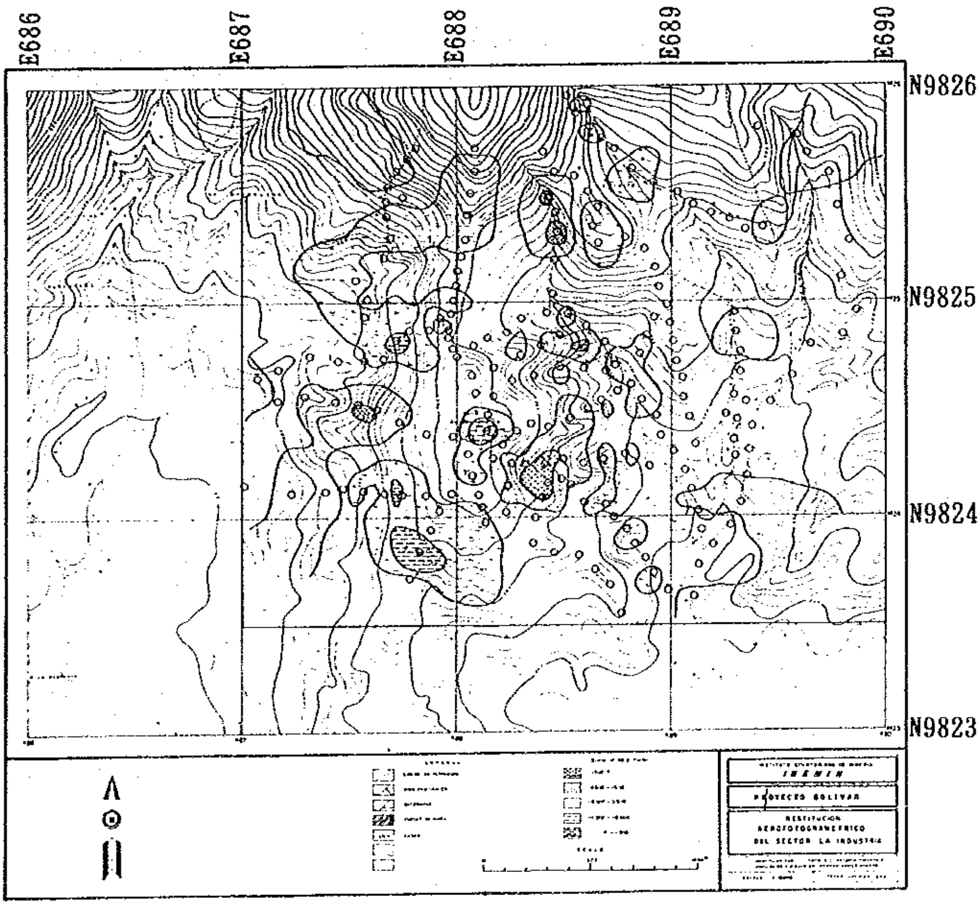


Fig. II-4-4(2) Distribution map of factor score of the La Industria-Yatubi area(Zn-Cu) of the area, in addition, in the silicificated zone at the mountaintop of CBA and Caimito South mineralized zone.

(3) Discussion

A comprehensive geochemical anomalies (Fig.II-4-5) were detected through determining process of the threshold value for each element by univariate analysis and anomalous factor score zones (positive and negative) for both factors by multivariate analysis (factor analysis). Comprehensive geochemical anomalous zones were selected and delineated at four places, where anomalies are overlapped, by means of superimposing geochemical anomalous zones for each element, and high and medium score zones for each factor. Constituents for each comprehensive geochemical anomalies are shown in Fig.II-4-6, which consist of geochemical anomalous zones of each element, and high or medium factor scores (called "anomalous" in Fig.II-4-6).

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

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

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

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

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

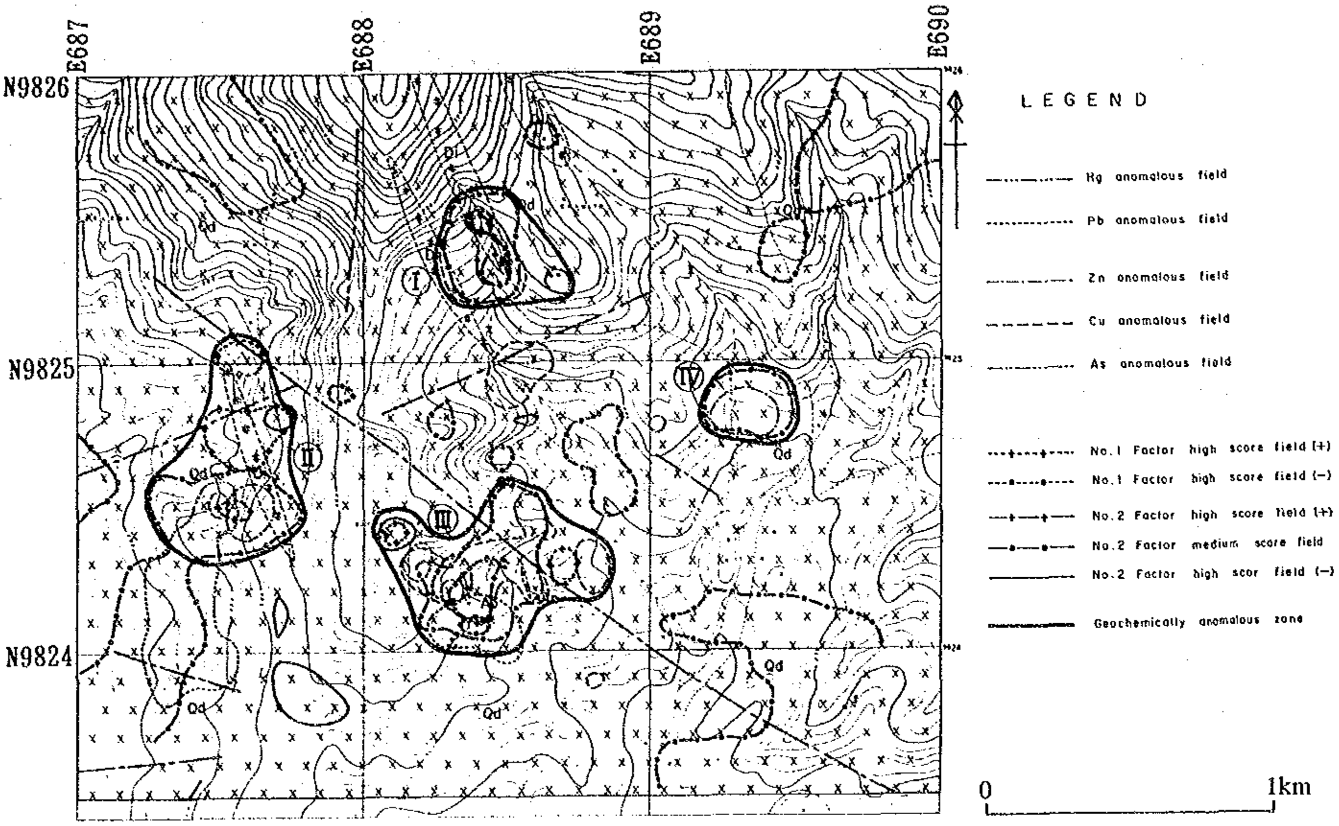


Fig. II-4-5 Synthetic geochemical anomalous zone map of the La Industria-Yatubi area

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

Fig. II-4-6 Constituents of synthetic geochemical anomalous zones